“To Design the Parameters for Carbon Trading System in Pakistan”

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A thesis submitted in partial fulfilment of the requirements for the degree of

Bachelors of Engineering

In

Environmental Engineering

Institute of Environmental Sciences and Engineering (IESE)

School of Civil and Environmental Engineering (SCEE)

National University of Sciences and Technology (NUST)

To Design the Parameters for Carbon Trading System in Pakistan

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DEDICATED

TO

OUR LOVING FAMILIES

AND

FRIENDS

It wouldn’t have been possible without their prayers and constant support.

ACKNOWLEDGEMENT

We have no words to express our deep sense of thankfulness and countless gratitude to **ALMIGHTY ALLAH**, the compassionate and merciful, who bestowed on us His blessings and gave us courage to complete the present studies and dissertation.

We have no words to express our sincere gratefulness to our respectable and worthy supervisor **Col Dr Salahuddin Azad**, Institute of Environmental Sciences and Engineering, for his keen potential interest, skilful guidance, constructive criticism, and ever encouraging attitude throughout the course of research work.

We would like to thank **Muhammad Anwar of Pakistan bureau of Statistics** for providing us his assistance for interpreting of CMI data.

We would like to thank **Kaleem Anwar of Global Climate Impact Study Centre, Ministry of Climate Change** for providing us with his guidance and support for the calculation of CO_2 Emission of Manufacturing Industries of Pakistan

Abstract

Earth third planet from sun where we live, currently earth's environment is at stake. Global warming the phenomenon of average increase in earth's temperature is biggest challenge we humans would have ever faced. It has various negative impacts including changes in precipitation patterns, depleting snow covers, intense weather conditions.

World's emissions are needed to be controlled and reduced to make it sustainable for our future generations.

Carbon trading certainly could be an option; it is a management approach which utilizes financial incentive to reduce emissions. Where less pollution producing industries will get benefit. Emission contributions are divided broadly into three sectors (Energy, Manufacture, and Agriculture)

To develop carbon trading systems we must have calculated emissions data. We calculated emissions of different industries and predicted Pakistan's emission for 2030 from fossil fuel burning and cement production. Currently, Pakistan in ranked 33rd in emissions from fossil fuel burning and cement production. Pakistan's emission increase from 1990 to 2030 was 140 percent. Pakistan's emissions in 2020 and 2030 would be 687 and 833 MT of CO2 respectively (ignoring CPEC).Adding CPEC in picture our Emissions will be 1369.6 MT in 2030.We will be among top 10 polluters of world in 2030.Pakistan is expected to be 8th most worst, effected country, due to global warming by 2030.Pakistan government needs to take bold decisions today in order to reduce emissions & most importantly securing, Future of our Children

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1 Introduction

Earth’s climate is changing. The temperature is intensifying; the snowfall pattern is changing, extreme weather events have occurred, such as heavy rain and high temperatures. Global researchers and scientists are very assertive that many of the significant changes are linked to the anthropogenic increment in GHG emissions, particularly CO_2.

1.1 Climate Change

Since the start of the industrial revolution of the 17th century, people have increased the amount of greenhouse gases in the troposphere; in particular fossil fuels emissions and deforestation have contributed. The major greenhouse gas emissions are carbon dioxide (CO_2), methane (CH_4), nitrogen oxide (NO_X), and fluorinated gases. When these gases are released into the atmosphere, they have different residence times, which can be in decades.

1.1.1 Mechanism

GHGs are called Greenhouse gases" as they cover the heat (energy), such as the greenhouse at the bottom of the atmosphere. As a result of additional gas in the stratosphere more heat is caught. This excess heat causes the temperature of the air near the surface of the earth to raise, the weather pattern changes, thus ultimately increases water levels of oceans at ports.

1.1.2 Effects

These perceived changes affect general public and the environs in an important way. For example, sea level increments, glacier dissolution, plant and animal cycle changes. These types of changes can lead to major ecosystem conflicts ultimately affecting flora and fauna, local communities and biodiversity. These changes may also affect quality of life as well as where people can live, which sorts of yields are the most sustainable, what types of works can flourish in some areas, and the state of construction and infrastructure .

Over time, many of these changes have a negative impact on humans and society.(Barker, 2007)

1.1.2.1 Temperature

- The eleven years of the past 12 years (1995-2006) are the global 12-year of warmest surface temperature (since 1850).Linear heating from 1956 to 2005 (0.13 to 0.16 per year) is almost double that of 1906 to 100 years in 2005.
- High temperatures occur around the world, with high latitudes. Over the past 100 years, the average temperature of the Arctic has tripled. Observations since 1961 show that the global average temperature is higher than 3,000 meters, and the ocean accounts for more than 80% of the warm climate of the climate system.

1.1.2.2 *Sea Level*

The rise of the sea level is in line with the heating between 1993 and 2003, with the world average sea level rising by 1.8 (1.3 to 2.3 mm) a year, on average 3.1 (2.4 to 3, 8 mm) per year. If the fastest rate from 1993 to 2003 reflects a constantly changing or rising long-term trend, it is not clear.

Since 1993, the thermal expansion of the oceans has contributed to the sea level rise of about 57 percent of the individual, ice and ice contribution by about 28 percent and the loss of ice sheet has led to the remaining loss.

1.1.2.3 Snowfall

The sharp fall in snow and ice is also in line with warming up. Satellite data since 1978 show that the average annual decline of the glaciers over the past decade is 2.7 mm (2.1 to 3.3) and 7.4 mm (5.0 to 9.8) in the summer. The average of the hemisphere glaciers and snow has fallen. Since 1900, the northern hemisphere will fall to 7% of the seasonal land and 15% in the spring.

1.1.2.4 Precipitation

At continental, regional and oceanic levels, the climate has many long-term changes. In many of the larger precipitation areas the observed changes were from 1900 to 2005. During this time, the Northrup precipitation in North Asia, Central Asia, North America and South America increased significantly, and precipitation went back to South and South Africa.

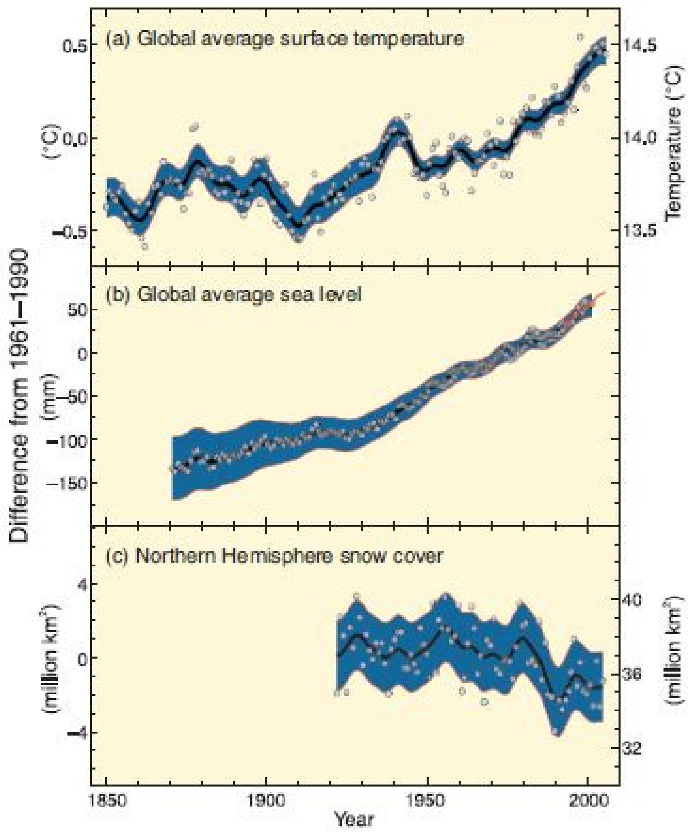

Figure 1: Global Climate Changes(Barker, 2007)

1.1.3 Greenhouse Gases associated with anthropogenic activities

As mentioned above, the GHG's discharged into the atmosphere are commonly carbon dioxide, methane, nitrogen oxide and fluorine. Many of the big greenhouse gases remain in the atmosphere after ten thousands of years. They are usually mixed at the bottom of the atmosphere, called the troposphere (a few kilometres from the surface of the earth), reflecting the common contribution of past and current sources of emissions around the world. Due to this global convergence, the effects of these emissions are not dependent on their position in the world.

The concentration of these gases, regardless of the position of the measurement, is comparable, as long as the gas measures a large source or zinc.

1.1.3.1 Residence Time

The life expectancy of some other substances is much shorter (less than a year), but is still related to climate change. Important short-acting substances that affect the climate are water vapour, ozone in the troposphere and pollutants that cause ozone and aerosols (air molecules) such as black cabbage and sulphates. Water vapour, tropospheric ozone and black carbon contribute to heating, while other aerosols can cause cooling effects. Because these substances are short-lived, their impact on the climate can be influenced by their emissions, and concentrations are concentrated from place to place. Several factors determine the influence of global warming on the climate. One factor is the residence time of gas in the atmosphere.(Myhre et al., 2013)

1.1.4 Global Warming Potential

The other factor is the distinctive ability of each gas to absorb energy. As one of these factors, scientists calculate the natural gas potential and measure the number of greenhouse gases that can be generated by global warming after a period of time (e.g. 10 to 100 year). In contrast, global warming potential (GWP) is calculated so that global warming is possible. The following table describes several important sources of long term heating potential, GHGs

Table 1: Major Gases

Green House Gas	Production Source	Average Residence Time	100- Year Global Warming Potential
Nitrous Oxide	Agricultural & Industrial activities, Combustion of fossil fuel & solid waste	121 years	265 – 298
Fluorinated Gases	Group of gases that contain fluorine including hydrofluorocarbon, perfluorocarbon and Sulphur hexafluoride among other chemicals. These gases are emitted from a variety of industrial processes and commercial and household users and do not occur naturally.	A few weeks to thousands of years	Varies (Sulfur hexafluoride 23500 years)
Methane	Emitted during production & transport of oil & natural gas as well as coal. Livestock and agricultural practices , anaerobic decay of waste also emit CH4	12.4 years	28 – 36
Carbon dioxide	Burning of fossil fuel, solid waste, trees and wood products. Deforestation and soil degradation.	Varies	1

Source: (Myhre et al., 2013)

100 year global warming potential is the effect that occurs due to emitted gases over period of 100 years

1.1.5 Unsustainable Environment

With the increase in greenhouse gas emissions of human activities, they accumulate in the atmosphere and heat the atmosphere, leading to other changes in the world - the atmosphere, the earth and the sea. These changes have a positive and negative impact on people, society and the environment (including plants and animals). Because many gases of greenhouse effect continue to exist for hundreds of thousands of years after the atmosphere is released, the impact of climate-friendly climate heat still exists for a long time and can thus influence current and future generations.

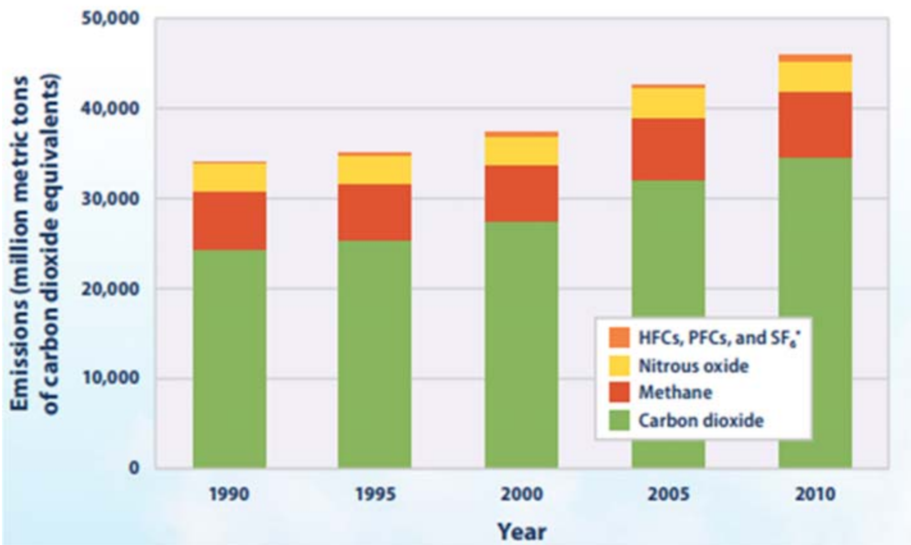

Figure 2: Global CO2 Equivalent Emissions (. IPCC (Intergovernmental Panel on Climate Change). 2014. Climate change 2014: Mitigation of climate change. Working Group III contribution to the IPCC Fifth Assessment Report. Cambridge, n.d.)

The graph depicts the Total emission of major GHGS in terms of CO_2equivalent.

The global warming potential of each greenhouse gas is different. There is also an agreement to better understand the carbon dioxide equivalent of global warming potential for greenhouse gases.

1.1.6 Carbon dioxide Emissions (CO_2 Equivalent and concentration)

The effects of heat (radiative forcing) on the global climate system are different due to the different lives of radiation and atmospheric greenhouse gas. These warm effects can be expressed in a common scale based on the effect of CO2 radiation.

- Equivalent carbon dioxide emissions are carbon dioxide emissions, which will result in the same combined radiative forcing with long-term greenhouse gas (GHG) or greenhouse gas mixtures over a specific time frame. Within the time frame, carbon dioxide emissions are obtained by multiplying greenhouse gas emissions by their own GOPs. A combination of greenhouse gases is obtained by collecting carbon dioxide emissions from each gas. Carbon dioxide emissions are the standard and useful measure of comparing greenhouse gas emissions, but not the same climate change

- The concentration of carbon dioxide equivalent is the concentration of carbon dioxide that results in the same amount of radiation forcing with some combination of carbon dioxide and other forced components.

2 Carbon Trading Concept

In recent years, the reason for the darkening of the sky is that only the lasting effects of each carbon dioxide in the environment have changed. The continuous accumulation of carbon dioxide in the climate has led to an increase in so-called global warming. In addition to the expansion of carbon dioxide consumption in the oil derivatives environment, the few reasons are the deliberate perspective of forests, more processing plants and other human structures to clear the road. Given the development of harmful levels of greenhouse gases and the aftermath of global warming, government experts and private associations are forced to update the carbon framework in the environment that helps to reduce carbon dioxide measurements.

In the current situation, global warming has caused a lot of money, making the green plan to promote natural strategy and management. It is known that carbon dioxide is the most emitted substance by burning energy (fossil fuels, including coal and gasoline) that has become the cause of global warming because. This opens the door to cross boarder exchanging CO_2 credits inside and outside the management area, making the "carbon market" around the world.

2.1 Koyoto Protocol

- It was one of the benchmarks in moving the world towards a sustainable and environment friendly community
- The Kyoto Protocol was launched by the United Nations Framework Convention on Climate Change (UNFCCC) and was confirmed by 181 countries and the European Union as a whole, a single article in 1997 and entered into force in 2005.(Gupta, 2011)

2.1.1 Proposals

The Global Panel proposes this Global Panel to address and reduce releases resulting from ozone depletion of environmental change. The protocol is obligatory to reduce the most advanced carbon dioxide mobility, to reduce the recommended levels, to buy carbon credits that can be made in the market, or automatic part, the payer does not charge.

2.2 Carbon Credit

Global settlements have identified greenhouse gas stocks that can be developed and developed for the organization. By encouraging companies to manage better business prerequisites, tools such as carbon credits and carbon balances are known and improved. Carbon credits allow tons of carbon dioxide or any other place to release other greenhouse gas comparison measures. Organizations that exceed their share need to buy carbon dioxide emissions to get too much emission.(Gupta, 2011)

2.2.1 Credits Trade Mechanism & Developed World

These credits can be exchanged between organizations or purchased and sold on world markets to earn the cost of the commercial sector in two operations, in particular the Chicago Climate Exchange and the European Climate Exchange. India's multi-commodity exchange (MCX) can soon pay the third largest trading partner on the planet to trade carbon credits. The extent of global emissions can be controlled by the purchase and delivery of CO_2 credits in the carbon trading strategy. It is very easy and cost effective to buy carbon credits from different companies, comparable to any other tax instrument, because they have exchanged an open market.(Forrister, 2013)

Carbon trading is used when organizational discharges exceed the carbon credit standard, allowing them to buy credits from different organizations that have carbon credits. Therefore, total CO_2 emissions remain at reasonable levels, and organizations believe that naturally reasonable methods of business management. The framework also encourages associations to be more eco-friendly in order to increase their profits by providing carbon credits. As carbon credits openly exchange the market, they allow organizations to go beyond the framework. There are no complex rules or methods to be retained, which improves their recognition and makes the framework very effective.

Carbon credits can also be purchased, regardless of the possibility that you are not an association without considering the ultimate goal to reduce your own impression of carbon. The money you put in this way is intended to subsidize environmental activities in every neighbourhood of the planet to execute the outputs due to your exercises. This agreement and the purchase of carbon credits promote the reduction of uncontrolled emissions of greenhouse gases throughout the world. The organizations responsible for air pollution are meant to pay their demonstrations while compensating those who make progress. In the current situation, the carbon credit market directly affects the research regarding the money of the association.

This has led companies to effectively seek ways to reduce their release and develop cleaner ways to work together. Thus, the overall framework persuades organizations and governments to provide conditions for a cordial process to reduce ozone depletion.

Carbon exchange, also known as divergence, is a joint effort that limits the carbon measurements that create different organizations, associations, and elements over a period of time. Those who provide clean and innovative organizations, these procurement is the world's polluters. In the future, this framework can successfully manage the threat of dangerous atmospheric differences.

As of now there are various Carbon markets in the world but the most well established market is European Union Emission Trading system (ETS). First implemented in 2005 is now in its third phase of implementation with more complex and diverse system that also account for air and travelling related emission.

3 Methodology

There are different method used which depend upon the amount of sophisticated devices and the amount and type of data available to calculate carbon emission (Gómez et al., 2006)

3.1 IPCC Guidelines

IPCC gives 3 different approaches which require different types of parameters and data.

3.1.1 TIER 1 Approach

Applying a Tier 1 emission estimate requires the following for each source category and fuel:

- Data on the amount of fuel combusted in the source category
- A default emission factor

GREENHOUSE GAS EMISSIONS FROM STATIONARY COMBUSTION

Emissions GHG, fuel = Fuel Consumption fuel • Emission Factor GHG, fuel

Where:

Emissions GHG, fuel = emissions of a given GHG by type of fuel (kg GHG)

Fuel Consumption = amount of fuel combusted (TJ)

Emission Factor GHG, fuel = default emission factor of a given GHG by type of fuel (kg gas/TJ). For

CO_2, it includes the carbon oxidation factor, assumed to be 1.

3.1.2 TIER 2 Approach

Applying a Tier 2 approach requires:

- Data on the amount of fuel combusted in the source category;
- A country-specific emission factor for the source category and fuel for each gas.

It uses Tier 1 equation but require country specific emission factor

3.1.3 TIER 3 Approach

The Tier 1 and Tier 2 approaches of estimating emissions described in the previous sections necessitate using an average emission factor for a source category and fuel combination throughout the source category. In reality, emissions depend on the:

- Fuel type used
- Combustion technology
- Operating conditions
- Control technology
- Quality of maintenance
- Age of the equipment used to burn the fuel

In a Tier 3 approach this is taken into account by splitting the fuel combustion statistics over the different possibilities and using emission factors that are dependent upon these differences. In Equation, this is indicated by making the variables and parameters technology dependent. Technology here stands for any device, combustion process or fuel property that might influence the emissions.

GREENHOUSE GAS EMISSIONS BY TECHNOLOGY

Equation used to calculate CO_2Emission:

Emissions GHG, fuel, technology = Fuel Consumption fuel, technology • Emission Factor GHG, fuel, technology

Where:

Emissions GHG gas, fuel, technology = emissions of a given GHG by type of fuel and technology(kg GHG)

Fuel Consumption fuel, technology = amount7 of fuel combusted per type of technology (TJ)

Emission Factor GHG gas, fuel, technology = emission factor of a given GHG by fuel and technology type(kg GHG/TJ)

Application of a Tier 3 emission estimation approach requires:

- Data on the amount of fuel combusted in the source category for each relevant technology (fuel type used,
- Combustion technology, operating conditions, control technology, and maintenance and age of the equipment).A specific emission factor for each technology (fuel type used, combustion technology, operating conditions, control technology, oxidation factor, and maintenance and age of the equipment).
- Facility level measurements can also be used when available

We choose tier 2 approach to calculate carbon emission of manufacturing industries of Pakistan because data on the amount of fuel consume by each industry is available from Pakistan bureau of Statistics.

3.2 Data Acquisition and decoding of data

Census of manufacturing industries(2005-06) data which was acquired include types of industries, products, amount of fuel used, type of fuel used, quantity of fuel used and so on

The step to get the desire data from the cluster of different types of data were:

- Comprehend and decode the Census of Manufacturing Industries(CMI) data by help of Pakistan industries classification and determine the number of different types of industries
- Collecting the fuel data against each type of industry
- Determining the type of fuel which used by industry(furnace oil, diesel, natural gas, coal, kerosene oil)
- Determining the units in which they are measured(1000tonnes, tonnes,1000 kgs, cubic meters.1000cubic meters
- Collect all data which was extracted from CMI data and arrange all that in an excel file to get the different types of fuel used by each type of industry

3.2.1 Calculation method

As I mentioned earlier we were using tier 2 approach which needed the amount of fuel and country specific emission factors for calculation

- The fuel data we acquired from CMI was in different types of units.(tonnes, cubic feet)
- Fuel data is needed to be in converted into tonnes of oil equivalent.
- For the fuel value is converted into tonnes of oil equivalent, first the fuel data for particular fuel should be in unit consistency with the higher heating value.
- Then multiply fuel data with the higher heating value. Through which it gives the amount the heat produced by burning particular amount of fuel burnt.
- Use the heat produced for that particular amount of fuel to convert it to tonnes of oil equivalent
- Multiply the country specific emission factors with the tonnes of oil equivalent to get the amount of CO_2 produced

4 Results and Discussions:

Agriculture also contributes towards the emissions. There are different software's being utilised for this purpose. We only calculated emissions for the major crops of Pakistan. Data of crop area and production was acquired through Pakistan Bureau of statistics website(Bureau of Statistics, n.d.). Technical details were gathered regarding fertilizer, water, tube well, transportation, cropping period etc, were acquired from experts at Faisalabad, Ayub Agriculture, research Institute.

Lastly, Cool Farmers tool was the application utilized to produce the results, land use change was ignored for these calculations(World Health Organisation, n.d.)

As we speak of results, Rice crop was an outlier with approximately 202 MT of CO2 equivalent emissions, followed by wheat with much lower 53 MT emissions.

Whereas Cotton and sugar were almost insignificant with 4.6 and 2.6 MT of CO2 equivalent emissions

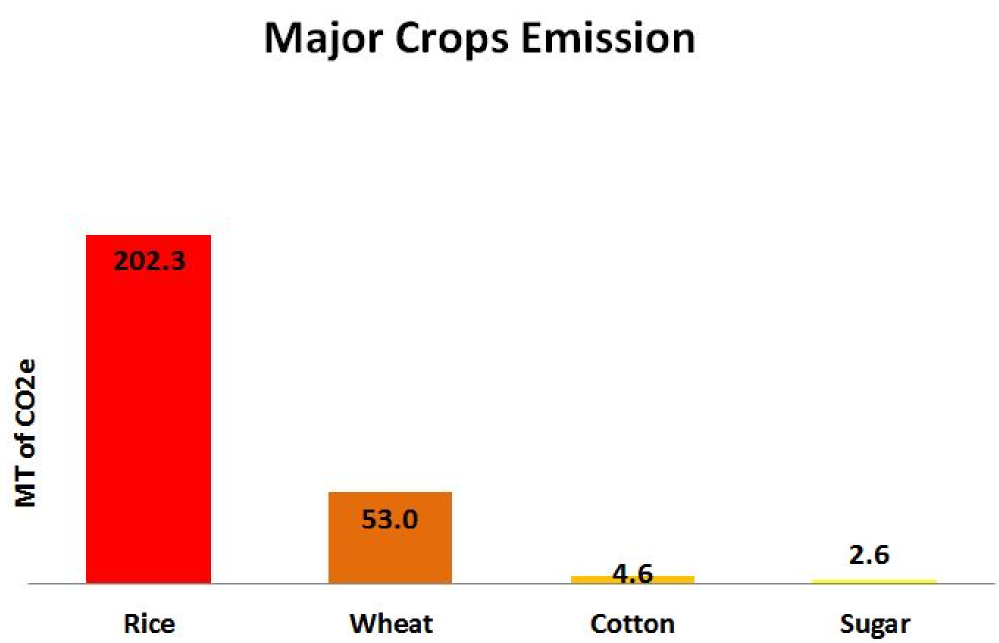

Figure 3: Major Crops Emissions

Emissions for major greenhouse gass emittiors were calculated based on reverse approach. Briefly, it is to calculate emissions based on the data of production. Various industries were visited to aquire data regarding fuel and production.

Industries visited includies

- Mapple leaf Cement, Mian Wali
- Pak Arab Fertilizers, Multan
- Itehad Chemicals, Lahore.
- Itehad Steel and Potohar Steel, Islamabad

We must state that, none of the industries stated above had exact data of there , emissions and fuel. Whereas, they weere hesitant to share data of there production. They provided data on individual plants, by approximation. The data was used for furhter data minning and over all emissions were calculated.

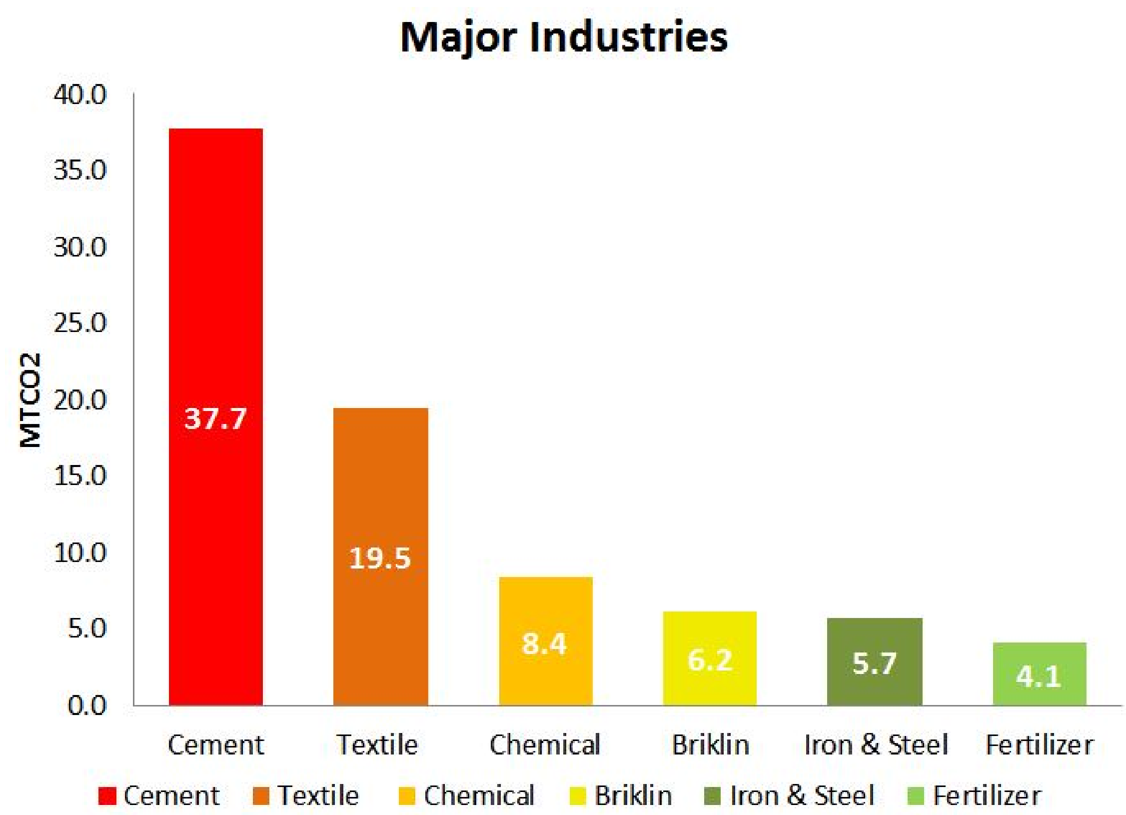

Figure 4: Major Industrial Emissions

This results acquired on the basis of fuel data, shows the huge CO2 emission contributors from industrial sectors. Textile industries leading followed by eatables, non-metallic mineral products, chemical and rubber industries. According to CMI data the no of textile industries in 2005 are much higher than others industries hence relatively the amount of fuel used by the textile industries which gives the reason behind higher contribution of CO2 emission

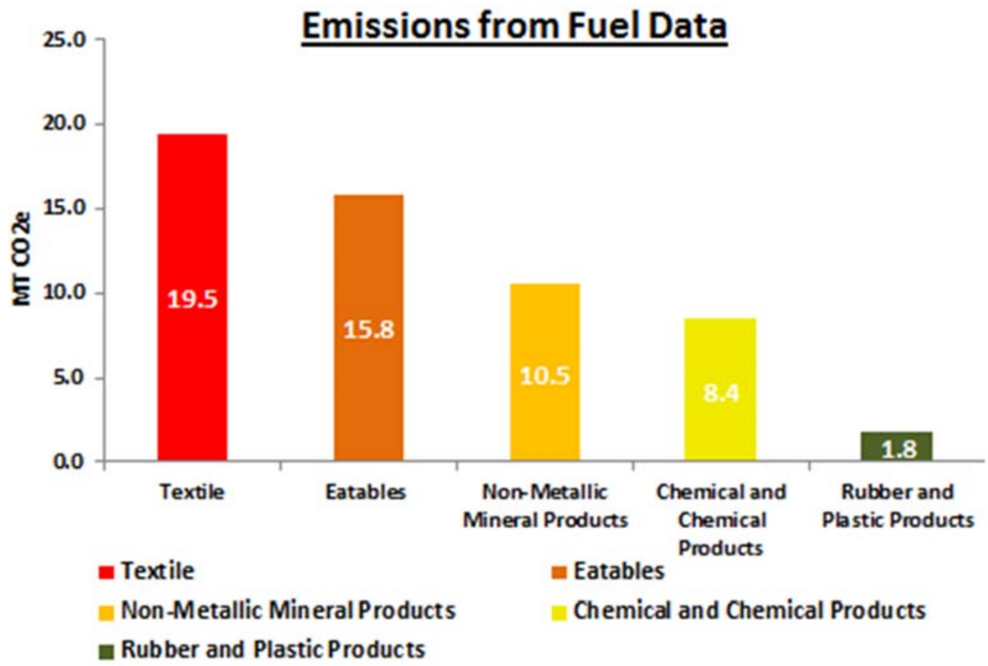

Figure 5: Emission in MT CO2 of different types of Industries by using CMI Data

Analysis was done for percentage share of emission from particular fuel type. The graph obtained shows that the major contribution is from Natural gas followed by furnace, diesel, and coal having very little share

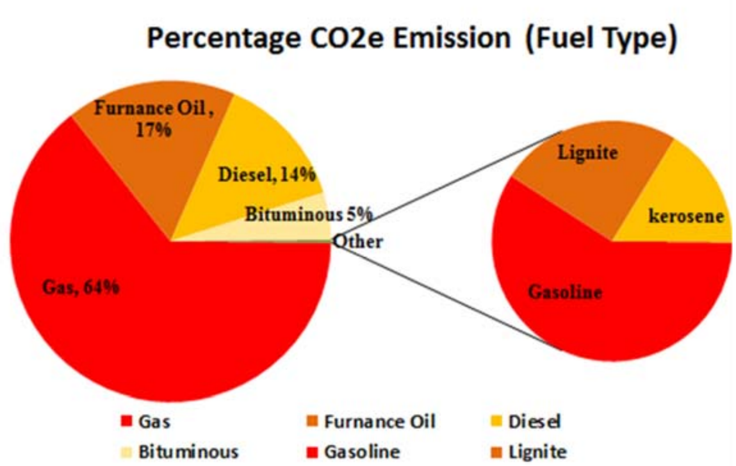

Figure 6: Percentage of CO2 emission by each fuel type

This graph results were used to compare our findings to world bank data of fuel based emission share, our data and results were, incoherence with the World Bank data

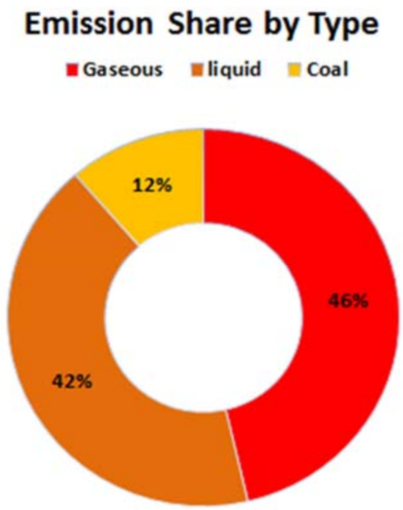

Figure 7: Emission of CO2 by types of Fuel (World Bank)

5 Future Prediction

Worlds annual emissions are reported in terms of emissions from fossil fuel emission and cement production as a convention, Pakistan as a country is on economic boom with industry thriving.

To fulfil the energy deficit coal based power plants will be the major source in near future which will increase countries GHG gas emissions remarkably.(Li, Lei, He, Wu, & Chen, 2016)

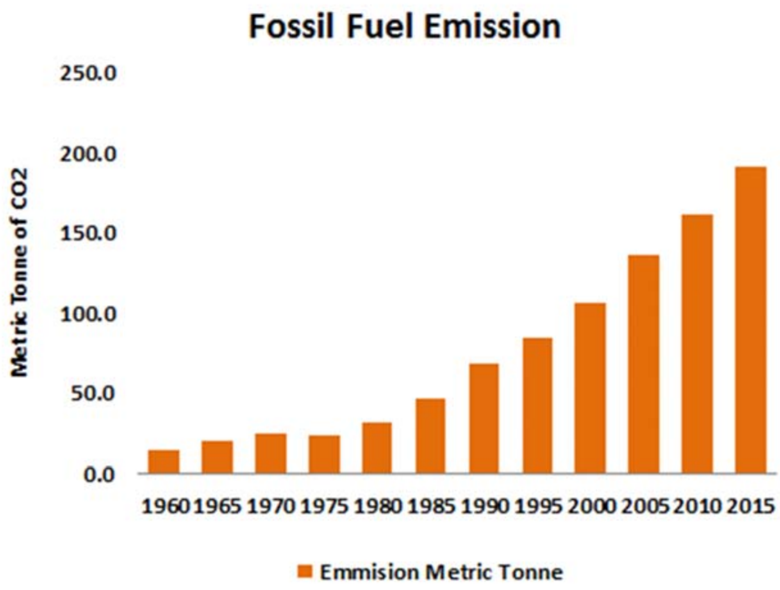

Figure 8 Fossil Fuel Emission profile of Pakistan (1960-2015)

This above graph shows the carbon emissions through 1960-2015 (from fossil fuel burning).It can be inferred from this graph that, from 1960 our emissions are continuously rising.

Climate change has threatened our economic, environmental, and social sustainability seriously. The world has taken active measures in dealing with climate change to mitigate carbon emissions. Predicting the carbon emissions peak has become a global focus, as well as a leading target. According to Paris agreement Pakistan's emissions will peak in year 2030. Scholars generally have studied the influencing factors of carbon emissions. However, research on carbon emissions peaks is not extensive. Therefore, this study predicts Pakistan's carbon emissions peak for year 2030 based on the data from 1998 to 2012 (provided by world bank) using the Stochastic Impacts by Regression on Population, Affluence, and Technology (STIRPAT) model. The results show that Pakistan will be among top emitters in 2030 Thus, puts forward that Pakistan must adapt to greener technologies as the modern world. Many countries especially Europeans, have the large-scale application of technology, innovation to improve energy efficiency and optimize energy structure, supply and demand.

In recent years, many institutions and scholars in the world have used different models to forecast Carbon emissions peak for big polluter's like China, we have adopted one such approach to predict Pakistan's emission peak. There are some methods employed for this prediction.

BP Corporation stated that energy growth in the world would be mainly concentrated in emerging economies such as China, India, Russia, and Brazil in the next 20 years from 2011. The global carbon emissions peak would arrive soon after 2020, when carbon emissions would be 20% higher than in 2005 (BP Energy Outlook, 2011)

The International Energy Agency (IEA) also noted that carbon emissions would peak in 2020. Scholars have also adopted different models and methods, such as the scenario analysis method, the index decomposition method, the structure analysis method, and the STIRPAT model. The scenario analysis method is easy to be used and can be analysed and compared with a variety of scenarios. However, the biggest flaw of this method is that the parameter setting of scenario prediction is quite arbitrary. The influence factors of carbon emissions are not comprehensive in the scenario analysis method, which may miss some more important variables as a result. For example, urbanization has a great effect on the increasing of carbon emissions, but it is difficult for the model to reflect this situation. Historical data can be used in the index decomposition method and the structural analysis method to accurately measure the influence factors of carbon emissions.

The STIRPAT model has two advantages. (H. Li, H. Mu, M. Zhang, 2012).

Firstly, it has better expansibility and can introduce multiple independent variables to test the influence of each independent variable's pressure on the environment when analysing environmental stress.

Secondly, the STIRPAT model is nonlinear, so the introduction of the index can be used to analyse the environmental impact of the no equal proportion of individual factors.

5.1 Model and Data

5.1.1 Model.

The STIRPAT model is derived from the IPAT model. Ehrlich and Holdren [26] first put forward the IPAT model in 1971. The IPAT model was adopted to quantitatively calculate the impact of people on the environment. *I* expresses environmental impact, *P* denotes population, *A* indicates affluence, and *T* denotes technology level. However, although the IPAT model has been widely recognized and applied to the analysis of influence factors of environmental change, there are also some obvious shortcomings. One shortcoming is that the influence of each factor is equal. To make up for this defect, scientists put forward the stochastic format(T, Dietz and E. A. Rosa, n.d.), which was called the STIRPAT model in

$I = \alpha P^a A^b T^c e$. **(1)**

The variables a, b, and c are the exponential terms of every factor, and e is the stochastic error. The STIRPAT model is widely used to study carbon emissions and their influence factors. (H. Li, H. Mu, M. Zhang, 2012)

Taking the natural logarithm of (1), (2) can be obtained in the following:

$\ln(I) = \alpha + a(\ln P) + b(\ln A) + c(\ln T) + e$. **(2)**

As urbanization level (UL), energy consumption structure (ECS), and economic structure (ES) are important influence factors of CO2 emissions, this study introduces UL, ECS, and ES into the model.

The description of the variables used is in the following table

Table 2: Variables

Variable	**Symbol**	**Definition**	**Unit**
CO2 Emission	I	CO2 Emissions in Pakistan	
Total Population	P	Total Population	Ten thousand
GDP per Capita	A	GDP Per Capita	constant 2010 US$
Carbon Intensity	T	CO2 Emissions per GDP	kg per2010 $
Urbanization Level	UL	The percentage of city population in total population	%
Energy Consumption Structure	ECS	The portion of coal consumption in energy consumption	%
Economic Structure	ES	The percentage of output value of second industry in GDP	%

Source: (H. Li, H. Mu, M. Zhang, 2012)

The modified model are shown in the following:

ln (I) =α+a ln (P) + b ln (A) + c ln (T) + d ln (UL) + m ln (ECS) + n ln (ES) + e. (3)

Regression analysis is performed for (2). Regression coefficients reflect the elastic relationships between explanatory variables and the variables being explained. For those models that contain many independent variables, there may be a certain correlation or high correlation between them.

5.1.2 Data

The data of P, A, T, UL, ECS, and ES between 1998 and 2012 were all acquired from World Bank data

5.2 Influence Factors and the Regression Equation Fitting

5.2.1 Population

Pakistan's population was 132 million in 1998 and it increased to 244.9 million in 2012 (World bank data). Although Pakistan's population increased in the time period, its population growth rate decreased from 1998 to 2004 and increased from there on towards 2012

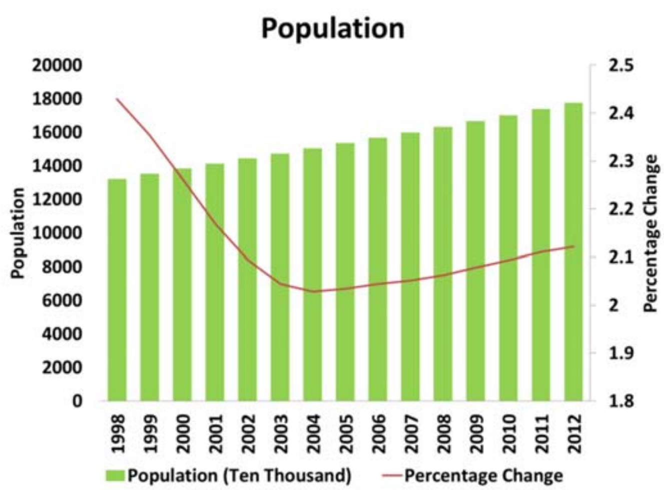

Figure 9: Population and Percentage Change (World Bank, n.d.-e)

5.2.2 GDP per Capita

Pakistan's GDP per capita was 823.9 (constant 2010 US$) and it increased to 1063.6 (constant 2010 US$) in year 2012

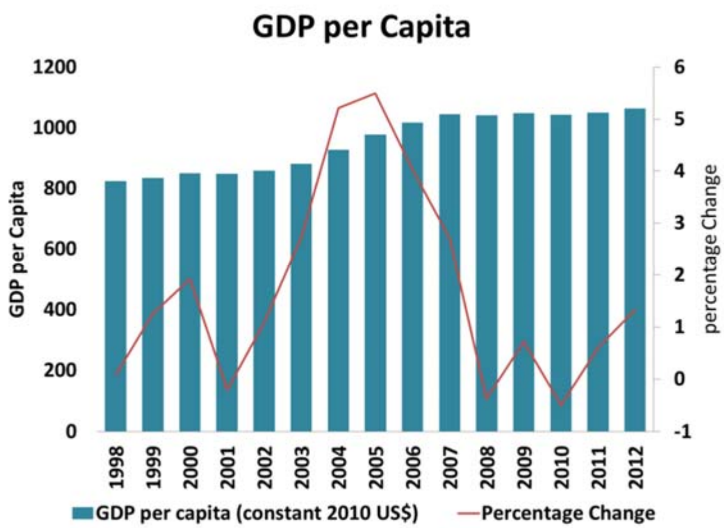

Figure 10 GDP per Capita & Percentage Change

(World Bank, n.d.-d)

5.2.3 Carbon Emissions Intensity from 1998 to 2014.

It is the amount of CO2 emitted per Dollar of GDP earned.

Pakistan's Emission intensity was 0.898 kg per 2010$ which rose up to 0.95 in 2007 and decreased onwards towards 2012 to a value of 0.864 kg per 2010$.Percentage change rate have a random trend with slight increments' in certain years followed by decrement after 2007

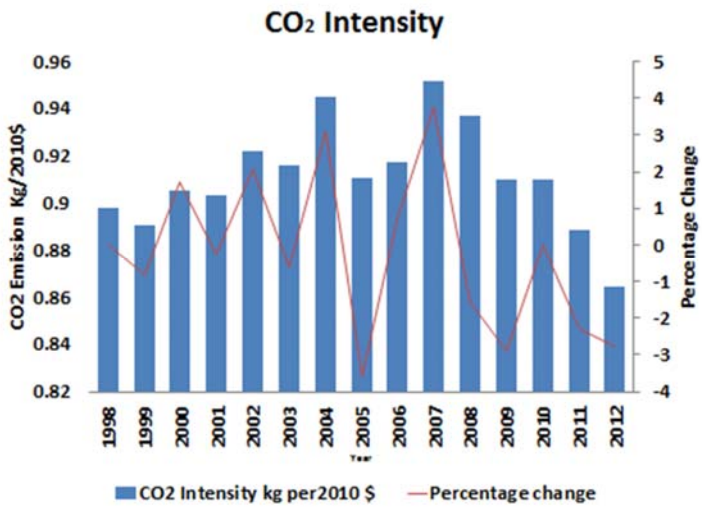

Figure 11 CO2 Intensity & Percentage change(World Bank, n.d.-a)

5.2.4 Urbanization Level from 1998 to 2014

Urbanization level is total percentage of people residing in urban areas. Pakistan is a rural country with major portion of population residing in rural areas, due to lack of basic facilities of life in urban areas, Pakistan's urbanization has been increasing ever since.

Urbanization level increased from 32.6 to 37.428 percent from 1998 to 2012 which is expected to increase to 47.3 percent in 2025 and 50 percent by 2030, as per weighted approach analysis

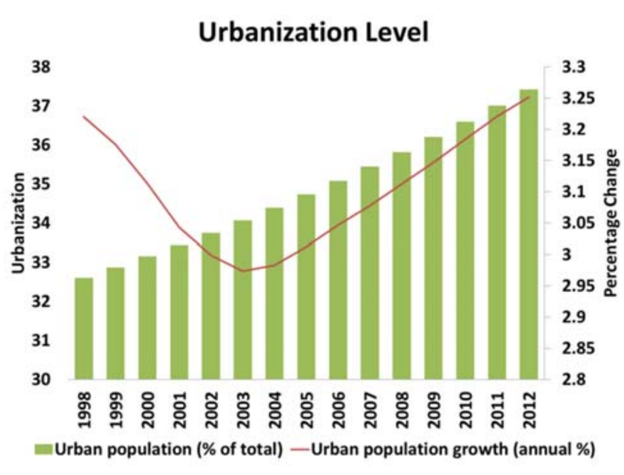

Figure 12 Urbanization level & Percentage Change (World Bank, n.d.-f)

5.2.5 Energy Consumption Structure from 1998 to 2014.

It is the percentage share of coal based emissions, Pakistanis coal based emissions or minimal as we rely mainly on natural gas followed by fuel. Pakistan's energy consumption structure was8.38 % in 1998 which increased to 10.6 percent in 2011 and was reduced to 8.65 percent in 2012.

Pakistan's energy consumption structure is expected to be 14.7 and 16.3 in year 2025 and 2030 respectively.

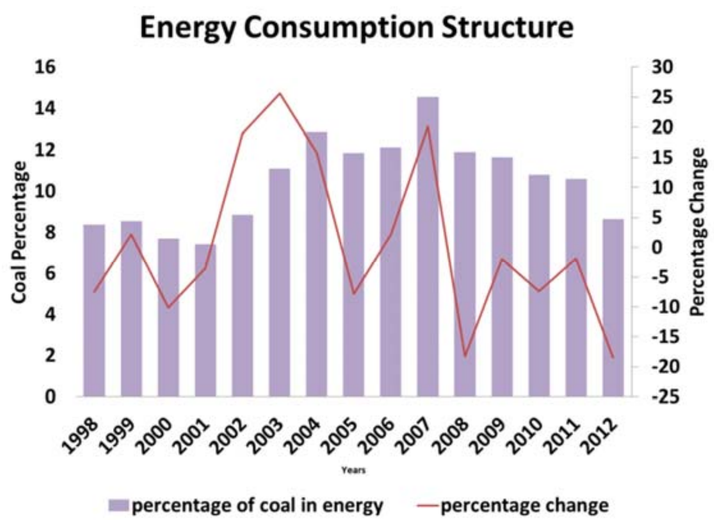

Figure 13 Energy Consumption Structure & Percentage change (World Bank, n.d.-c)

5.2.6 Economic structure:

It is the percentage of GDP added by industry. Pakistan's economic structure has shown ordinary progress from 1998 to 2012 with peaking value of 27.1 % in 2005. Highest growth rate was in year 2007 – 2008 i.e. 8.47%.

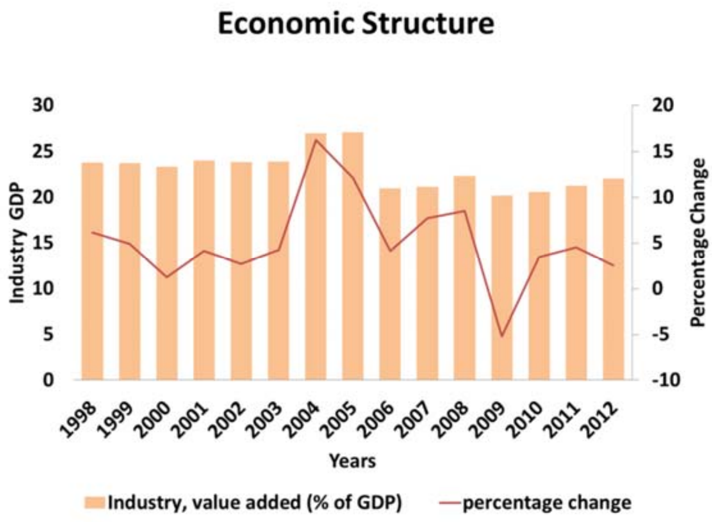

Figure 14 Economic Structure and Percentage Change (World Bank, n.d.-b)

5.3 Future Trends

- Pakistan's population in 2025 and 2030 according to World Bank population prediction is expected to be 227 & 244.9 million people.
- According to vision 2025 and economic surveys Pakistan's economy would be continuously increasing towards 2030. With a value of 4200 & 5000 US$ respectively.
- Trend of urbanization will also be on a rise and will be 47.3 and 50 % in year 2025 and year 2030 respectively.
- Pakistan currently is highly relying on gasoline as fuel for industry but due to lack of ability to foresee the negative impacts of global warming Pakistan is switching towards Coal as there fuel. Pakistan's Coal utilization in energy sector is expected to be 14.7 and 16.3 percent.
- Percentage Share of industry in terms of GDP is expected to increase to 23 and 26 percent in year 2025 and year 2030.
- CO_2 intensity will also increase as a result of industrialization and increment of Coal utilization as fuel source

5.4 Regression Analysis:

Regression analysis of the STIRPAT model was done using values from 1998 till 2012. Variables: a, b,c were determined and emission for future was predicted using the forecasted values for all the constraints. We predicted Pakistan's Emission for year 2025 and 2030 using this model.

5.5 Predicted Results and Discussion

We were able to generate best fit trending line, depicting the remarkable increment in emissions. Emissions will keep on rising due to increment in energy demand and the reason that Pakistan will be heavily dependent on fossil fuel as energy source in future.

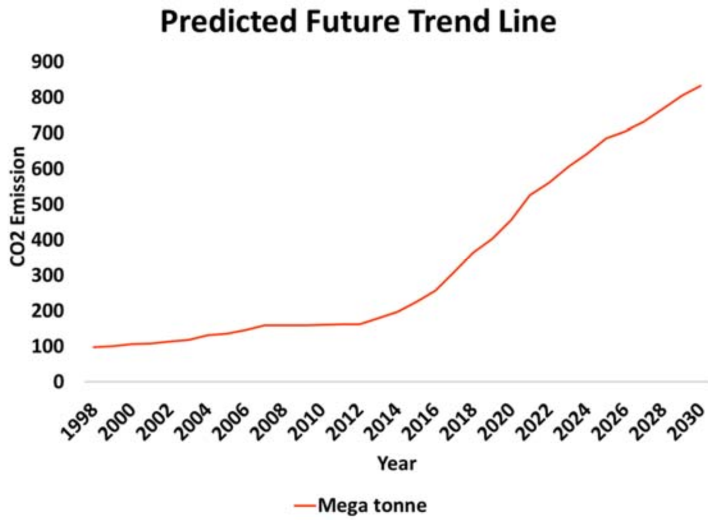

Figure 15 The Graph is an illustration of predicted emission trend

As per the calculation Pakistan's emissions will be on the higher side in the coming decades with 687 MT CO_2 equivalent emissions in 2025 and 833 MT CO_2 in year 2030 respectively. Keeping in mind these emissions are from energy sector while ignoring CPEC projects and National coal operated plant. (Coal based plants will be added in national grid to come over the energy fall).

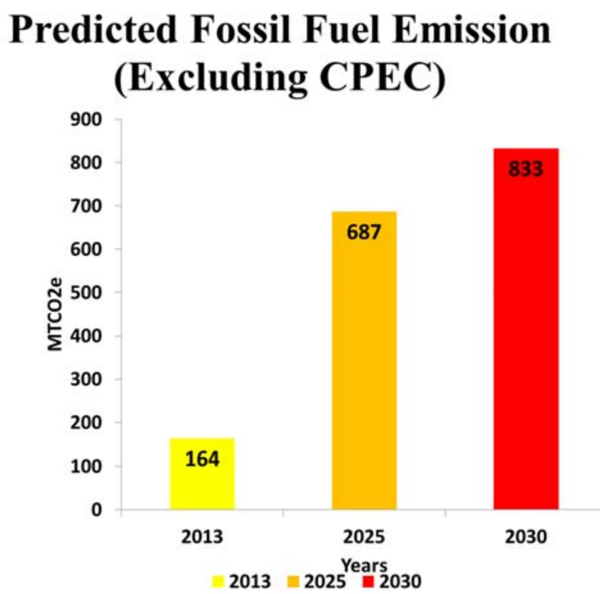

Figure 16: Fossil Fuel Emissions

6 CPEC, the Game Changer

Currently Pakistan is facing energy shortfall, with load shedding across the country. Power break down in some rural areas is around 12 to 13 hours a day. (Dirk Forrister, n.d.)

6.1 National Grid

Countries first preference is to cope up with the energy short fall. Pakistan is going to establish 13 coal fired power plants to generate electricity. One of the plants under the project is operational now (i.e Aug,2017). This would be the initialization of new trouble for Pakistan, we won't be able to shut down these plants before their service life due to heavy economy losses, further as these plants would get old, there efficiency would be greatly reduced, having a further increment in CO_2 emissions.

Emission calculation for these 13 plants when fully operational was being done using available literature. Further Software Designed by sustainable energy Ireland was used .

Table 3 Coal Based National Grid Emissions

Sr #	Coal based power plants	No of Plants	Total Capacity Mega Watt	Emission Metric Tones of Co2
1	Coal-fired Power Plants at Port Qasim Karachi	2	1320	11.100672
2	Sahiwal Coal Power Plants	2	1320	11.100672
3	Engro Thar Coal Fired Plant	2	660	5.550336
4	Gawadar Coal Power Project	1	300	2.52288
5	Muzaffargarh Coal fired Power Project	2	1320	11.100672
6	Rahimyar Khan Coal Power Project	2	1320	11.100672
7	CPih Mine Mouth Power Plant	2	1320	11.100672
	Total	**13**	**7560**	63.576576

All thirteen Plants will Produce 7560 Mega Watt of electricity. As per the calculations performed they will add 63.57 MT of additional CO_2.

6.2 Cement & Steel

CPEC will need a lot of infrastructure including mega structures, metros and motorways giving a boost to construction industry of Pakistan. Major raw materials for construction are Cement and Steel.

As an estimate Cement requirement would be 3 time of Pakistan's current need.

Steel utilization will also increase, as it is the enforcement in a structure, additional steel produced would be twice of the amount being currently produced.

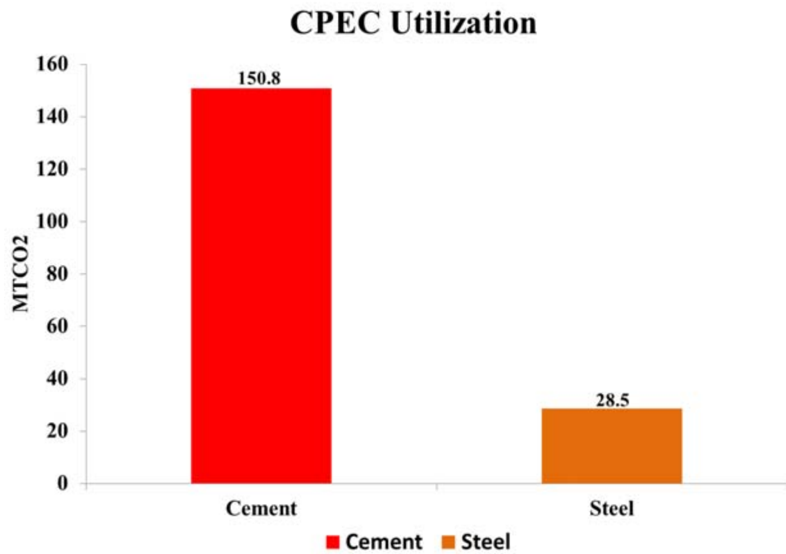

Figure 17 Cement & Steel Emissions

Cement do have a greater value of greenhouse gas emissions due to the fact that coal is being utilized in cement manufacturing.

6.2.1 CPEC Industries

Under CPEC industries will be established in huge numbers. As of now due to Political sensitivity of the project exact details of the project are not being made public. But as per details acquired from some specified sources 25 different industrial zones will be established.

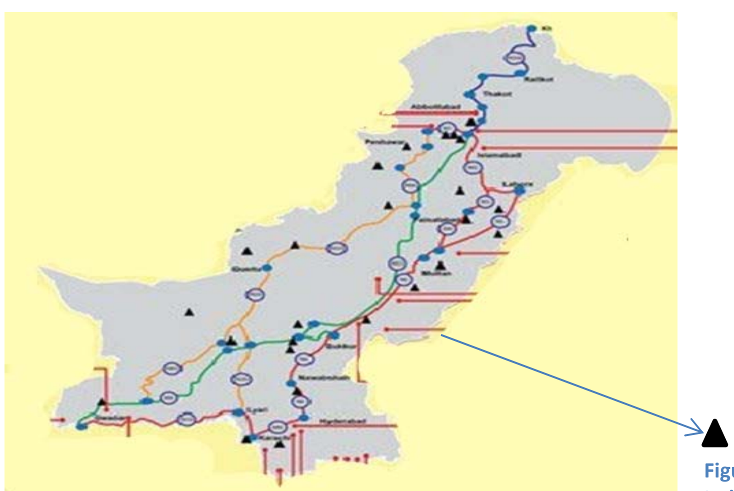

Figure 18: Industrial ZONE

Figure 19 CPEC Industrial Zones

As of now 780 industries have been registered with Pak Army. It will need 35000MW of electricity with estimated emission of 294MT of CO_2 (These are additional emissions due to CPEC)

Ultimately Pakistan will be among top polluters of the world, due to adopting unsustainable means for energy demands. Pakistan's emissions, as per this study, will be around 13700 Mega Tone of CO_2 equivalent by 2030.

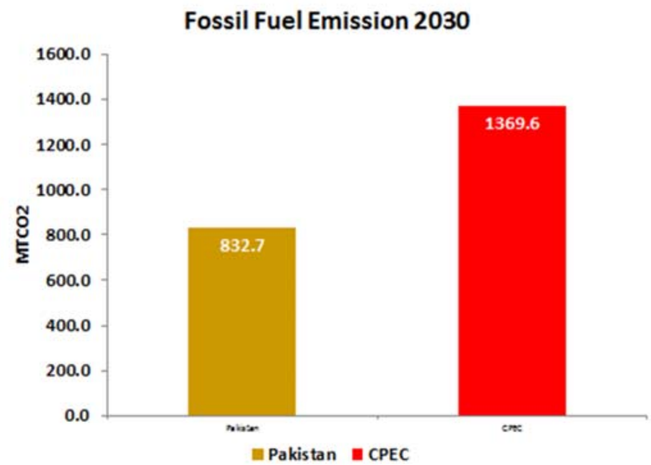

Figure 20 Cement & Steel Emissions

7 Credits Distribution:

Carbon credit is a term used for tradable certificates or to emit one tonne of carbon dioxide or the mass of another GHG to one tonne of carbon dioxide (tCO2e)

It is one of GHG mitigation projects. This approach can be used to finance carbon reduction schemes b/w trading partners around the world

1 carbon credit=1 metric ton of C02eq

1 carbon credit(recent)=$15.40 or Rs1620.85/metric tonne CO2 eq.

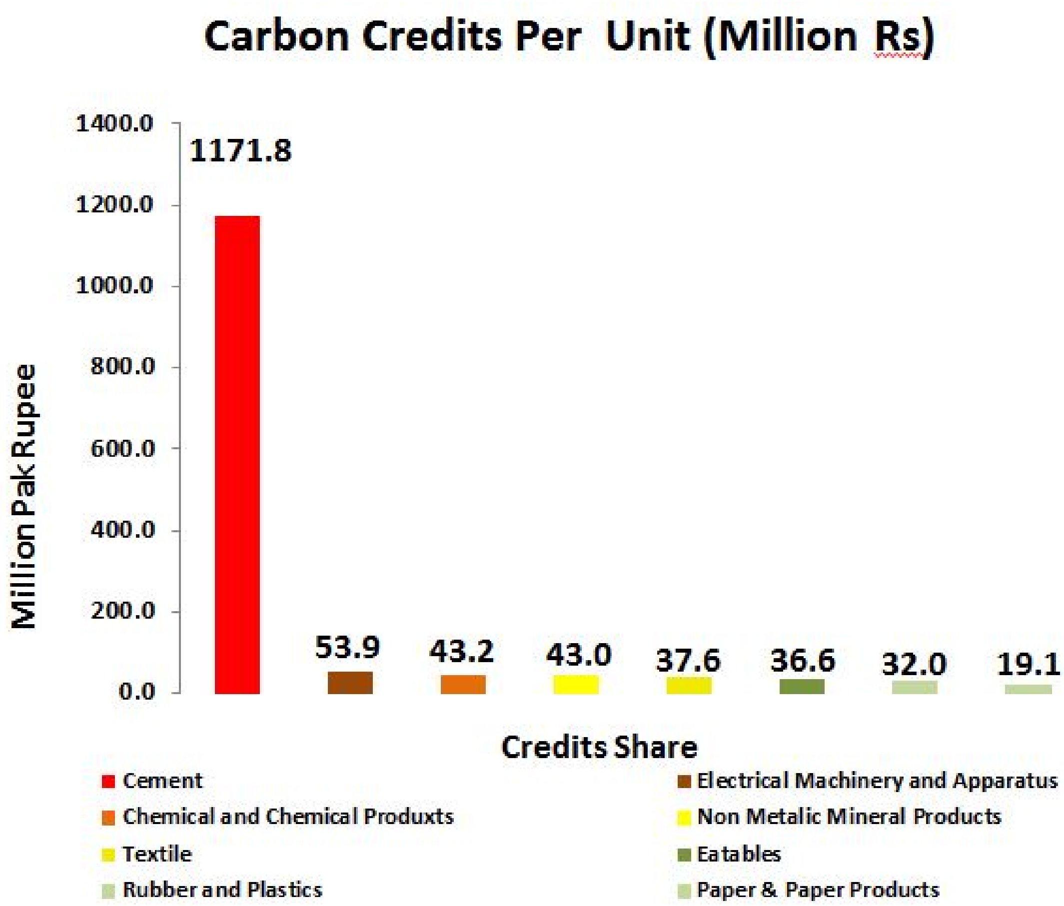

Figure 21 Industrial Credits Share

Total no of emissions (CO_2eq) from each of these industrial sectors were calculated, potential contributors are shown in ------ and **Error! Reference source not found.**. Multiplying each sectorial emissions with unit carbon credit share gives us the total carbon credits for each industrial sector, **Error! Reference source not found.** , as indicated in million Pak Rupees.

Cap is set on carbon emissions. Companies that reduce emissions below cap, earn credits that can be sold. Companies that don't reduce emissions below cap must purchase credits.

8 Conclusion:

World's Top emitters are China, United States and India the reason being the centre of heavy industries that run on the bases of Fossil fuel burning. There emissions are 9977, 5233.2 and 2406.5 Metric Tons of CO_2 Equivalent in 2013. Pakistan's ranked 33rd with 163 MT of CO_2 equivalent emissions, from fossil fuel burning and cement manufacturing. Pakistan on the previously stated calculation and prediction will be among top ten polluters in year 2030. (Anthropogenic GHG Emission).

Our percentage change from 2013 to 2030 is expected to be 739.4 %.Energy sector will retain its top position and will further devastatingly pollute the environment and will contribute highest GHG emissions. Percentage share of GHG emissions for agricultural crops will reduce relatively in future due to an increment of energy and manufacturing sector contribution

9 Recommendation:

- Pakistan need to get censes of its industries done on urgent basis, with details of the fuel being utilized (both amount and type) to be known.
- Industries must be monitored for their emissions, using standardized monitoring devices and equipment.
- Pakistan will be among the countries being worse affected by the global warming. In the decades to come Pakistan along the world will have to make a way for sustainability. Where, Carbon Credits will certainly be the best way as it is the economic incentive too. Pakistan need a lot of work and effort to be done, in order to establish its carbon trading market.
- Carbon counterbalance and carbon credit still needs to discover its place in layman's vocabulary. Consequently, mass mindfulness on the issue through far reaching training is required, to give our future eras the better, cleaner condition. Yet at the same time the expanded request streaming to carbon credits and the presentation of more up to date monetary instruments for discharge exchanging are for the most part indications of uplifted movement. World need to get greener, that is only possible with innovation.

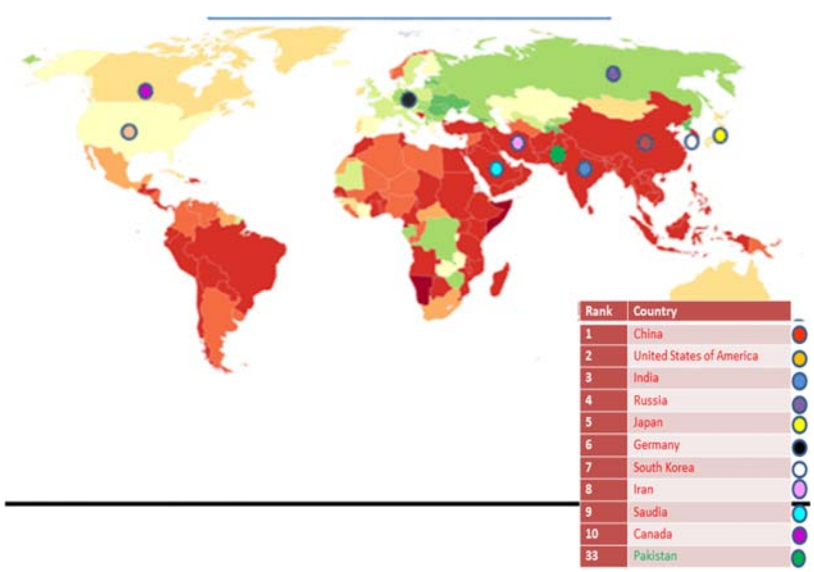

Figure 22: Worlds Carbon Emission Profile (2013)

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