TEXTILE AND SPORTS INDUSTRY (ASSESSING DECARBONIZATION AND GROWTH POTENTIAL)

Alternate
Development Services

ISBN: 978-969-23709-1-2.

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Edition: November 2023.

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Acknowledgements

Alternate Development Services (ADS) extends its heartfelt gratitude to the industries, their representatives, and the corresponding associations who actively participated in this study and generously shared their invaluable insight, information, and feedback. Their cooperation and contributions have been instrumental in advancing our understanding of energy consumption, renewable energy transition plans, challenges, and policy recommendations within the textile and sports/apparel manufacturing sectors. Their commitment to sustainability and environmental stewardship is greatly appreciated and will undoubtedly pave the way for a greener, cleaner, and sustainable future.

The ADS team is particularly indebted to the following individuals for their helpful contribution in this study: Mr. Tariq Tayyab (Additional Secretary-PTEA Faisalabad), Ms. Mashal Hassan (Deputy Secretary-PTEA Faisalabad), Mr. Rao Dilshad Ali (Secretary General-ABPUMA, Multan), Mr. Hameed (Deputy Director-Environmental Protection Agency, Multan), Mr. Muhammad Shameel (Additional Secretary General-RCCI, Rawalpindi), Mr. Bilal Sharif (Deputy Secretary Finance-FCCI), Mr. Muhammad Shafiq (Secretary General-MCCI), Zahida Khan (CEO-PHDF, Faisalabad), Saima Fiaz and Zahida Khan (Program Managers - PHDF), Waseem Ashraf (Project Coordinator-WWF Faisalabad), Mr. Milad Hussain (Project Manager WWF Multan), Rana Muhammad Hammad (Secretary

General- SMCCI Multan), Mr. Dr. Muhammad Sultan (Associate Professor-BZU Multan), and Mr. Amir Shirazi (Textile College Multan).

We would like to extend our profound gratitude to Mr. Khwaja M. Hussain (CEO-ALM Groups of Industries, Multan), Mr. Abdul Haq (CEO, Hide and Textile Industries, Multan), Mr. Aasim Shah (CEO -Rainbow Industries, Multan), Mr. Farooq Shah (Director-Rainbow Industries, Multan), Mr. Muhammad Umar Farooq (Director-Noor Fatima Mills, Faisalabad), Mr. Ishfaq (Associate Boiler Engineer-Moon Textile, Faisalabad), Mr. Muhammad Arshad (Manager-Dawood Textile, Faisalabad) and Mr. Najam Tariq (Maintenance Engineer - Sitara Textile, Faisalabad).

Amjad Nazeer
CEO – Alternate Development Services.
Islamabad
18 November 2023.

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Acronyms

3D	Three-dimensional
ADS	Alternate Development Services
AGOA	African Growth and Opportunity Act
ALM	Alif Lam Meem Group of Industries, Multan
BZU	Bahauddin Zakariya University, Multan
CAD	Computer-Aided Design
CEO	Chief Executive Officer
CNC	Computer Numerical Control
CO_2	Carbon Dioxide
COP	Conference of the Parties
CPEC	China-Pakistan Economic Corridor
EPA	Environment Protection Agency
ERS	Export Refinance Scheme
EU	European Union
FESCO	Faisalabad Electric Supply Company
FGDs	Focus Group Discussions
FIFA	French for International Association Football Federation
GIZ	German Government International Aid Agency
HFO	Heavy Fuel Oil
HR	Human Resource
IC Engine	Internal combustion Engine
KIIs	Key Informant Interviews
KVA	Kilovolt-Ampere
kWh/kg	Kilo Watt Hour Per Kilogram
kWh/m^2	Kilo Watt Hour Per $Meter^2$
LCA	Life Cycle Assessment
LNG	Liquefied Natural Gas
LTFF	Long-Term Financing Facility
MCCI	Multan Chamber of Commerce and Industry

MW	Megawatt
NAMA	Nationally Appropriate Mitigation Action
NCCP	National Climate Change Policy (Pakistan)
NDCs	Nationally Determined Contributions
NEQS	National Environmental Quality Standards
NUST	National University of Science and Technology
MCSTSI	Multan Chamber of Small Traders and Small Industry
ABPUMA	All Pakistan Bedsheets & Upholstery Manufacturer Association
PRGMEA	Pakistan Readymade Garments Manufacturers and Exporters Association
PSGMEA	Pakistan Sports Goods and Manufacturers Exporters Association
PTEA	Pakistan Textile Exporters Association
PV	Photovoltaics
R & D	Research and Development
RCCI	Rawalpindi Chamber of Commerce and Industry
RLNG	Re-Gasified Liquefied Natural Gas
SBP	State Bank of Pakistan
SCCI	Sialkot Chamber of Commerce and Industry
SDGs	Sustainable Development Goals
SDPI	Sustainable Development Policy Institute
SDSC	Sustainable Development Study Centre
SESCO	Sialkot Electric Supply Company
UMT	University of Management and Technology
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
WAPDA	Water and Power Development Authority
WWF	Worldwide Fund for Nature

Chapter 1:
Methodology and Introduction

1. Methodology Adopted and Introduction

1.1. Methodology

The study has adopted a robust methodology encompassing literature review, site visits and experts' and executives' interviews to collect primary data. The ADS team first conducted a desk review, followed by on-site observation and analysis that encompassed both qualitative and quantitative assessments of the industries' sources of energy and plans for renewable energy transition, if any. These methods provided insight into the operations, processes, and challenges experienced by these industries, complementing the broader context offered by secondary sources. Subsequently, an in-depth analysis of the data gathered identified patterns, trends, the obstacles that industries face, contributing to a comprehensive understanding of the state of industrial decarbonization processes in Pakistan. Particular attention has been devoted to understanding the processes and mechanisms that contribute most to the emissions, highlighting potential areas for intervention to decarbonize the industry.

1.1.1. Desk review

The ADS team commenced the study by diligently studying and gathering information from various external and secondary sources. Initial skimming through and literature review developed the ADS team's reasonable understanding of the concerned industries' scale of energy consumption and carbon emission within the target areas. Additionally, the team delved into understanding the co-relation the national and international commitments and agreements like Paris Climate Agreement, Nationally Determined Contribution (NDC) and Net-Zero by 2030 etc.

with the industry (in this case textile and sports/apparel industry), all of which are geared towards assuming renewable sources of energy, as well as curbing and mitigating emissions.

This holistic approach to data acquisition served as a solid foundation for the subsequent phases of our research, providing critical insights into the current state of affairs and the broader context surrounding environmental sustainability and carbon reduction efforts in the country. The research in hand looks into and introduces a broader picture of the existing situation along with policy and practical preferences to approach net zero within the stipulated time frame.

1.1.2. Primary data collection

1.1.2.1. Qualitative survey

The ADS team conducted Key Informant Interviews (KIIs) with the representatives of 12 textiles and 15 sports/apparel industries. The aim was to capture the respective representatives' insights on various aspects, including their energy needs, existing energy mix and energy tariffs, the forms of energy or heat generation sources industries are using, their energy transition plans and strategies (if any), the challenges industries face in adopting renewable means of energy, the cost benefit equation, they (industries) are considerate about, their (industries) intentions or initiatives for decarbonization in their respective textile operations and their comments or criticism of the government policies, their system of energy production and transmission and their role in promoting or obstructing in the process of transition from conventional fuels to renewable energy sources meant to reduce carbon emissions.

1.1.2.2. Quantitative survey

The ADS team also drew a comprehensive quantitative analysis of the textile and sports/apparel industries, primarily focusing on gathering statistical data that was later on tabulated and transformed into graphs and illustrations. The team developed a survey questionnaire to assess the current sources of energy used by the select textile industries, their objectives regarding the shift from traditional energy to renewables, and the initiatives they have undertaken or planning to undertake to mitigate carbon emissions within their operations. In total the team filled the questionnaire with 16 pertinent questions to assess the current sources of energy, transition potential, future plans and obstacles on the way. The precise analysis allowed the team to gain valuable insights into the energy consumption patterns of the industries – in the textile as well as sports sector. The quantitative analysis incurred helped the team to delineate the current energy profile and their potential for transitioning towards sustainable, environmentally friendly, and eco-friendly practices.

1.2. Introduction

The combustion of fossil fuels for industrial processes, energy production and transportation induces significant amount of CO2 emissions. These high emissions contribute to global warming and climate change, which in turn lead to problems like increased frequency and intensity of extreme weather conditions, rise in seas level, and loss of biodiversity. Like many other countries Pakistan is also facing environmental issues. As of the National Greenhouse Gas Inventory 1994

- 2015, the energy sector is the largest contributor to greenhouse gas emissions in Pakistan, responsible for 50.8% of the emissions. The sector encompassing all of the industrial processes and product use sector is responsible for 8.2% of emissions[i]. According to the Pakistan Energy Yearbook 2018, the industrial sector consumed 37.5% of the total energy in Pakistan, behind only the transport sector[ii]. Pakistan's industrial sector forms a crucial segment of the national economy, contributing significantly (28.11%) to the Gross Domestic Product (GDP).

Among the myriad of industries, textile, sports, leather, and fashion industries are vital pillars of Pakistan's industrial growth and economic sustenance. The textile industry in Pakistan has traditionally been a dominant sector, both in terms of its contribution to the GDP and employment generation. It is the country's largest manufacturing industry, accounting for around 60% of the total exports, contributes about 8.5% to the GDP and employing about 45% of the total labor force in the country[iii]. From the cultivation of cotton to the fashion markets, the textile industry forms an integrated manufacturing sector that includes spinning, weaving, processing, and garment manufacturing[iv].

The sports goods manufacturing industry of Pakistan primarily located ins Sialkot, enjoys a prominent position in the global market, notably in the production of hand-stitched footballs, exports goods to over 100 countries while producing about 70% of the total world's hand-sewed footballs (around 40 million pieces annually). This niche dominance resulted in these balls being used in several FIFA World Cups[v]. The industry provides direct and indirect employment to a significant part of the population, 500,000 to 550,000 to be precise[vi].

Pakistan's leather industry, another major contributor to the economy, provides raw materials and finished products to the domestic and international markets. Pakistan's leather goods, including footwear, garments, and accessories, are exported worldwide. As stated by the Pakistan Tanners Association, it contributes nearly $1 billion in foreign exchange annually. This industry provides direct employment to more than 500,000 people, demonstrating its vital role in the labor market. The leather industry in Pakistan, while being a significant contributor to the economy, is also energy-intensive. The tanning process, in particular, requires substantial energy input for various processes such as curing, dyeing, and finishing.

The energy sources used in this industry often include electricity and fossil fuels like natural gas, coal, and oil[vii]. The fashion industry, though comparatively new, has seen rapid growth in Pakistan over the past few decades. With the rise of home-grown fashion labels and designers, Pakistan's fashion industry is slowly but steadily gaining international recognition. The fashion and apparel industry is burgeoning in Pakistan. As per a report by the Pakistan Readymade Garments Manufacturers and Exporters Association (PRGMEA), ready-made garment exports contributed around $2.3 billion to the economy in the fiscal year 2018-2019, showing its substantial economic importance. The fashion industry also has energy-related considerations. Manufacturing textiles and garments involves processes like spinning, weaving, dyeing, and sewing, which require energy, especially electricity. Pakistan's energy crisis and irregular electricity supply can impact the production and efficiency of these processes. To mitigate the energy challenges, both of these industries could invest in backup power solutions, energy-efficient machinery, improved supply chain management, sustainable renewable energy integration, energy audits, waste management and policy support[viii].

Pakistan's National Climate Change Policy 2012 recognizes the need to promote cleaner production and energy efficiency in the industrial sector, and the implementation framework for this policy proposes several specific measures such as encouraging the use of cleaner fuels, promoting energy-efficient technologies, and establishing a cleaner production center[ix]. The Government of Pakistan has introduced several policies to boost the industrial sector. For instance, the Textile Policy 2014-19, aimed to enhance the textile industry's output by offering various incentives, including subsidized energy supply and technological upgrades[x]. Similarly, the Leather Export Promotion Policy 2022 aimed to maximize leather exports by addressing issues related to raw material availability and modernizing the manufacturing process[xi]. However, these industries also face significant challenges.

Energy crises, high production costs, and technological backwardness are some of the fundamental issues plaguing Pakistan's industrial sector. International competition, coupled with changing global trade scenarios like the advent of the African Growth and Opportunity Act (AGOA) and the China-Pakistan Economic Corridor (CPEC), also pose considerable challenges and opportunities for these industries. As for the fashion and sports industries, there is a lack of targeted policy intervention. However, schemes such as the Long-Term Financing Facility (LTFF) and the Export Refinance Scheme (ERS) do offer indirect support by facilitating access to finance for exporters[xii].

Pakistan actively participates in global climate change agreements to contribute to international efforts in mitigating climate change and adapting to its impacts. Pakistan is a signatory to the United Nations Framework

Convention on Climate Change (UNFCCC) and the Paris Agreement. These agreements provide a framework for global cooperation and aim to limit global temperature rise and enhance climate resilience.

The United Nations Framework Convention on Climate Change (UNFCCC) was adopted in 1992 and serves as the foundation for international efforts to combat climate change. Pakistan has been an active participant in the annual Conference of the Parties (COP) meetings under the UNFCCC, where countries negotiate and discuss climate change-related issues. Pakistan has consistently voiced its concerns and priorities, highlighting the challenges faced by developing countries in addressing climate change. The Paris Agreement, adopted in 2016, builds upon the UNFCCC and aims to keep the global temperature increase well below 2 degrees Celsius above pre-industrial levels and pursue efforts to limit it to 1.5 degrees Celsius. As a signatory to the Paris Agreement, Pakistan has committed to contributing to global efforts to reduce greenhouse gas emissions, enhance climate resilience, and support sustainable development.

1.2.1. Importance of decarbonization for sustainable industrial development

Decarbonization, or lowering carbon emissions and moving to a low-carbon economy, is critical to attain long-term sustainable industrial development. In an era when industries like textile, sports, and fashion are significant contributors to global carbon emissions, decarbonization is a strategic and environmental obligation.

1.2.2. Environmental and atmospheric aspect

From an environmental perspective, the textile, sports, fashion, and leather industries are known to have high levels of carbon emissions. These come from energy use in manufacturing processes, the extraction and processing of raw materials, and the use and disposal of products. By decarbonizing these industries, Pakistan can reduce its overall greenhouse gas emissions, and may contribute to global efforts to mitigate climate change[xiii].

1.2.3. Economic aspect

From an economic perspective, decarbonization can foster innovation and lead to the development of new and more efficient technologies. These efforts can reduce costs in the long run and make industries more sustainable and competitive. For instance, renewable energy sources, such as solar and wind energy are cost-effective and environment friendly alternative to fossil fuels for powering industrial processes[xiv]. Additionally, there is a growing global market for sustainable products. Embracing decarbonization presents a dual advantage for companies in Pakistan.

By adopting eco-friendly practices, businesses can tap into the growing market of environmentally conscious consumers, while also positioning themselves for increased exports and economic growth. This shift towards sustainability not only differentiates companies in the market but also aligns with global trends and addresses Pakistan's pressing environmental challenges, ultimately fostering innovation, job creation, and long-term resilience to climate risks[xv].

1.2.4. Social aspect

From a social perspective, decarbonization is important for improving public health and living conditions. Industrial emissions are a significant source of air pollution, which is linked to a wide range of health problems, including respiratory diseases and premature death. By reducing these emissions, the quality of air can be improved, and public health outcomes can be bettered[xvi]. Furthermore, climate change is a threat to social stability, as it can exacerbate problems like poverty and inequality.

For example, extreme weather events can destroy homes and livelihoods, particularly among the poor who are least able to adapt. In Pakistan, specific instances of extreme weather events underscore the imperative of decarbonization. The 2008, 2010 and 2022 floods displaced millions, exposing the susceptibility of impoverished communities to climate-induced disruptions; a shift to cleaner energy sources is essential to curtail these events exacerbated by global warming.

Similarly, the 2015 Karachi heatwave led to over 1,200 fatalities and highlighted the urgency of reducing carbon emissions to mitigate the escalating frequency and intensity of such heatwaves. Additionally, the country's water scarcity and recurrent droughts, attributed to climate change, necessitate decisive decarbonization measures to conserve the Himalayan glaciers and stabilize Pakistan's water resources. In this context, decarbonization emerges as a pivotal approach to avert the far-reaching impacts of extreme weather events on vulnerable populations, social stability, and economic prosperity[xvii].

In the Pakistan context, the imperative of decarbonizing industries transcends emissions reduction alone. A comprehensive study by the Ministry of Climate Change reveals that the industrial sector is a notable contributor to the country's carbon footprint, with emissions accounting for approximately 24% of the total. Transitioning to cleaner technologies not only curbs emissions but also aligns with Pakistan's "Vision 2025" economic agenda. Research conducted by the Pakistan Business Council underscores that sustainable practices and innovation in industries not only enhance competitiveness but also attract international investment. Moreover, the Lancet Countdown on Health and Climate Change highlights the tangible health benefits; reducing air pollution from industries can avert an estimated 17,000 premature deaths annually. Socioeconomic stability is inherently linked to environmental harmony. The Sustainable Development Policy Institute (SDPI) emphasizes that mitigating climate risks through decarbonization is pivotal for safeguarding livelihoods, particularly in vulnerable rural communities. Thus, decarbonization forms an inextricable strand of Pakistan's sustainable development fabric, interweaving innovation, competitiveness, public health, and societal well-being.

1.2.5. Research objectives

Studying Energy Emissions and Transitions in targeted industries seeks to investigate the emissions and energy transitions in Pakistan's textile, sports, fashion, and leather industries. The research will adopt a broad lens to understand the interconnected impact of these industries on Pakistan's overall industrial emissions. Both primary and secondary data will be scrutinized to come up with actionable recommendations for industrial decarbonization.

Chapter 2:

Contextualizing Energy Challenges in Textile and Sports/Apparel Industries

2. Industrial processes and their environmental impacts

2.1. Textile industry

Textile manufacturing in Pakistan involves several processes, starting from fiber and yarn production to the final finishing of fabrics. The key processes in the textile industry include fiber collector, spinning, weaving, knitting, dyeing, printing, and finishing[xviii].

2.1.1. Processes[xix]

2.1.1.1. Fiber collection

This is where raw materials like cotton, wool, or synthetic Fibers are collected or sourced.

2.1.1.2. Spinning

This process involves the conversion of raw fibres into yarn. Pakistan's textile industry predominantly uses ring spinning and open-end spinning methods for yarn production. The total energy consumption can be estimated in kilo watt hour per kilogram (kWh/kg) of yarn[xx].

2.1.1.3. Weaving/Knitting

Yarns are woven or knitted to create fabrics. Pakistan has a significant presence in both weaving and knitting sectors, with a wide variety of fabric types produced. The total energy consumption can be estimated in kilo watt hour per meter (kWh/m^2) of fabric.

2.1.1.4. Dyeing/Printing

Fabrics are dyed or printed to add colour and patterns. Dyeing processes include traditional methods, such as exhaust dyeing, as well as more advanced techniques like continuous dyeing and digital printing. The total energy consumption can be estimated in kilo watt hour per kilogram (kWh/kg) of fabric.

2.1.1.5. Finishing

After dyeing or printing, fabrics undergo finishing processes to enhance their appearance, texture, and performance. Finishing processes include treatments like bleaching, mercerization, and coating. The total energy consumption can be estimated in kilo watt hour per kilogram (kWh/kg) of fabric.

2.1.2. Analysis of energy-intensive machines and equipment[xxi]

2.1.2.1. Ring spinning machines

Ring spinning is a widely used method in the textile industry. These machines require significant electrical power to drive the spinning process and control various parameters. The total energy consumption can be estimated in kilo watt hour per kilogram (kWh/kg) of yarn. For example, a typical ring spinning machine can consume around 0.35-0.45 kWh per kilogram of yarn produced.

2.1.2.2. Open-end spinning machines

Open-end spinning is another method used for yarn production. These machines also consume significant electrical power during operation. The energy consumption can be estimated in kilo watt hour per kilogram (kWh/kg) of yarn. Open-end spinning machines typically consume around 0.25-0.35 kWh per kilogram of yarn produced.

2.1.2.3. Power Looms

Power looms are widely used in the weaving process. They consume substantial amounts of electricity during fabric production. The energy consumption can be estimated in kilo watt hour per meter^2 (kWh/m^2) of fabric. Depending on the type and efficiency of the power loom, energy consumption can range from 0.8 to 2.5 kWh per square meter of fabric produced.

2.1.2.4. Shuttle less looms

Shuttle less looms (e.g., air jet, rapier, projectile) are modern weaving machines known for their higher production speeds and energy efficiency compared to traditional shuttle looms. These machines consume electricity during fabric production, and their energy consumption can be estimated in kilo watt hour per meter^2 (kWh/m^2) of fabric. Depending on the specific type and efficiency, shuttle less looms typically consume around 0.5-1.5 kWh per square meter of fabric produced.

2.1.2.5. Circular knitting machines

Circular knitting machines are widely used in the knitting process. They consume electricity during fabric production. The energy consumption can be estimated in kilo watt hour per meter^2 (kWh/m^2) of fabric. Depending on the type and efficiency of circular knitting machines, energy consumption can range from 0.2 to 0.6 kWh per square meter of fabric produced.

2.1.2.6. High-temperature dyeing machines

High-temperature dyeing machines (e.g., jet dyeing machines, winch machines) are commonly used for batch dyeing. These machines consume significant energy due to the heating, pumping, and drying processes involved. The energy consumption can be estimated in kWh/kg of fabric. Depending on the specific machine type and efficiency, energy consumption for high-temperature dyeing machines can range from 5 to 15 kWh per kilogram of fabric processed.

2.1.2.7. Rotary screen-printing machines

Rotary screen-printing machines are widely used for fabric printing. They consume significant energy during the printing process. The energy consumption can be estimated in kWh/kg of fabric. Depending on the specific machine type and efficiency, energy consumption for rotary screen-printing machines can range from 0.2 to 1 kWh per kilogram of fabric printed.

2.1.2.8. Flatbed screen printing machines

Flatbed screen printing machines are also employed for fabric printing. They consume energy during the printing process, and their energy consumption can be estimated in kWh/kg of fabric. Depending on the specific machine type and efficiency, energy consumption for flatbed screen printing machines can range from 0.1 to 0.5 kWh per kilogram of fabric printed.

2.1.2.9. Stenters

Stenters are used for the heating and drying of fabrics during the finishing process. They require energy to operate. The energy consumption can be estimated in kWh/kg of fabric. Depending on the specific machine type and efficiency, energy consumption for stenters can range from 2 to 10 kWh per kilogram of fabric processed.

2.1.2.10. Calendars

Calendars are used for fabric flattening and gloss enhancement. They consume energy during operation. The energy consumption can be estimated in kWh/kg of fabric. Depending on the specific machine type and efficiency, energy consumption for calendars can range from 0.5 to 2 kWh per kilogram of fabric processed.

2.1.2.11. Compactors

Compactors are used to improve the fabric's dimensional stability and handle. They consume energy during operation. The energy consumption can be estimated in kWh/kg of fabric. Depending on the specific machine type and efficiency, energy consumption for compactors can range from 0.5 to 2 kWh per kilogram of fabric processed.

2.1.3. Impact of current practices on CO_2 emissions[xxii]

2.1.3.1. Energy source

The textile industry in Pakistan relies heavily on fossil fuels, particularly natural gas and coal, for its energy needs. The combustion of these fuels releases carbon dioxide (CO_2) emissions into the atmosphere. The carbon emissions resulting from energy consumption can be estimated by multiplying the energy consumption (kWh) by the carbon emission factor associated with the energy source.

2.1.3.2. Inefficient machinery

Many textile manufacturing units in Pakistan still utilize outdated and energy-inefficient machinery. These machines consume more energy than their modern counterparts, leading to higher carbon emissions per unit of production[xxiii]. The energy efficiency of machines can be evaluated by comparing their actual power consumption with the power consumption of energy-efficient alternatives.

The difference in energy consumption indicates the potential for carbon emission reductions[xxiv].

2.1.3.3. Lack of energy conservation measures

Limited adoption of energy conservation practices, such as energy-efficient motors, waste heat recovery systems, and process optimization, further contributes to higher carbon emissions. The impact of energy conservation measures on carbon emissions can be assessed by comparing the energy consumption before and after implementing energy-saving technologies. The reduction in energy consumption directly translates into carbon emission reductions[xxv].

2.1.3.4. Chemical usage

Certain dyeing and finishing processes involve the use of chemicals that generate greenhouse gas emissions when produced or disposed of improperly. Effluent treatment and waste management play a crucial role in reducing the carbon footprint associated with chemical usage. The carbon emissions associated with chemical usage can be estimated by considering the carbon footprint of the chemicals used. This includes the emissions generated during the production, transportation, and disposal of chemicals. Life cycle assessment (LCA) methodologies can be employed to quantify the carbon emissions associated with different chemicals and their disposal processes.

2.2. Sports industry[xxvi]

Sports goods manufacturing in Pakistan, specifically in Sialkot, revolves around several categories like footballs, cricket equipment, hockey sticks, and various sports apparel. This sector contains distinctive processes, including Design and Prototype Development, Material Preparation, Forming & Shaping, Joining & Assembling, and Finishing & Quality Control[xxvii].

2.2.1. Processes[xxviii]

2.2.1.1. Design and prototype development

In the design phase, industry-standard software such as Computer-Aided Design (CAD) tools are utilized to create intricate and precise product blueprints, which form the basis for prototypes. The development of prototypes, which involves small-scale manufacturing using

3D printers, CNC machines or manual craftsmanship, tests the design feasibility. The energy usage in this stage mainly comes from operating these high-end devices and systems.

2.2.1.2. Material preparation

Raw materials, such as leather, wood, textiles, rubber, and various composites, are procured and prepared for use. Leather undergoes a process of soaking, fleshing, deliming, bating, and tanning. Wood is processed through cutting, seasoning, and shaping. Textiles are woven or knitted, and rubber and plastics are synthesized or procured ready-made. The machinery used for these activities consumes energy, contributing to the carbon footprint.

2.2.1.3. Forming and shaping

The prepared materials are then subjected to processes that shape them into individual components of the final product. For example, leather for footballs is cut into panels, wooden blanks are shaped into cricket bats or hockey sticks, and textiles are cut into patterns for sportswear. The machinery involved, like hydraulic presses, lathes, and cutting machines, is often energy-intensive, especially when heating or high pressure is involved.

2.2.1.4. Joining and assembling

The shaped components are joined or assembled to create the final product. Stitching machines are a crucial element in football manufacturing, consuming a significant amount of energy. Hockey sticks might require high-temperature adhesive applicators for binding the handle and blade. Sports apparel involves extensive stitching and sewing. The energy usage here is predominantly electrical, leading to direct CO_2 emissions from fossil fuel-based electricity production.

2.2.1.5. Finishing and quality control

Final touches include branding (using heat transfers or printing), varnishing (in the case of wooden products), and quality tests. These processes often involve heating or pressure, consuming energy. The quality control phase may also involve automated testing equipment, such as bounce testers for balls or tension testers for apparel, contributing to electricity consumption.

2.2.2. Analysis of energy-intensive machines and equipment

2.2.2.1. CAD workstations

CAD software is used for product design, requiring high-performance workstations. These workstations consume electrical power during operation. The energy consumption can vary depending on the workstation's specifications and usage patterns, ranging from 200 to 500 watts per hour.

2.2.2.2. 3D printers

3D printers are used to create prototypes, utilizing additive manufacturing techniques. They consume electrical power during the printing process. The energy consumption can vary depending on the type of 3D printer and the size and complexity of the prototype, ranging from 50 to 500 watts per hour.

2.2.2.3. Cutting machines

Cutting machines are used to shape raw materials such as leather, textiles, and plastics. They consume electrical power during the cutting process. The energy consumption can vary depending on the type and size of the cutting machine, ranging from 200 to 800 watts per hour.

2.2.2.4. Textile machinery

Textile machinery, such as looms or knitting machines, is used to process textile materials for sports apparel. They consume electrical power during fabric production. The energy consumption can vary depending on the specific machine type and efficiency, ranging from 0.5 to 3 kWh per square meter of fabric produced.

2.2.2.5. Hydraulic presses

Hydraulic presses are used to shape materials like rubber, plastics, or metals. They consume energy, particularly during the application of high pressure. The energy consumption can vary depending on the press's size and operating parameters, ranging from 5 to 100 kWh per hour.

2.2.2.6. Moulding machines

Moulding machines, such as injection moulding or blow moulding machines, are used for forming plastic components. They consume energy during the moulding process. The energy consumption can vary depending on the machine type and size, ranging from 1 to 50 kWh per hour.

2.2.2.7. Stitching machines

Stitching machines are used to join fabric components together, such as in the production of sports apparel or equipment. They consume electrical power during the stitching process. The energy consumption can vary depending on the machine type, speed, and efficiency, ranging from 50 to 300 watts per hour.

2.2.2.8. Adhesive applicators

Adhesive applicators, such as hot melt glue guns, are used for bonding components together. They consume electrical power during the application process. The energy consumption can vary depending on the applicator type and size, ranging from 50 to 200 watts per hour.

2.2.2.9. Heat transfer machines

Heat transfer machines are used for branding or adding graphics to sports goods. They consume electrical power during the heating and pressing process. The energy consumption can vary depending on the machine size and efficiency, ranging from 500 to 2,000 watts per hour.

2.2.2.10. Quality testing equipment

Quality testing equipment, such as tension testers or bounce testers is used to assess the performance characteristics of sports goods. They consume electrical power during testing. The energy consumption can vary depending on the specific testing equipment, ranging from 50 to 500 watts per hour.

2.2.3. Impact of current practices on CO_2 emissions

2.2.3.1. Dependence on grid electricity

Given the dependence on grid electricity, the emissions factor for the local electricity grid directly affects the CO_2 emissions from sports manufacturing. A shift towards renewable sources in the national grid could have a significant impact on the industry's carbon footprint.

2.2.3.2. Aging infrastructure

Older machinery not only uses more energy per unit of output but also often lacks energy-saving features like automatic standby or optimal operation indicators. Investment in modern, energy-efficient machinery can significantly reduce the energy consumption per unit of production and hence reduction in carbon emissions.

2.2.3.3. Limited implementation of sustainable practices

Efforts like waste recycling, energy recovery from waste heat, or switching to renewable energy sources for manufacturing processes are still relatively limited. These practices, if widely adopted, could significantly reduce the industry's carbon footprint.

2.2.3.4. Resource-intensive raw materials

The sourcing and processing of raw materials like leather, wood, and synthetic polymers are often resource-intensive and carry a substantial carbon footprint. Sustainable procurement practices, efficient material usage, and effective waste management could alleviate these environmental impacts.

2.2.3.5. Absence of advanced energy management systems

Advanced energy management systems can help reduce energy consumption by optimizing usage, scheduling operations efficiently, and minimizing waste. Their absence may lead to unnecessary energy use and consequent carbon emissions.

2.3. Fashion industry

The fashion industry encompasses various processes, including design, material sourcing, manufacturing, and distribution. Understanding the production processes, evaluating energy-intensive equipment and technologies, and analyzing the carbon footprint are essential for assessing the industry's environmental impact[xxix].

2.3.1. Processes

2.3.1.1. Design and concept development

In the design phase, industry-standard software such as Computer-Aided Design (CAD) tools are utilized to create intricate and precise product blueprints, which form the basis for prototypes. The development of prototypes involves small-scale manufacturing using 3D printers, CNC machines, or manual craftsmanship to test the design feasibility. The energy usage in this stage mainly comes from operating these high-end devices and systems. For example, a CAD workstation can consume approximately 200-300 watts per hour, while a 3D printer can consume around 50-100 watts per hour.

2.3.1.2. Material selection and sourcing

Materials for fashion production are sourced from various suppliers, including natural fibers (cotton, silk, wool), synthetic fibers (polyester, nylon), and other materials like leather or fur. Energy is consumed during material extraction, transportation, and processing stages, resulting in associated carbon emissions. The energy-intensive processes involved in material sourcing can vary. For instance, cotton production is known to be resource-intensive, with estimates suggesting that it takes around 20,000 liters of water to produce one kilogram of cotton.

2.3.1.3. Pattern making and cutting

Pattern making involves creating templates for garment components, while cutting involves precisely cutting the fabric according to these patterns. This stage utilizes computer-controlled cutting machines or manual cutting tools, contributing to energy consumption. Energy consumption can vary based on the type of cutting machinery used. For instance, laser cutting machines are known to be more energy-efficient compared to traditional fabric cutting methods, resulting in reduced energy consumption.

2.3.1.4. Garment construction

Garment construction includes stitching, seaming, and adding trims or embellishments to the cut fabric pieces. Sewing machines, overlock machines, and other specialized equipment are used, consuming electricity during the assembly process. The energy consumption of sewing machines can vary depending on the machine type, speed, and efficiency. For example, industrial lockstitch machines consume around 100-250 watts per hour, while overlock machines can consume approximately 300-500 watts per hour.

2.3.1.5. Finishing and quality control

The finishing stage involves processes like pressing, ironing, and attaching buttons or zippers to ensure the final product's quality and appearance. Steam irons and pressing machines are commonly used, consuming electricity, and contributing to carbon emissions. The energy consumption of pressing machines can vary depending on the size, type, and efficiency of the equipment. For instance, steam irons typically consume around 1,000-2,000 watts per hour.

2.3.2. Evaluation of energy-intensive equipment and technologies

2.3.2.1. Sewing machines

Industrial sewing machines are a fundamental part of garment manufacturing. Different types of sewing machines, such as lockstitch machines, chain stitch machines, or overlock machines, vary in energy efficiency. Evaluating and comparing their power consumption can highlight areas for potential energy savings. For instance, modern energy-efficient sewing machines equipped with servo motors can result in energy savings of up to 50% compared to conventional clutch motor-driven machines.

2.3.2.2. Cutting machines

Automatic fabric cutting machines, such as computer-controlled cutting systems or laser cutters, are used for precision cutting. These machines consume varying amounts of energy based on their type, size, and efficiency. Assessing their energy consumption can identify opportunities for optimization. Laser cutting machines, for example, are known to provide higher precision with lower energy consumption compared to traditional cutting methods.

2.3.2.3. Pressing machines

Pressing machines, such as steam irons, fusing machines, or heat transfer machines, play a crucial role in garment finishing. These machines require electrical energy for heating and operation. Analyzing their energy consumption can help identify areas for efficiency improvement. For example, adopting steam irons with energy-saving features like auto-shutoff or variable temperature controls can significantly reduce energy usage.

2.3.3. Impact of current practices on CO_2 emissions

2.3.3.1. Transportation

Transportation of raw materials, finished garments, and other fashion industry components contributes to the carbon footprint. This includes emissions from various modes of transportation, such as trucks, ships, or airplanes. The carbon footprint associated with transportation depends on factors such as distance, mode of transport, and fuel efficiency. For instance, using more fuel-efficient vehicles or optimizing shipping routes can reduce carbon emissions.

2.3.3.2. Chemical usage

Chemical processes like dyeing, printing, or finishing can contribute to carbon emissions through the use of energy-intensive machinery or the production and disposal of chemicals. Assessing the carbon footprint associated with chemical usage requires considering the emissions generated throughout their lifecycle. Adopting sustainable chemical management practices, such as using eco-friendly dyes or implementing water-saving dyeing processes, can help reduce the carbon footprint of chemical usage.

2.3.3.3. Waste management

The fashion industry generates substantial waste, including fabric scraps, trimmings, and packaging materials. Proper waste management practices, such as recycling or reusing, can reduce carbon emissions associated with waste disposal. Implementing efficient waste sorting and recycling systems within manufacturing facilities and promoting sustainable packaging materials can help minimize the carbon footprint of waste management.

2.4. Leather industry

The leather industry involves various processes, including raw material sourcing, tanning, manufacturing, and distribution. Understanding the production processes, evaluating energy-intensive equipment and technologies, and analyzing the carbon footprint are crucial for assessing the industry's environmental impact[xxx].

2.4.1. Processes[xxxi]

2.4.1.1. Raw material sourcing

The leather industry relies on raw materials obtained from animals, such as cattle, sheep, goats, or exotic animals. The sourcing process includes animal husbandry, slaughtering, and skin or hide removal. Energy consumption and associated carbon emissions in this stage can arise from activities like transportation, refrigeration, and storage of raw materials. For instance, the transportation of animal skins or hides from slaughterhouses to tanneries contributes to carbon emissions, especially when long distances are involved.

2.4.1.2. Beamhouse operations

This includes soaking, dehairing, liming, and fleshing the hides or skins to prepare them for tanning.

2.4.1.3. Tanning

Tanning is a critical process that converts raw hides or skins into leather through various chemical and mechanical treatments. Energy-intensive activities in the tanning process include soaking, liming, fleshing, splitting, degreasing, dyeing, and finishing. Different tanning methods, such as chrome tanning, vegetable tanning, or synthetic tanning, have varying energy requirements and environmental impacts. For example, chrome tanning, while energy-intensive, is known for its shorter processing time compared to other tanning methods.

2.4.1.4. Manufacturing

Leather manufacturing involves transforming tanned hides or skins into finished products like footwear, bags, accessories, and upholstery. This process includes cutting, stitching, gluing, and assembling leather components. Energy consumption in leather manufacturing mainly arises from operating cutting machines, sewing machines, and other equipment used in the assembly process. For instance, the use of computer-controlled cutting machines with efficient blade movement algorithms can reduce energy consumption during the cutting stage.

2.4.1.5. Finishing and quality control

The finishing stage involves processes like polishing, buffing, embossing, and applying protective coatings to enhance the appearance and durability of leather products. Quality control measures, including testing for strength, colorfastness, and compliance with standards, contribute to the final stage of production. Energy consumption in this stage comes from the operation of machinery and equipment used in finishing processes. Efficient application methods, such as spray guns or roller applicators, can help minimize energy consumption during the finishing stage.

2.4.2. Evaluation of energy-intensive equipment and technologies

2.4.1.6. Tanning machinery

Tanning machinery, such as drums, vats, and drying racks, plays a significant role in the tanning process. The energy consumption of tanning machinery can vary depending on the type of equipment and the specific tanning method employed. Assessing energy usage and exploring energy-efficient alternatives can help identify opportunities for reducing carbon emissions. For example, the adoption of closed-loop systems for water circulation can optimize energy usage in the tanning process.

2.4.1.7. Cutting and stitching equipment

Cutting machines, sewing machines, and other equipment used in leather manufacturing can consume substantial amounts of energy. Evaluating the energy efficiency of these machines, considering factors like power consumption and idle energy usage, can help identify energy-saving options and contribute to carbon footprint reduction. The use of energy-efficient servo motors in sewing machines, for example, can result in significant energy savings.

2.4.1.8. Finishing machinery

Machinery used in finishing processes, such as buffing machines, embossing machines, and coating applicators, can significantly impact energy consumption. Assessing the energy efficiency of finishing machinery and exploring technologies like energy-efficient motors and automated controls can lead to energy savings and carbon emission reductions. For instance, the use of brushless motors in buffing machines can reduce energy consumption and improve efficiency.

2.4.3. Impact of current practices on CO_2 emissions

2.4.3.1. Chemical usage

The leather industry utilizes various chemicals in the tanning and finishing processes, such as dyes, tanning agents, and finishing agents. The production, transportation, and disposal of these chemicals contribute to carbon emissions. Assessing the carbon footprint of chemical usage involves considering the emissions associated with their life cycle, including production, transportation, application, and waste management. The use of eco-friendly chemicals, such as bio-based dyes or vegetable-based tanning agents, helps reduce the carbon footprint associated with chemical usage.

Promoting the adoption of eco-friendly chemicals necessitates a multifaceted approach. Initiatives encompass raising consciousness within businesses about the advantages tied to eco-friendly chemicals, encompassing diminished carbon impact, improved consumer perception, and enduring sustainability. Regulatory frameworks, including mandates and incentives like tax incentives and grants, can stimulate businesses to embrace sustainable practices. Investment in research and development is crucial for pioneering economical and inventive alternatives to conventional chemicals. Fostering collaboration across supply chains—unifying suppliers, manufacturers, and retailers—is indispensable for guaranteeing the accessibility and cost-effectiveness of eco-friendly chemicals.

The establishment of certification programs facilitates businesses in showcasing their employment of eco-friendly chemicals, enabling consumers to make judicious selections. As consumer awareness regarding sustainability escalates, enterprises are poised to gravitate toward eco-friendly alternatives to meet burgeoning market demand. Collaborative endeavors with industry consortia and organizations serve to propagate best practices, exchange insights, and collectively propel the assimilation of eco-friendly chemicals. Harnessing technological progressions augments the efficiency and efficacy of eco-friendly chemical synthesis procedures.

2.4.3.2. Waste management

The leather industry generates waste materials, including trimmings, shavings, and process residues. Proper waste management practices, such as recycling, reusing, or proper disposal, can minimize the carbon footprint associated with waste. Implementing efficient waste management systems within tanneries and promoting sustainable practices, like converting waste into useful byproducts, can help reduce environmental impacts. For instance, converting leather waste into bio-based materials or utilizing them for energy generation through anaerobic digestion can contribute to waste management and carbon emission reduction.

2.4.3.3. Sustainable tanning practices

Adopting sustainable tanning practices, such as utilizing eco-friendly tanning agents, optimizing chemical usage, and implementing water recycling systems, can significantly reduce the carbon footprint of the leather industry. The implementation of renewable energy sources and energy-efficient technologies can further contribute to carbon emission reduction. For example, the integration of solar panels or biomass energy systems in tanneries can help reduce reliance on fossil fuel-based energy and lower carbon emissions.

2.5. Policy landscape in Pakistan

2.5.1. Government initiatives and regulations

Pakistan has undertaken various national policies to promote decarbonization and combat climate change. One of the key policies is the Pakistan Climate Change Policy, which was launched in 2012 and aims to address climate change challenges through sustainable development and mitigation measures. The policy emphasizes the reduction of greenhouse gas emissions, increasing the share of renewable energy, and enhancing climate resilience[xxxii]. Additionally, the National Energy Policy, formulated in 2013, focuses on diversifying the energy mix by increasing the share of renewable energy sources such as wind, solar, and hydropower. It aims to reduce Pakistan's reliance on fossil fuels and promotes the use of clean and sustainable energy technologies[xxxiii]. The Green Pakistan Program, initiated in 2017, is another significant initiative aiming to enhance forest cover, combat deforestation, and promote biodiversity conservation. This program recognizes the importance of forests in absorbing carbon dioxide and mitigating climate change impacts[xxxiv].

To address industrial emissions and promote sustainability in this sector, Pakistan has implemented the National Environmental Quality Standards (NEQS). These standards set emission limits for various pollutants, including air and water pollutants, noise levels, and hazardous waste management, among others. Industries are required to comply with these standards to ensure environmental protection and minimize their impact on climate change. The implementation of the NEQS in Pakistan has yielded notable outcomes. Primarily, it has engendered heightened awareness within the industrial sector concerning environmental imperatives and the imperative of adhering to stipulated pollution control benchmarks. This initiative concurrently accentuates the necessity for consistent monitoring of industrial emissions. Additionally, NEQS has furnished a legal framework for overseeing emissions emanating from industries, instigating certain enterprises to embrace pollution mitigation measures to align with the prescribed standards. This alignment has in turn engendered discernible reductions in the discharge of hazardous pollutants, exemplifying a positive stride towards ecological sustainability. The implementation of NEQS in Pakistan has faced challenges in enforcement due to limited resources, corruption, and capacity constraints, resulting in instances of non-compliance by industries.

Criticism has emerged regarding the perceived inadequacy of NEQS standards to effectively tackle industrial pollution, prompting calls for more stringent and urgent benchmarks. The policy's effectiveness hinges on reliable and transparent data collection and reporting, as deficiencies in this realm could compromise enforcement credibility. Furthermore, the level of public engagement, a key factor in successful policy execution, remains a concern, as the extent of public participation in decision-making and monitoring processes could influence NEQS's overall efficacy[xxxv].

The National Energy Efficiency and Conservation Act, passed in 2016, provides a framework for promoting energy efficiency in industrial processes. It encourages industries to adopt energy-efficient technologies, improve resource management, and reduce greenhouse gas emissions. The act also establishes energy conservation standards and promotes energy audits and awareness programs to enhance energy efficiency practices in industries[xxxvi].

Pakistan's National Climate Change Policy (NCCP) 2012 recognizes the need to promote cleaner production and energy efficiency in the industrial sector, and the Implementation Framework for this policy proposes several specific measures such as encouraging the use of cleaner fuels, promoting energy-efficient technologies, and establishing a cleaner production center[xxxvii]. The Government of Pakistan has introduced several policies to boost the industrial sector to opt renewable energy in their operations. The Textile Policy 2014-19, for instance, aimed to enhance the textile industry's output by offering various incentives, including subsidized energy supply and technological upgrades[xxxviii]. Similarly, the Leather Export Promotion Policy aimed to maximize leather exports by addressing issues related to raw material availability and modernizing the manufacturing process[xxxix]. However, these industries also face significant challenges.

Energy crises, high production costs, and technological backwardness are some of the fundamental issues plaguing Pakistan's industrial sector. International competition, coupled with changing global trade scenarios like the advent of the African Growth and Opportunity Act (AGOA) and the China-Pakistan Economic Corridor (CPEC), also pose considerable challenges and opportunities for these industries. As for the fashion and sports industries, there is a lack of targeted policy intervention. However, schemes such as the Long-Term Financing Facility (LTFF) and the Export Refinance Scheme (ERS) do offer indirect support by facilitating access to finance for exporters[xl].

2.5.2. International commitments and agreements

International agreements have played a significant role in shaping Pakistan's policies and strategies for industrial decarbonization.

The commitments made under the Paris Agreement 2016, such as Nationally Determined Contributions (NDCs), have guided Pakistan's efforts to reduce greenhouse gas emissions. These agreements emphasize the need for transitioning to low-carbon technologies, promoting renewable energy, and enhancing energy efficiency in industries. Pakistan's NDC includes targets and actions to mitigate climate change in various sectors, including industry.

The NDC outlines specific measures to enhance energy efficiency, increase the share of renewable energy, and promote sustainable practices in industries. These measures aim to reduce the carbon footprint of industrial activities and contribute to national and global emissions reduction goals. The Paris Agreement also emphasizes the importance of technology transfer and capacity-building initiatives to support developing countries in their decarbonization efforts.

Pakistan's national policies are aligned with global sustainability goals, as outlined in international agreements such as the

Sustainable Development Goals (SDGs) and the Paris Agreement. The policies focus on reducing greenhouse gas emissions, promoting renewable energy, enhancing energy efficiency, and addressing climate change impacts. Pakistan's policies on decarbonization and climate change mitigation align with multiple SDGs, including Goal 7 (Affordable and Clean Energy), Goal 9 (Industry, Innovation, and Infrastructure), Goal 11 (Sustainable Cities and Communities), Goal 12 (Responsible Consumption and Production), Goal 13 (Climate Action), and Goal 17 (Partnerships for the Goals).

By aligning national policies with the SDGs and the Paris Agreement, Pakistan demonstrates its commitment to achieving sustainable development while addressing the challenges of climate change. These policies prioritize the reduction of greenhouse gas emissions, the promotion of renewable energy, the enhancement of energy efficiency, and the adoption of sustainable practices in industries. Pakistan has set its own targets for reducing emissions and increasing the share of renewable energy in its energy mix. These targets are in line with the global sustainability goals and demonstrate Pakistan's commitment to achieving a sustainable and low-carbon future.

Chapter 3:
Energy Consumption Landscape: Textile and Sports/Apparel Sector

3.1. Primary data

The ADS team visited textile and sport/apparel manufacturing facilities intending to gather valuable data on their energy consumption and sources within their industry. Furthermore, they engaged in discussions with company representatives to document their perspectives on their energy transition strategies, the obstacles they encounter when embracing renewable energy, and their recommendations for government policies to encourage the shift from conventional fuels to renewable energy sources and reduce carbon emissions.

3.2. Visits and data collection

During the information-gathering phase, the ADS team had the opportunity to collect valuable insights regarding the decarbonization initiatives of various industries, including Textile and Sports/Apparel. The information-gathering process involved Focus Group Discussions (FGDs), Key Informant Interviews (KIIs), and Structured Questionnaire (see Appendix A), arranging and conducting meetings with representatives from renowned industries, their associations and academics institutions in Rawalpindi, Faisalabad, Sialkot, Multan, and Lahore. Through these interactions, the ADS team was able to comprehend and document the varied measures each industry has adopted or on the path towards achieving their decarbonization goals, aligning with sustainable practices.

3.2.1. Textile sector

In its visit to Noor Fatima Mills in Faisalabad, the ADS team met with Mr. M. Umar Farooq (Director/Owner) and Ijaz (Technical Advisor).

The mill currently consumes 50 tonnes of coal daily but plans to shift to biomass from coal and gas. They are transitioning due to the shutdown for the past 3 months and the high daily expenses of Rs 6-7 lacs and 4,000 mm Btu gas consumption. Around 70-80% of Faisalabad's industries have already shifted to biomass, and coal rates' non-viability has led them to use local coal from Quetta. The mill operates 28 days a month with 2 days reserved for maintenance.

Upon visiting Nishat Limited in Faisalabad, its Power Plant Boiler Inspector provided valuable insights into the company's operational priorities and energy sources. Nishat Limited's primary focus is on cost reduction, and they currently employ an IC engine running on natural gas, boasting an efficiency of 38-43%. However, carbon emissions control has not been a prominent aspect of their efforts, despite acknowledging that natural gas offers a lower carbon footprint compared to coal or fuel, signaling some environmental awareness. Regrettably, the company has not received any government support for their sustainability initiatives. At present, their Faisalabad power plant has a capacity of 30 MW, with 12 MW powered by HFO and the remaining generated through dual fuel (HFO & gas), utilizing 18 MW on gas. In an effort to embrace renewable energy, Nishat Limited plans to install a 6 MW solar photovoltaic (PV) plant by the upcoming year. Additionally, they operate another plant in Saya Wallah, with a capacity of 4.7 MW, functioning on biomass. In a bid to optimize energy efficiency, Nishat Limited employs waste heat recovery systems for steam, exemplifying their commitment to eco-friendly practices.

Throughout the ADS team's visit to Moon Textile in Faisalabad, its Associate Engineer Boiler, provided essential insights into the company's energy practices and future plans. Moon Textile relies on diesel generators for power and utilizes local Quetta coal and agricultural residues for heating, with 3 MW of generators comprising 5-6 units of 500-600 kW each. They plan to shift to biomass, but solar energy is not under consideration due to space constraints, despite recognizing lower biomass efficiency compared to coal. Emission control measures are in place, including dust particle removers, air preheaters, and cyclones, ensuring that the emission of white smoke meets EPA standards. The company has enhanced energy efficiency by reducing the number of turbines used from 3 to 1.5. Discharged water is filtered in 2-3 sump tanks, they are plaining to integrate the waste heat recovery system for higher efficiency, but it is not yet implemented. They primarily use 0-100 mm coal, with local rates at 36/kg and Afghani coal at 56/kg, operating four days a week. Overall, Moon Textile strives to adopt sustainable energy alternatives while gradually improving their share in environmental impact.

At Dawood Textile in Faisalabad, its Manager Electrical, shared crucial information about the industry's energy sources and usage. The sources required for operations are electricity, hot water, or steam. Electricity is supplied from FESCO and natural gas, with usage dependent on tariffs, as they opt for the lower one. Although a policy introduced by former Finance Minister set a tariff of 20/unit, it was not sustained. Consequently, they shifted to gas for electricity supply due to tariff hikes. The industry consumes approximately 6-7 lacs kWh units per month, prioritizing gas, then FESCO, and finally diesel based on tariffs. Boilers for hot water were gas-fired initially, but during the crisis, they were transitioned to solid fuel (coal). The rates for captive power and industrial power vary, with coal used for steam production, and some machines operate on natural gas. The trial of agricultural residue in the boilers proved unsuccessful, as, the boiler engineer, informed the industry about biomass's ineffectiveness in the same boiler. Both local and Afghani coal are utilized. The installation of a 50kW solar system occurred about 6-7 years ago, which continues to operate, although the overall capacity of the industry is 1500 kW. Dawood Textile has also installed a waste heat recovery system and air preheaters. Furthermore, they have conducted an energy audit to optimize their energy usage.

During the ADS team's visit to Sitara Textile in Faisalabad, the Maintenance Engineer provided valuable insights into the industry's energy infrastructure and initiatives. Notably, the processing department is equipped with thermal oil heaters, while the bleaching department relies on hot air for various operations. Sitara Textile boasts a combination of diesel and gas generators, alongside coal and gas-fired boilers. An essential addition to their energy mix is the biomass steam boiler. The industry efficiently controls and reduces ash content by approximately 75-80% through a sophisticated showering system in the boilers' chimneys.

Established in 1960, Sitara Textile is dedicated to making the most of available agricultural residues, including corn straw, rice husk, and sugarcane bagasse, as fuel for their biomass boiler. When it comes to electricity supply, the company predominantly relies on FESCO, but they are actively working on the installation of a 2 MW solar plant to meet their energy needs. Their boilers, with a combined capacity of 15 million tonnes, have undergone transformation, with two initially being coal-fired and then modified to be biomass-fired, while two oil heaters remain coal-fired.

The industry houses a total of 65 machines and operates with two diesel generators, producing 957 kWh and 800 kWh, and two gas generators, each with a capacity of 1 MW. Collaborating with UNIDO, Sitara Textile emphasizes regular energy audits to optimize their energy usage and foster sustainable practices. However, due to the poor condition of available resources, water-related projects remain challenging for the company. Overall, Sitara Textile exemplifies a proactive approach towards sustainable energy utilization and environmental consciousness, evident in their diverse energy sources and commitment to renewable energy ventures.

During the ADS team's visit to Hina Sana Textile in Faisalabad, the Owner shed light on the company's energy practices and operational considerations. One of their key strategies involves using whichever fuel is available at a cheaper rate, allowing them to maintain cost-efficiency. While the textile industry primarily relies on electricity, Hina Sana Textile consciously minimizes its natural gas consumption due to the comparatively higher prices in Punjab as compared to Sindh. Surprisingly, Haji Sahib mentioned that despite emitting white smoke, their industry has never faced closure by the Environmental Protection Agency (EPA) as they believe it to be harmless to the atmosphere. However, a rather concerning matter was raised during the visit, with talks about bribery to EPA engineers, raising potential ethical and regulatory concerns that warrant further investigation.

While engaging with the Deputy Secretary of Pakistan Textile Exporters Association (PTEA), a comprehensive overview of the textile industry's fuel practices and their efforts towards renewable alternatives emerged. The majority of industries currently rely on traditional fuels, with natural gas being the primary choice, and around 90% of the sector using LNG as the main component. Although they are contemplating a shift towards renewables, they emphasize the crucial need for government support and involvement, advocating for a campaign at a larger scale involving government officials. While the textile sector has not experienced gas supply shortages, they acknowledge the lack of diversification in fuel sources.

Moreover, the sector has minimal utilization of wastewater treatment facilities. PTEA is actively engaged in raising awareness about sustainable practices, conducting seminars, and workshops to educate stakeholders. Despite their efforts in creating awareness, they clarified that the implementation and financing of the transition rests beyond PTEA's scope. Nonetheless, they work with 26 members nationwide, collaborating with international clients and renowned organizations like GIZ, International Labor Organization, and WWF. PTEA's commitment to upholding labor standards in the textile sector surpasses those of Bangladesh. They envision a mandatory shift to renewables by 2030. Ma'am Mashal offered to facilitate connections with Waseem from WWF and welcomed the ADS team to attend any seminars at their office. Additionally, she expressed willingness to link them with the Pakistan Textile Council in Islamabad for further collaboration and insights.

During a meeting with the former President of MCCI representing ALM Textile Mills in Multan, the ADS team came to know about the textile industry's heavy reliance on energy, accounting for approximately 70% of costs excluding raw materials, and about 50% when raw materials are included. The industry utilizes two types of energy, WAPDA and gas, but after the 18th amendment, Punjab experienced higher gas rates compared to Sindh due to provincial rights. Changes in government have caused fluctuations in tariffs and incentives, impacting the industry negatively. With nearly 50 textile mills relying solely on electricity and others using a hybrid approach involving gas, electricity, and fossil fuels, the industry faces challenges. However, the net metering limit of 1MW and the high cost of solar energy hinder potential solutions.

An offered biogas plant installation by Orient was deemed infeasible due to market volatility. Disparities in RLNG availability between Punjab and Sindh create further issues, affecting the industry's competitiveness. The textile industry, being export-driven, calls for a cost of service-based tariff system. The stakeholders emphasized the necessity for government policy support and collaboration with CCIs to address these challenges, with a potential consideration of establishing export warehouses in various countries.

During a recent discussion, the ADS team met with the Boiler Engineer from Shams and Brothers Fabrics in Lahore. The engineer highlighted a significant achievement in their industry, as their offices have successfully transitioned to solar energy, showcasing their commitment to adopting sustainable practices.

However, it was noted that the manufacturing and production processes still relies heavily on conventional grid energy sources, with machinery operating on grid energy rather than solar power. To further enhance their dedication to renewable energy and reduce their environmental impact, the need to explore and implement viable solutions for integrating solar or other renewable energy sources into the manufacturing and production processes was emphasized. By doing so, the company can adopt a more comprehensive and eco-friendly approach to their operations, leading to a greener and more sustainable future for their industry.

In a recent discussion, with the Manager of Style Textile in Lahore, the manager acknowledged the importance of transitioning their industry to 100% renewable energy for achieving environmental sustainability and reducing their carbon footprint. However, the manager also highlighted the current financial challenges that hinder this transformation. While solar energy has shown promise as a sustainable solution, its increasing cost poses a significant hurdle for industry.

Additionally, the absence of government financing for renewable energy projects further compounds the difficulty, particularly in the current economic climate. As responsible stakeholders, they understand the need to balance environmental aspirations with economic realities. To overcome these obstacles, they emphasized the importance of engaging in thoughtful dialogue with policymakers and exploring innovative financing options that can make renewable energy more accessible and affordable for their industry. By working collaboratively towards this goal, they aim to navigate the financial constraints and gradually move towards a greener and more sustainable future for their operations.

3.2.2. Sports/apparel sector

In Sialkot, the Pakistan Sports Goods and Manufacturers Exporters Association (PSGMEA) is represented by Mohsin Masood, the Secretary General, and Arshad Latif Butt, the Chairman. Their discussions highlighted significant challenges faced by sports industries in embracing sustainable practices. While industries working with prominent brands like Nike or Adidas have successfully transitioned, either partially or entirely, to solar energy, smaller industries lack awareness of the increasing demand for eco-friendly products from international clients who are willing to pay a premium for them. PSGMEA emphasizes that the lack of outreach and government support further compounds these challenges.

Despite the apparent benefits of solar installations, the absence of incentives remains a major hurdle, leading PSGMEA to propose that a portion of the government's fossil fuel investments should be redirected to assist industries in adopting solar energy solutions. Moreover, the region's geographical constraints limit the feasibility of wind energy, rendering solar energy the primary viable option. PSGMEA urges the government to provide favorable terms such as 5-7 years of soft loans to facilitate the transition to solar energy.

To drive positive change, PSGMEA suggests focusing on policy research and effective campaigns to raise awareness about the advantages of sustainable practices. However, PSGMEA notes that smaller industries encounter difficulties accessing solar loans from commercial banks, as these institutions prefer extending credit to larger corporations. PSGMEA advocates for a correlation between export performance and the allocation of loans to specific regions.

Additionally, they raise concerns about gas distribution, with resources predominantly allocated to big companies rather than being distributed equitably among other industries. PSGMEA expresses readiness to run awareness campaigns and host seminars to promote sustainable practices. PSGMEA acknowledges that while they engage in dialogues with the State Bank of Pakistan (SBP), tangible outcomes have been limited thus far. Despite 90% of SMEs expressing willingness to adopt solar energy, the scarcity of available loans significantly impedes their transition. PSGMEA underscores the urgency of implementing supportive policies and financial measures to accelerate the widespread adoption of sustainable practices within industries.

During the ADS team's visit to Comet Sports Industry in Sialkot, led by Sohail Yaqoob, it discovered a company with a rich history of 70 years, specializing in the production of footballs, gloves, and apparel. The facility mainly focuses on the cutting and stitching of finished products, resulting in minimal energy consumption. Presently, they rely on WAPDA electricity and use diesel generators as backup power sources, which helps keep greenhouse gas emissions at a low level with no significant concerns.

However, Sohail Yaqoob mentioned that despite no current plans for solar installation, the widespread adoption of solar energy could potentially impact WAPDA's viability, attributing this as a hindrance posed by the government. He suggested that facilitating low-cost solar imports for industries could be a solution to encourage sustainable practices. Furthermore, Comet Sports Industry is taking proactive steps towards digitization, aiming to reduce emissions by implementing digital apparel labels. Despite their minimal energy consumption and emissions, Comet Sports Industry remains open to exploring environment- friendly initiatives and fostering collaboration with the ADS team and other relevant stakeholders for the industry's sustainable growth.

During the ADS team's meeting with MB Malik in Sialkot, owned by Malik Ali, it was revealed that the company relies on WAPDA for electricity and is considering conversion to solar for their personal use in offices. However, they have not yet taken any concrete initiatives and lack knowledge on the process and feasibility of the conversion. With no boilers or steamers in their industry, they have relatively lower energy consumption, yet face significant monthly electricity bills.

While specializing in cricket bats, balls, and hockey equipment, MB Malik expressed interest in exploring solar energy as a sustainable option. They expressed disappointment in the lack of government support for transitioning to renewable sources but are in communication with a solar company. The ADS team discussed potential solutions and offered their expertise to guide MB Malik through the process of adopting solar energy, emphasizing the importance of knowledge-sharing and collaboration with reputable solar providers to ensure a smooth and successful transition.

During the ADS team's meeting with Yousaf Nawab Pvt. Ltd in Sialkot, the Company’s Manager disclosed that currently it relies on SESCO for electricity and is in the process of obtaining quotations from vendors for solar installation. With two units, the industry operates a 50 kVA unit, and gas is exclusively used for the boiler. While receiving unofficial energy-saving advice from Allied Energy Consultant, they are contemplating installing solar panels on their roofs this summer initially for offices, followed by assessing its feasibility for the entire industry. They recognize that sports machines can be adapted for solar power. The company emphasizes the need for government subsidies on solar installation for export-oriented industries. Additionally, diesel generators serve as backup power sources. Though some work is outsourced, other companies in the sector also rely predominantly on WAPDA for their energy needs.

During the ADS team's visit to Awan Sports in Sialkot, the HR Manager informed us that the manager was unavailable, leading to a subsequent exploration of nearby industries. Other industries in the vicinity revealed that they had installed solar panels primarily for office usage. Awan Sports, Ma'am Rehana shared that industries working with brands are more aware of renewable energy and green products. Previously, their main energy source was WAPDA, followed by gas and diesel generators. However, since April 2022, they have successfully converted 50% of their energy consumption to solar power.

During the ADS team's visit to Talon Sports in Sialkot, Nouman, the HR Manager, interacted with the team and shared valuable insights. Talon Sports utilizes multiple energy sources, including WAPDA, gas, and generators. Notably, they resort to alternative sources like coal, wood, corn, and wheat residues in winter when gas availability is limited. However, the shift to solar energy remains limited due to three primary reasons: area shortages, government incentives' absence, and a lack of awareness and commitment to pursue sustainable practices for the future. Mr. Nouman emphasized the need for the government to initiate a campaign promoting solar energy adoption. The facility relies on diesel generators for backup power and is involved in sewing and processing, with gas being a crucial energy source for the latter. Talon Sports produces sportswear, active wear, and puffed jackets, and although experienced, their staff can be somewhat conventional, posing challenges to embracing modern changes and sustainable practices.

A formal meeting between the ADS team and Athlito World International, based in Sialkot and owned by Fakhar Javed, took place, where in-depth discussions were held regarding their operations and production processes. Athlito World International specializes in the manufacturing of Leather and Sportswear, with a long-standing experience in leather production and a recent expansion into sports products since 2019. Their leather stitching processes are efficiently carried out using both WAPDA and UPS, while the sports sector is equipped with pre-package machines, press machines (mold), and boost technology. To accommodate the sports machinery, the company upgraded its transformer capacity from 25 kVA, initially provided by the government, to 100 kVA. For backup power, they rely on a 200 kVA generator, as the cost of running the generator is significantly higher, at approximately 1 lakh per hour. The factory is equipped with a 10,000-watt heater for various processes.

Despite exploring green energy alternatives, solar power rates are currently not deemed feasible for their operations, mainly due to the shading effect from neighboring factories. However, constructing an additional floor could potentially alleviate this issue and lead to a reconsideration of solar energy options. Athlito World International's primary focus is on the production of paddle rackets, for which they specialize in leather stitching. It is noteworthy that there are only 40-60 factories in Pakistan engaged in paddle racket manufacturing.

During an insightful discussion, the ADS team had the opportunity to engage with the Manager of Active Apparel in Lahore. The manager proudly shared that the company has made significant strides in adopting sustainable practices, with 30% of their industry's operations already powered by solar energy. This achievement reflects their strong commitment to reducing their environmental impact and embracing renewable energy solutions. Looking ahead, the company remains determined to further increase the share of solar energy within their energy portfolio. They plan to achieve this by implementing strategic planning, making necessary investments, and continuously striving towards incorporating an even larger portion of solar energy in their operations. By progressively expanding their reliance on clean and renewable energy sources, they aim to set an example of environmental responsibility and contribute to a more sustainable future not only for their industry but also for the planet as a whole.

3.2.3. Associations

During the interaction with Muhammad Shameel, the Additional Secretary General at Rawalpindi Chamber of Commerce and Industry (RCCI), the ADS team was apprised of the Green Chamber's achievements, including the successful implementation of a rainwater harvesting system and their commendable plantation drives. Furthermore, discussions centered around the ADS team's endeavor to promote renewable energy options to industries, notwithstanding the challenges involved in enforcing such practices. The Green Chamber's unwavering commitment to fostering environmental consciousness among businesses was also highlighted during the meeting.

In Sialkot, the Sialkot Chamber of Commerce and Industry (SCCI), ADS team engaged with Salman Mir, the Senior R&D Officer, regarding the Innovation Centre of NUST (ICON), which was established around 6-8 months ago. While the center was inaugurated last August 2022 with the aim of fostering collaboration between academia and industries, it has not yet produced tangible results, and they were not kept in the loop about its progress. The Director of ICON is Mr. Farid, and SCCI believes that ICON should be a valuable resource for industry-related data. Mr. Salman expressed his willingness to aid if needed.

During a formal meeting between the ADS team and Rana Muhammad Hammad, the Secretary General of the Multan Chamber of Small Traders and Small Industry (MCSTSI), insightful discussions were held regarding the current state of solar adoption within the small industry sector. It was highlighted that while every small industry aspires to transition towards solar energy, the prevailing solar rates present a significant hindrance, deterring businesses from making the shift. The constraints lie in the fact that solar energy can only be feasibly employed for electric use, whereas small industries often require biogas for their boilers, and the readily available logistics for biogas remain an issue.

Although the food and packaging industries have demonstrated a shift towards solar for self-consumption, a noteworthy observation emerged that the utilization of solar energy for processes in Multan remains relatively limited. Encouragingly, it was disclosed that around 60% of small industries have successfully converted to solar energy, reflecting a positive trend towards sustainable practices. The meeting served as an opportunity to gain valuable insights into the challenges and progress of solar adoption within the small industry sector, paving the way for potential avenues of collaboration and further exploration to promote renewable energy solutions in the region.

Our ADS team also had the discussion with Rao Dilshad Ali, the Secretary-General of ABPUMA (Multan). During this discussion, Mr. Ali elucidated a matter of significant concern with the utmost transparency and simplicity. He stressed the importance of conveying information in an easily comprehensible manner to avoid undue alarm and ensure our message resonates with all stakeholders.

While their ultimate goal is to promote clean energy, Mr. Ali emphasized the necessity to articulate this in relation to a tangible cost-benefit analysis. He noted that Pakistan's energy demand is currently in a state of decline due to the closure of numerous industries. Capitalizing on this situation, he asserted the government's role in facilitating solar financing options for both commercial and residential sectors. By implementing these strategies, he believes we can promote a reduction in electricity bills and pave the way for universal access to clean energy.

During a recent discussion with the ADS team, Muhammad Ayub, Secretary North Zone of

PHMA, Lahore, highlighted the crucial roadblocks inhibiting the extensive adoption of renewable energy sources. He identified these challenges as the viability and the cost of energy production. He underscored that ensuring renewable energy technologies are economically viable and capable of satisfying energy demands is instrumental in their assimilation into the global energy mix. Mr. Ayub asserted that to surmount these obstacles, there needs to be strategic investments in research and development to stimulate technological advancements. Additionally, the establishment of supportive policies that incentivize the shift towards cleaner and more sustainable energy solutions is required. By tackling these issues, he believes that the path towards a greener and more environmentally conscious energy future can be paved.

3.2.4. Academic sector

In a formal discussion, the ADS team had the opportunity of meeting with Dr. Amir Abbas Shirazi, the Principal of the Textile Engineering College at BZU, Multan. During our dialogue, Dr. Shirazi underscored the quintessential role of an effective solution to the energy crisis in fostering the progressive growth of nations, particularly Pakistan. He expressed concern regarding the substantial disruptions that have impinged on Pakistan's energy mix, resulting in prevailing uncertainties about the optimal exploitation of various energy sources, including hydel, nuclear, coal, and furnace oil. Mr. Abbas also highlighted the conspicuous absence of Pakistan in the Australian market, overpowered by competitors from Bangladesh and India. According to him, the 'Made in Pakistan' label is largely overshadowed due to the limited purchasing power of the country that impedes its global competitiveness.

Furthermore, he delineated that the textile mill owners primarily rely on gas-powered plants, reflecting the criticality of a consistent supply and necessitating affordable energy rates. The discourse concluded with Dr. Shirazi reiterating the unanimous call from industrialists for the provision of energy at minimal costs coupled with an uninterrupted supply, to bolster the country's industrial sphere.

In an insightful conversation, the ADS team had the opportunity to engage with Dr. Muhammad

Dawood, an Assistant Professor of Environmental Science at BZU, Multan. Specializing in Toxicology, Dr. Dawood expressed his disquiet over the noticeable gap between the formulation and implementation of climate change policies in Pakistan.

Despite the nation's commitment to combatting climate change, he lamented the disheartening shortfall in practical policy execution, which poses a significant impediment to mitigating the negative impacts of climate change. Dr. Dawood emphasized the urgent need for Pakistani policymakers to prioritize the effective execution of climate change strategies. He asserted that such a task necessitates the active participation and cooperation of governmental entities, regulatory bodies, research institutions, and the broader public. He advocated for the cultivation of a culture ingrained with accountability and responsibility to bridge the existing chasm between policy design and tangible action.

Moreover, Dr. Dawood highlighted the need for policymakers to comprehend the multifaceted nature of climate change, its implications across different sectors, and the interconnected challenges it poses, such as air pollution, water scarcity, and the prevalence of environmental hazards. He insisted that these complex issues demand an integrated approach for successful resolution.

In a recent interaction, our ADS team happened to interact with Dr. Mumtaz Hassan Malik, Professor and Dean of the Department of Textile Engineering at the School of Textile and Design, UMT Lahore. Although the current focus of their operations is not primarily energy-centered, Dr. Malik underscored the critical role of energy within the textile sector, Pakistan's largest industrial domain. He highlighted that significant energy consumption exists within spinning mills, implying substantial potential for energy conservation and efficiency enhancements. He reiterated the necessity to address energy efficiency in weaving, as well as dyeing and printing processes.

Furthermore, Dr. Malik pointed out the water scarcity challenges the textile industry confronts, emphasizing the urgency to address these concerns. With their extensive network and partnerships across the industrial centers of

Faisalabad, Lahore, and Karachi, Dr. Malik assured their preparedness to engage with stakeholders in tackling the critical energy and water issues plaguing the textile sector.

The ADS team also met with Prof. Dr. Faiza Sharif, Director of the Sustainable Development Study Centre (SDSC) at GC University, Lahore. The SDSC operates as a vibrant interdisciplinary platform, collaborating closely with multiple departments to meet its objectives. At present, the center's main focus lies in conducting research on sustainable livelihoods, environmental management, and community development in Pakistan. Acknowledging the pressing issues of environmental degradation and associated challenges, the SDSC is keen on bringing national attention to these matters.

A crucial objective of the center is to lead applied research originating from academic pursuits, with the potential to influence policymakers in the field of socio-economic development. Moreover, forging robust partnerships with other esteemed institutions engaged in environmental research bolsters the center's efforts. Through the development of interdisciplinary courses and comprehensive research, the SDSC is poised to bridge the gap between policymakers and academia, thereby fostering enhanced trust and collaboration. In essence, the center is committed to making a lasting contribution to promoting sustainable practices and advancing environmental well-being in the region.

3.2.5. Other industries

During a recent meeting of ADS team with Haji Atta ur Rehman, the owner of Allahdin Group of Companies (Multan), it was revealed that the company is currently in the process of solarizing its certain units. However, a major challenge, in his opinion, is that the industry is facing the lack of support from the government in terms of incentives and subsidies for adopting solar energy solutions. The absence of such financial assistance is hindering their ability to effectively compete in the international market. The participants emphasized the need for reduced tariffs to make solarization more viable and economically attractive for businesses.

Furthermore, it was noted that while the government has entered into agreements at the international level to promote renewable energy, many industries, including Allahdin Group of Companies, are not adequately informed or aware of these opportunities. Notably, five years ago, UNIDO approached them with an offer to assist in the transition towards sustainable energy practices. Despite the potential benefits, the current lack of government support and awareness about international initiatives remain significant barriers in their journey towards adopting solar energy.

During the meeting held between the ADS team and Sheikh Abdullah, the CEO of Hide and Textiles (Multan), significant insights into the company's industrial activities were gathered. Initially renowned for their leather industry, which primarily focused on exports, the company has transitioned to exclusively engage in the Textile sector. Presently, their Textile industry primarily involves the spinning process.

Although the company previously specialized in leather, their current focus lies in the spinning process, where 70 percent of their electricity is sourced from the grid. Notably, the cost of electricity has increased over time, rising from Rs.20 per unit to 46 per unit. To mitigate their reliance on grid electricity, they have begun exploring alternative energy solutions such as biomass and solar power. However, the adoption of biomass is at an initial stage, posing significant risks and uncertainties in its logistical implementation. Presently, the company's energy consumption stands at 2 MW, with gas serving as an additional fuel source for their boiler operations. Acknowledging the importance of sustainable energy practices, the company welcomes the government's initiative to increase incentives for solar energy adoption. To optimize their energy utilization, the company regularly conducts energy audits. It is pertinent to mention that wood is solely used for boiler operations in Multan, alongside gas, which is a common practice in this region. Emphasizing the promotion of solar energy, Sheikh Abdullah strongly advocates for its integration into their industrial operations to foster environmental sustainability and reduce dependence on conventional energy sources.

Our ADS team had the opportunity to converse with Engr. Atif Imran, the CEO of Signaring-Renewable Company. Engr. Imran shared his company’s mission, which involves promoting the use of solar energy, particularly targeting the farming and residential sectors, by providing solar system installations. With the escalating electricity tariffs, he explained that people are becoming increasingly conscious of the benefits associated with adopting solar energy solutions. He indicated that the implementation of solar systems can significantly alleviate the financial strain of soaring electricity bills, which have skyrocketed over the past year. He cited an instance where individuals frequently incur monthly expenses between 30,000 to 35,000 PKR merely for operating air conditioning units. Engr. Imran emphasized that such financial burdens have fueled the growing demand for affordable solar energy alternatives. In response, his company offers solar system installations payable through convenient installments. Engr. Imran assured us that all their solar panels are sourced from reputable suppliers, mainly imported from China, to guarantee the highest quality and reliability for their customers.

In Faisalabad, under the leadership of Waseem Ashraf as the Project Coordinator, WWF plays a significant role in working with various small and medium-scale industries. They offer free energy audits to these industries, aiming to persuade them to become WWF signatories. Possessing substantial funds, WWF is open to collaboration and welcomes seminars or workshops to further their cause. Their primary focus lies in the decarbonization of Pakistan's textile and leather sector. As part of their endeavors, they are initiating a new project called Nationally Appropriate Mitigation Action (NAMA). Additionally, they can facilitate connections with their representatives in Sialkot and Karachi, extending their influence and network for a wider impact on sustainable initiatives.

The ADS team had the pleasure of meeting with Mr. Rashid Ahmed, Manager of Capacity Building and Trainings for the Freshwater Program at WWF-Pakistan. During our discussion, Mr. Ahmed brought attention to the global trend towards the utilization of renewable energy sources. He elaborated on their project, in partnership with the European Union (EU), which is focused on the transformation of the sugar sector from low-pressure to high-pressure systems. The sugar sector, he noted, is self-sufficient in electricity generation, depending entirely on its own resources. To bolster sustainability, they have installed energy-efficient systems and optimized boiler efficiency within the industry. Besides their engagement with the sugar sector, they also have significant involvement in the leather and textile industries, having made considerable progress in enhancing processes such as spinning, weaving, and looms in the latter. By targeting multiple sectors, their project aspires to boost energy efficiency and sustainability, in line with the EU's wider goals of advocating renewable energy and reducing environmental footprint. Mr. Ahmed assured them of their commitment to making a substantial and lasting contribution to both industries and the environment, paving the way towards a greener and more sustainable future.

3.3. Analysis

A comprehensive analysis of primary data collected from the textile and sports/apparel sector in Pakistan, focused on current practices is discussed in this section. Data was collected through a multi-faceted approach, involving focal group discussions, key informant interviews, and detailed questionnaires. These methods allowed for a diverse range of inputs and perspectives, providing a rich source of information to inform our understanding of the decarbonization landscape within these sectors. The questionnaire and the entirety of the collected data can be found in Appendix A section. In the following sections, we delve into this primary data, dissecting and interpreting it to derive key insights and implications. This deep dive offers a holistic view of the current scenario of Pakistan's textile and sports/apparel sector.

3.3.1. Textile sector

The ADS team conducted comprehensive site visits to 12 prominent textile industries situated in Faisalabad, Multan, and Lahore. During these visits, the team administered a meticulous questionnaire to assess the prevailing energy utilization practices at these textile plants and units. The findings reveal that the current energy mix adopted by these industries follows a hybrid model, wherein all 12 establishments rely on grid electricity as their primary energy source. Unfortunately, 8 of these textile industries have augmented their energy supply by incorporating both natural gas and coal as supplementary sources. Conversely, a mere 4 establishments have embraced renewable energy solutions, notably solar power, albeit restricted to meeting their office-based energy requirements. Figure 1 elegantly illustrates the current energy mix data, encapsulating the diverse energy usage patterns among the textile industries in the above-mentioned regions. The textile sector relies predominantly on grid electricity for its operations, accounting for approximately 37% of its energy sources. Coal and natural gas each contribute 25% to their energy mix, while renewable energy makes up only 13%. However, the textile industry is committed to decreasing its reliance on fossil fuels and increasing its utilization of renewable energy sources.

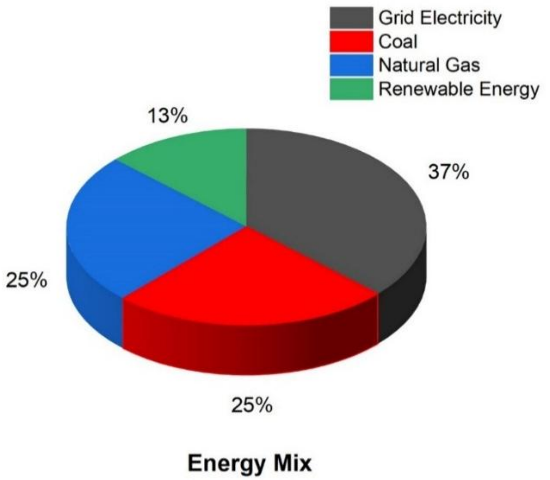


Figure 1: Current Energy Mix of Textile Sector

Table 1. shows the data of companies working with external organizations to transform their energy supply from conventional energy sources to renewable energy sources. But unfortunately, none of the mentioned industries under review have established collaborative engagements with external organizations or partners to facilitate the integration of renewable energy sources or implement energy efficiency measures within their operations.

Table 1. Status of Working with any External Organization (Textile)

Are you working with any external organizations or partners to adopt renewable energy or energy efficiency measures?		
	Frequency	**Percentage**
Yes	0	0
No	12	100

Among the cohort of 12 industries, a noteworthy majority of 9 establishments have undertaken energy audits to assess their current energy consumption patterns and identify areas for potential improvement in their energy mix scenario. Two industries have not yet conducted energy audits but are currently planning to carry out such audits in the near future. The data is shown in Table 2.

Table 2. Energy Audits Status (Textile)

Have you conducted an energy audit of your production process to identify opportunities for energy savings?		
	Frequency	**Percentage**
Yes	9	75
No	2	16.67
N/A	1	8.3

From Table 3 it can be seen encouragingly, 8 out of the 12 industries have expressed intent to invest in on-site renewable energy generation, signaling a positive shift towards sustainable practices. Furthermore, 4 of these industries have already initiated their renewable energy ventures and are actively planning to expand their existing renewable energy capacities.

Such proactive initiatives showcase a growing awareness and commitment to embracing renewable energy alternatives and reducing the environmental footprints of their operations. Another indication is that only 2 of the industries have indeed set specific targets. Notably, these targets align with the ambitious global initiatives, namely "Net Zero by 2030" as advocated by the United Nations Development Program (UNDP), and the commitment to achieve "Net Zero by 2050," in accordance with the Paris Agreement. Conversely, 66.67% of the participating companies have not yet established formal objectives for reducing their carbon emissions.

Table 3. Plans of Investing in On-Site Renewable Energy (Textile)

Are you planning to invest in on-site renewable energy generation?		
	Frequency	**Percentage**
Yes	8	66.67
No	0	0
Already Installed	4	33.33

Figure 2 showcases the frequencies and corresponding percentages of responses obtained from the multiple response question, aimed at discerning the strategies that industries are actively considering reducing their greenhouse gas emissions. Out of the strategies presented, 'Energy Efficient System' emerged as the most favored option, garnering 25% of respondents' support. This indicates a keen awareness of the importance of optimizing energy consumption to minimize environmental impact.

Following closely, 'Renewable Energy' gained traction among 16.67% of respondents, suggesting a growing recognition of the benefits derived from transitioning to sustainable and renewable energy sources. On the other hand, 'Combined Heat and Power,' while showcasing potential advantages in emissions reduction, did not register any affirmative responses, signifying it is not currently being considered as a prominent approach by the participating organizations. 'Reduce, Reuse, Recycle' gathered considerable interest, with 33.33% of respondents expressing an intent to adopt waste reduction and recycling measures to combat greenhouse gas emissions effectively.

However, it is noteworthy that a significant number of respondents (58.3%) indicated that they are currently not considering any of the listed strategies. This observation highlights the need for further research and outreach to encourage wider adoption of sustainable practices within the business sector.

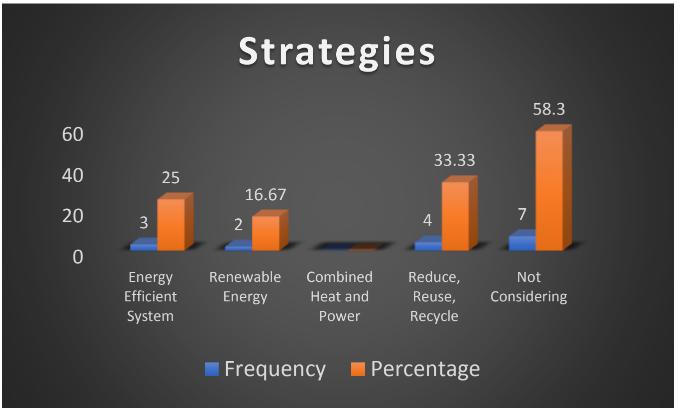
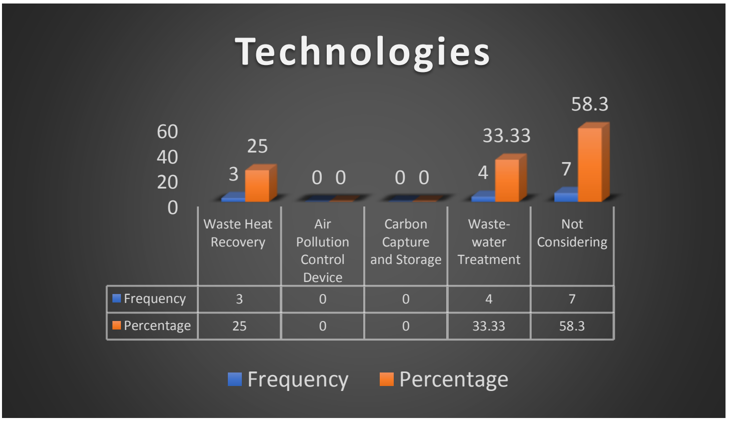


Figure 2: Frequencies and Percentages for Reducing Greenhouse Gas Emissions (Textile)

The question sought to elicit insights into the technologies currently under consideration by esteemed companies to address their greenhouse gas emissions, depicted in Figure 3, showcases the degrees of interest in each potential technology. Among the listed technologies, 'Waste Heat Recovery' emerged as the most favored option, garnering 25% of respondents' support. This indicates a recognition of the significance of harnessing wasted thermal energy to reduce emissions and enhance energy efficiency.

Conversely, 'Air Pollution Control Device' and 'Carbon Capture and Storage' did not register any affirmative responses, suggesting that these particular technologies are not currently being contemplated as prominent approaches for emissions reduction by the participating organizations. 'Waste-water Treatment' garnered considerable interest, with 33.33% of respondents expressing intent to explore wastewater treatment technologies to mitigate greenhouse gas emissions effectively. However, it is noteworthy that a significant number of respondents (58.3%) indicated that they are currently not considering any of the listed technologies due to high rates etc.



	Waste Heat Recovery	Air Pollution Control Device	Carbon Capture and Storage	Waste-water Treatment	Not Considering
Frequency	3	0	0	4	7
Percentage	25	0	0	33.33	58.3

Figure 3: Technologies for Reducing Greenhouse Gas Emissions (Textile)

3.3.2. Sports/apparel sector

The research team extensively surveyed 15 units of Sports and Apparel industries and plants to determine their current energy mix. The results indicate significant variation in energy choices among these establishments. Specifically, 11 units primarily rely on grid electricity, while 6 units use coal and natural gas as auxiliary energy sources. Unfortunately, only 4 units have partially adopted renewable energy solutions, such as utilizing solar power for specific energy needs. These diverse energy usage patterns are summarized in Figure 4 by the ADS team.

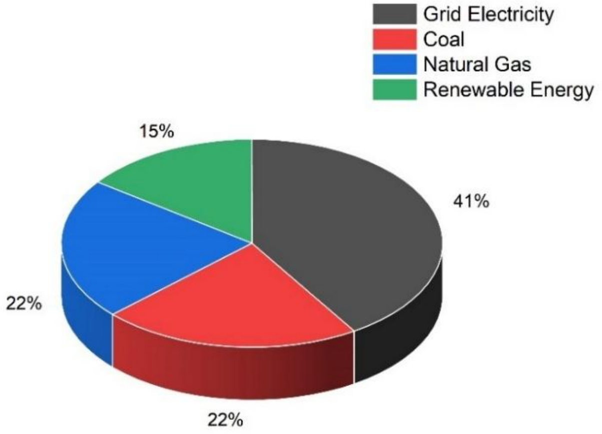


Figure 4. Current Energy Mix of Sports/Apparel Sector

In our comprehensive assessment of 15 distinct industries, an unfortunate absence of external alliances for the integration of renewable energy resources and the implementation of energy efficiency procedures in operational frameworks was observed. The tabular data is shown in Table 4.

Table 4. Status of Working with any External Organization (Sports/ Apparel)

Are you working with any external organizations or partners to adopt renewable energy or energy efficiency measures?		
	Frequency	**Percentage**
Yes	0	0
No	15	100

Despite this, a fraction of industries has undertaken energy audits, 5 to be precise, albeit with the primary objective of mapping their current energy usage, rather than identifying potential improvement areas. 5 industries didn’t conduct energy audit with any external organization to measure the energy efficiency by the integration of renewable energy.

Table 5. Energy Audits Status (Sports/ Apparel)

Have you conducted an energy audit of your production process to identify opportunities for energy savings?		
	Frequency	**Percentage**
Yes	5	33.33
No	5	33.33
N/A	5	33.33

A total of 9 industries have shown intent to invest in in-house renewable energy generation, yet this falls short of a full commitment to sustainable practices. A smaller subset (6) have initiated renewable energy projects, demonstrating a tepid interest in reducing their environmental impact rather than a dedicated commitment to sustainability. Merely 2 industries have set clear sustainability objectives in alignment with global initiatives such as the UNDP's "Net Zero by 2030" and the Paris Agreement's "Net Zero by 2050".

However, a disconcerting 66.67% of companies surveyed have yet to establish formal strategies for carbon reduction. The sports goods sector typifies this lack of genuine commitment to renewable energy, largely limiting its application to office operations. The industry’s resistance to a more extensive transition is often justified by low-emission claims. However, it is unequivocal that the manufacturing sectors, including sports goods, must need to undergo an immense transition from conventional energy sources to renewable energy sources.

Table 6. Plans of Investing in On-Site Renewable Energy (Sports/ Apparel)

Are you planning to invest in on-site renewable energy generation?		
	Frequency	**Percentage**
Yes	9	60
No	0	0
Already Installed	6	40

In response to a multiple-choice question probing the strategies under consideration for mitigating their company's greenhouse gas emissions, participants offered a varied and somewhat disconcerting set of answers. Energy efficient systems, adopted by four respondents (26.7%), signifies a devotion to improved energy management, while renewable energy, selected by three firms (20%), implies a commitment to sustainable energy solutions.

However, the absence of favor for combined heat and power, with a response rate of 0%, is stark. A mere duo of companies (13.33%)

championed the established environmental credo of “Reduce, Reuse, Recycle”, emphasizing their focus on waste management and circular economy practices. Nevertheless, a troubling majority of 60% (a total of nine firms) disclosed no current strategies aimed at curbing greenhouse gas emissions, which suggests a widespread deficiency in environmental responsibility. The mention data is shown in Figure 5.

In response to a multiple-choice query soliciting the specific technologies that various industries are contemplating to curtail their greenhouse gas emissions, the responses emerged as diverse yet somewhat alarming. Waste Heat Recovery was favored by three industries (20%), suggesting an awareness of the opportunity to harness this typically squandered energy.

Likewise, Wastewater Treatment was opted for by three industries (20%), reflecting a commitment to emission reduction through enhanced water management practices. Contrarily, there was an absolute absence of any expressed interest in Air Pollution Control

Devices and Carbon Capture and Storage, each scoring a response rate of 0%, revealing a lack of enthusiasm in harnessing these advanced technological solutions. Most notably, a disturbing majority of 60% (encompassing nine industries) admitted to not presently considering any specific technological solutions for greenhouse gas emission reductions.

This insinuates a significant lacuna in proactive environmental stewardship within these sectors. The varied responses underscore the urgency for industries to investigate and adopt more comprehensive and innovative technological solutions to effectively mitigate emissions.

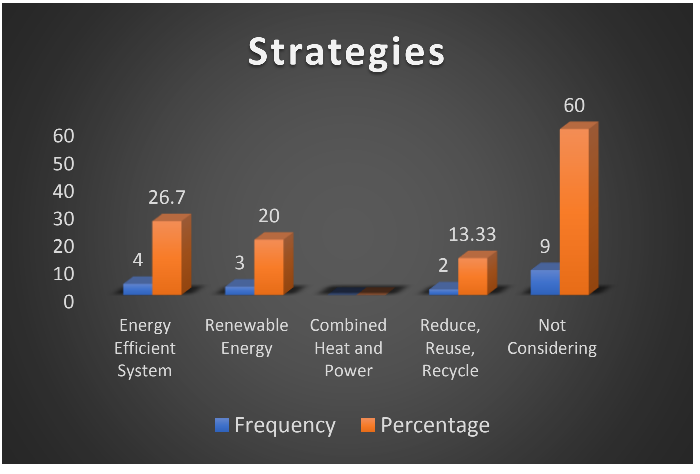


Figure 5: Percentages of Strategies for Reducing GHG Emissions (Sports/ Apparel)

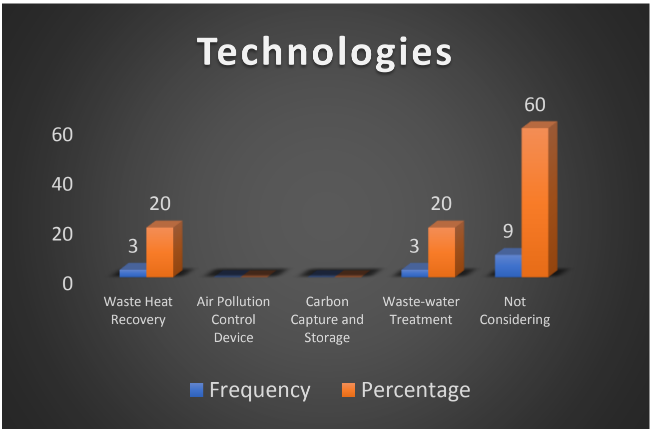


Figure 6:Technologies for Reducing GHG Emissions (Sports/ Apparel)

3.4. Challenges

In a similar vein, this section aims to present a detailed exploration of the formidable hurdles encountered by these industries in their pursuit of decarbonization. This section is predicated upon the candid revelations shared by personnel from each industry, thus providing an authentic snapshot of the current landscape of impediments. Here, we elucidate the manifold barriers stymying the transition towards sustainability and highlight the necessity for pragmatic solutions to overcome these systemic roadblocks. By doing so, we hope to facilitate a deeper understanding of the unique complexities faced by each industry and pave the way for targeted, effective strategies to expedite their decarbonization journeys.

3.4.1. Textile sector

Industries were queried regarding the difficulties encountered during the implementation of renewable energy in their production processes. A significant majority (83.33%, or ten out of twelve industries) affirmed the presence of challenges, signifying the pervasiveness of impediments in the transition towards sustainable energy practices. Conversely, a solitary industry (representing 8.33% of the total) reported a seamless transition, underscoring the potential for a frictionless integration of renewable energy under certain circumstances. Meanwhile, another solitary industry (8.33%) admitted to not having contemplated the incorporation of renewable energy, revealing an unexplored avenue for potential sustainability improvements.

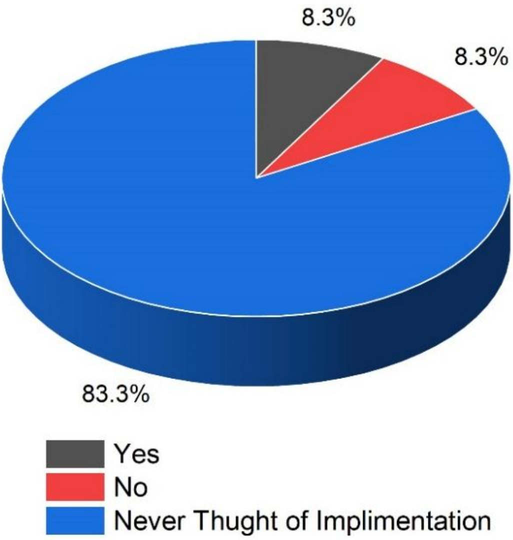


Figure 7: Barriers and Challenges in Textile Sector

Continuing with the exploration of challenges faced by industries in their quest for decarbonization and energy transition, it is evident that the data was collected through a comprehensive multiple-response question, enabling us to capture a nuanced understanding of the prevailing barriers. Technological challenges rank high among respondents, with four industries (33.33%) pointing to the complexities associated with adopting and integrating advanced sustainable solutions. The lack of supportive policy frameworks emerges as another significant barrier, cited by five industries (41.67%), emphasizing the crucial role of regulatory environments in fostering sustainable initiatives.

Meanwhile, two industries (16.67%) express concerns over uncertain returns on investments, necessitating reassurance and long-term viability. Most strikingly, inadequate access to financing options emerges as a widespread challenge, affecting ten industries (83.33%), underscoring the crucial role of financial support in propelling decarbonization efforts.

Additionally, logistics issues were noted by three industries (25%), while the cost of renewable technologies was unanimously identified as a major hindrance for all surveyed industries (100%), urging innovations to enhance the economic feasibility of sustainable technologies.

Finally, a solitary industry (8.33%) raised concerns about market volatility, adding yet another layer of complexity to the multifaceted challenges faced in this transformative journey towards sustainability. These candid insights elucidate the intricate and diverse range of obstacles confronted by industries, guiding the way towards targeted solutions for an effective transition to a low-carbon future.

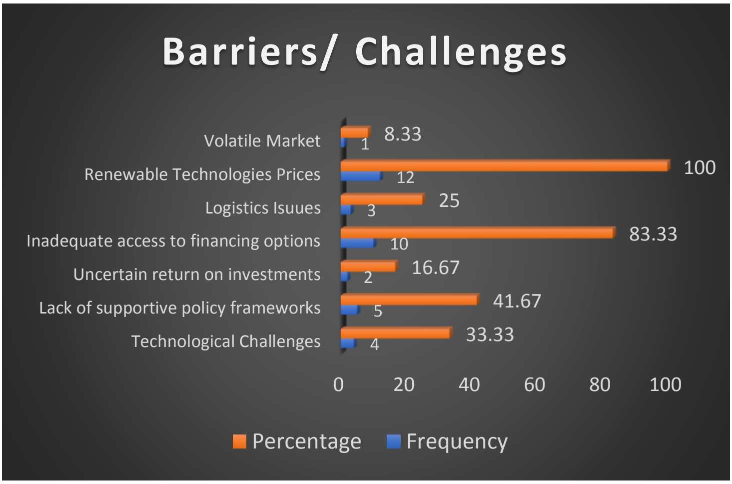


Figure 8: Barriers/ Challenges (Textile)

3.4.2. Sports/apparel sector

Industries were surveyed to gauge the challenges encountered in the implementation of renewable energy within their production processes. A noteworthy majority (53.3%, or eight out of fifteen industries) acknowledged facing hurdles, highlighting the pervasive impediments in transitioning towards sustainable energy practices. Conversely, a meager percentage (6.67%) reported a smooth integration of renewable energy, indicating the potential for seamless adoption under specific circumstances. In contrast, a substantial 40% of industries admitted to never having considered incorporating renewable energy, exposing an untapped avenue for potential sustainability enhancements. Notably, the prevalence of this sentiment in the sports equipment sector surpasses that of the textile industry, attributed to the comparatively lower emissions in the sports equipment manufacturing process.

However, when considering the entire manufacturing lifecycle, the sports equipment sector exhibits heightened emissions, necessitating a proactive embrace of renewable energy solutions to address its ecological impact. These findings accentuate the urgency for tailored strategies to overcome obstacles and foster sustainable transformations within industries.

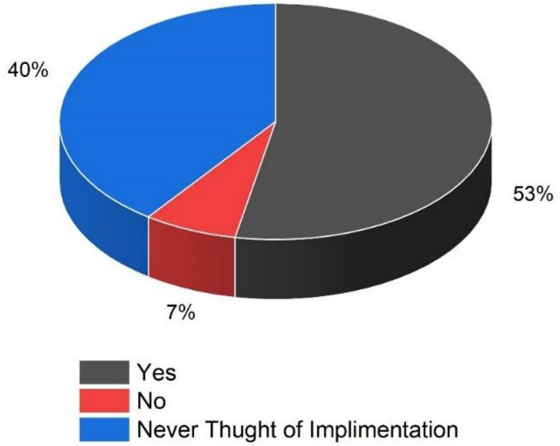


Figure 9: Barriers and Challenges in Sports/ Apparel Sector

Continuing the inquiry into barriers to decarbonization and energy transition within industries, the data was amassed through a comprehensive multiple-response question, allowing for a detailed assessment of prevailing challenges. Strikingly, several industries reported a lack of perceived technological challenges or uncertain returns on investments (both at 0%). However, two industries (13.33%) identified a lack of supportive policy frameworks as a formidable obstacle, underscoring the imperative for robust regulatory support to drive sustainable initiatives. In addition, three industries (20%) cited inadequate access to financing options as a significant challenge, emphasizing the need for accessible financial mechanisms to facilitate decarbonization efforts. Moreover, five industries (33.33%) flagged renewable technologies prices as a critical hindrance, necessitating innovative approaches to enhance cost-effectiveness. Notably, the largest proportion (60%) of industries indicated "N/A" for barriers, as they perceive their emissions to be negligible, reflecting a unique perspective warranting consideration.

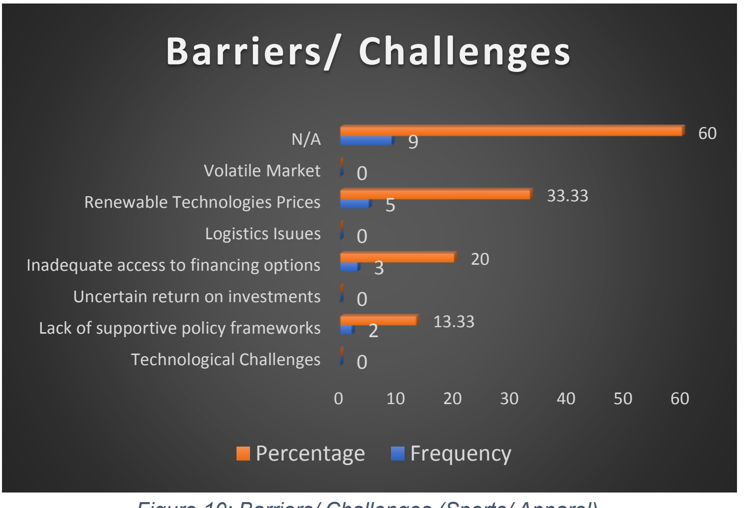


Figure 10: Barriers/ Challenges (Sports/ Apparel)

Mr. Hameed highlights a significant barrier to renewable energy adoption, noting that the

Government of Pakistan restricts net metering to 1MW. Additionally, he points out that interest rates on loans for solar system installation are higher compared to other countries. Dr. Muhammad Sultan, an Associate Professor at BZU Multan, expresses a pressing concern about Pakistan's reliance on imported renewable energy equipment, such as solar panels, inverters, and batteries, which burdens the economy and hinders the growth of the renewable energy industry. These challenges represent major obstacles to promoting renewable energy in industries.

Within the backdrop of these challenges, industry leaders emphasize the critical role that government can play in bolstering their endeavors through a range of supportive measures. As depicted in Figure 11, the government has the potential to extend a helping hand in various ways.

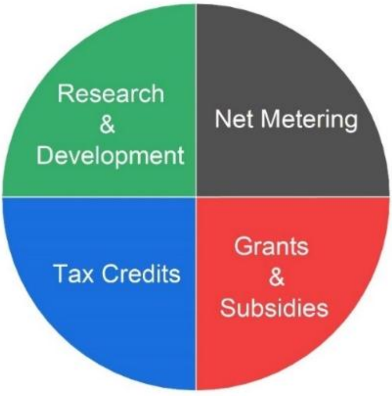


Figure 11: Suggestive Incentives by the Industries (Sports/ Apparel)

Chapter 4:

Policy Recommendations and Conclusion

4.1. Policy recommendations

Based on the challenges faced by the Textile and Sports/Apparel sector in Pakistan in transitioning to renewable energy and decarbonization of their processes, the following policy recommendations can be proposed:

4.1.1. Feed-in tariffs (FiTs) and power purchase agreements (PPAs)

i). Ministry of Energy and regulatory bodies under this ministry like NEPRA, AEDB and DISCO’s implement competitive FiTs and PPAs to encourage private sector investment in renewable energy projects. These agreements should offer attractive rates for wind, solar, and other renewable technologies.

4.1.2. Promote renewable energy adoption and incentives

i). Government should develop and implement specific incentives and subsidies for the adoption of renewable energy technologies, such as solar panels and biomass boilers.

ii). Establish feed-in tariffs and power purchase agreements to ensure a stable and attractive market for renewable energy producers, encouraging investment in renewable energy generation.

4.1.3. Enhance energy efficiency measures

i). Encourage industries to conduct regular energy audits to identify energy-saving opportunities and implement energy-efficient technologies and practices.

ii). Establish mandatory energy efficiency standards for industrial processes, machinery, and equipment, ensuring continuous improvement in energy performance.

4.1.4. Public-private partnerships

i). Facilitate collaborations between textile industries and renewable energy providers or developers to support the integration of renewable energy solutions within the industrial processes.

ii). Foster partnerships with financial institutions like commercial banks to provide accessible financing options for renewable energy projects in the sector.

4.1.5. Supportive policy and regulatory framework

i). Strengthen and enforce existing policies related to renewable energy integration, energy efficiency, and emissions reduction in the industrial sector.

ii). Introduce carbon pricing mechanisms or carbon trading schemes to incentivize industries to reduce their carbon emissions and adopt cleaner technologies.

4.1.6. Capacity building and training

i). Offer training programs and workshops to build the technical expertise of industrial personnel in renewable energy technologies and energy management practices.

ii). Develop a skilled workforce that can support the design, implementation, and maintenance of renewable energy projects in the sector.

4.1.7. R&D and innovation

i). Each company allocates funds for research and development in renewable energy technologies and sustainable manufacturing processes tailored to the Textile and Sports/Apparel industry.

ii). Establish innovation centers or technology hubs to facilitate collaboration between academia, industry, and research institutions to drive technological advancements in the sector.

4.1.8. Awareness and advocacy

i). Conduct awareness campaigns and workshops to educate industries about the benefits of renewable energy adoption and the importance of decarbonization.

ii). Engage industry associations and advocacy groups to promote sustainable practices and share best practices among companies.

4.1.9. Reporting and monitoring

i). Enforcing a requirement for companies in the Textile and Sports/Apparel sector to routinely report their carbon emissions data to the Ministry of Climate Change and Environmental Protection in Pakistan, promoting transparency and responsibility.

ii). Establish a robust monitoring system to track the progress of industries in meeting their carbon reduction targets and renewable energy integration goals.

4.1.10. Circular economy practices/ sustainable supply chains

i). Encourage companies to evaluate and reduce the carbon footprint of their supply chains by partnering with suppliers that follow sustainable practices and use renewable energy.

ii). Encouragement of recycling and reuse in manufacturing processes

iii). Development of sustainable supply chains and waste management systems.

4.1.11. Government support and funding

i). Allocate dedicated funds and financial support for research, development, and deployment of renewable energy technologies in the industrial sector.

ii). A green investment fund to support projects that align with the country's decarbonization objectives.

4.2. Conclusion

This comprehensive study paints a vivid picture of decarbonization efforts within the Textile and Sports/Apparel sectors in Pakistan. It reveals a prevailing dependency on grid electricity, supplemented by natural gas and coal, with only a minor shift towards renewable energy largely confined to administrative applications. Collaborations with external organizations for renewable energy integration and energy efficiency remain underexplored.

Interestingly, while a majority of the industries have conducted energy audits, the establishment of formal carbon reduction goals is not widespread. Nevertheless, a readiness to invest in on-site renewable energy and a focus on strategies like 'Energy Efficient System', 'Renewable Energy', and 'Reduce, Reuse, Recycle' are encouraging signs of a growing environmental consciousness. However, technologies such as 'Waste Heat Recovery' and 'Waste-water Treatment' dominate the landscape, whereas more advanced technologies like 'Air Pollution Control Device' and 'Carbon Capture and Storage' are overlooked, underscoring the need for increased awareness and investment.

The report underscores an urgent need for industries to adopt robust strategies and innovative technologies to reduce emissions. Overcoming decarbonization challenges - technological, policy-related, financial, and logistical - is paramount to accelerate their low-carbon transition. The role of government as an enabler in this transformation is underlined, with policy recommendations aimed at fostering renewable energy adoption, enhancing energy efficiency, establishing supportive frameworks, and promoting sustainable practices. Backed by necessary governmental support, these actions can help industries overcome their unique barriers and speed up their journey towards a sustainable future.

In the end, the study calls for industries to demonstrate a greater commitment to emission mitigation and renewable energy adoption, and for governments to take on a proactive role in facilitating this transition. It emphasizes our shared responsibility to build a sustainable, resilient industrial ecosystem for our shared environmental future.

Appendix A:

Questionnaire for Energy Consumption in Textile and Sports Sector

Industry Name: ________________________
Respondent Name: _____________________
Interviewer: ___________________________
Date: ___________________

1. What is the current energy mix of your units/plant?
   - Grid Electricity
   - Coal
   - Natural Gas
   - Renewable Energy
   - Any Other ___________

2. Please mention the share of fuel(s) in percentage?

Grid Electricity	Coal	Natural Gas	Renewables	Any Other

3. What renewable energy sources does your company currently utilize? Please also mention the percentage?

Solar	Biomass	Wind	Hydro	Any Other

4. Are you working with any external organizations or partners to implement renewable energy or energy efficiency measures? (Yes/No). If yes, then please mention the name.

    - SMEDA
    - UNIDO
    - NEECA
    - GIZ
    - WWF
    - CIBEA
    - NPO
    - Any Other

5. Have you conducted an energy audit of your production process to identify opportunities for energy savings? (Yes/No). If yes, please mention the year and measures suggested by the auditor.

    ____

    ____

    ____

6. Are you considering or planning to invest in on-site renewable energy generation? (Yes/No).

    If yes, please mention the year and how much? What steps do you plan to take in the future to increase the use of renewable energy sources?

____
____
____

7. What kind of challenges in implementing renewable energy or energy efficiency measures do you face in your production process? (Yes/No)

   If yes, please mention the specific challenges.
   1. ______________ 2. ______________
   3. ______________ 4. ______________

8. Which government policies or incentives would be most helpful in accelerating your company's transition to renewable energy sources?

   - Tax Credits
   - Grants and Subsidies
   - Carbon Pricing
   - Research & Development
   - Net Metering
   - Capacity Building
   - Any Other ____________

9. What specific strategies are you considering to reduce your company's greenhouse gas emissions? Please select.

   - Energy Efficient System
   - Fuel Switching (Renewable Energy)
   - Combined Heat and Power

- Reduce, Reuse, Recycle
- Any Other ___________

10. What specific technologies are you considering to reduce your company's greenhouse gas emissions?
    - Waste Heat Recovery
    - Air Pollution Control device
    - Carbon Capture and Storage
    - Waste-water Treatment
    - Any Other ___________

11. Have you set any targets or goals for reducing your company's carbon emissions aligned with any of the following? (Yes/No)
    If yes, please select.
    - Net Zero by 2030 (UNDP)
    - 50% by 2030 (UNDP)
    - Net Zero by 2050 (Paris Agreement)
    - 43% by 2030 (Paris Agreement)
    - 25% by 2025 (UN Environment)
    - Any Other ___________

12. Which type of work are you outsourcing?
    1. ______________ 2. ______________
    3. ______________ 4. ______________

13. How do you plan to engage your employees, customers, and other stakeholders in your decarbonization efforts?

14. What are the biggest barriers to decarbonization in your industry, and how do you plan to overcome them?

15. What role do you see the sports sector can play in reducing carbon emissions and transitioning to renewable energy in Pakistan?

16. Anything you want to share?

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