

## REVIEW ARTICLE

# CLIMATE CHANGE: INTIMIDATING REMARK TO GLACIERS AND ITS EXTENUATION STRATEGIES IN PAKISTAN-A REVIEW

Urva Akmal\*, Saba Shahzadi, Zahra Masood, Sana Zulfiqar\*, Noshabah Tabassum

Department of Environmental Sciences, Fatima Jinnah Women University, Rawalpindi Pakistan.

\*Corresponding Author Email: [urvaakmal4@gmail.com](mailto:urvaakmal4@gmail.com), [sanaazulfiqar@fjwu.edu.pk](mailto:sanaazulfiqar@fjwu.edu.pk)

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## ARTICLE DETAILS

## ABSTRACT

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Climate change now-a-days is considered as the major threat throughout the world. The average global temperature over the past 100 years has raised up to 0.3-0.6°C and global warming is the major cause of increasing temperature. Pakistan contributes to almost 0.05% in Green House Gases (GHG) emissions and consider as 7th most vulnerable country to climate change. The present article will focus on renewable energy resources to mitigate CO<sub>2</sub> emission in Pakistan and to secure glaciers from melting. Review's finding showed that the extraction of water for irrigation purpose requires 6 billion kWh of electricity which contributes to 3.8 million metric tons of CO<sub>2</sub> each year. Water productivity up to 40% can be enhanced by improved irrigation methods. Wind energy, biomass energy, fluidized coal combustion and integrated coal gasification combined cycle (IGCC) play a very important role in reduction of CO<sub>2</sub> which in result reduce the effect of global warming and Climate Change.

## KEYWORDS

Glaciers of Pakistan, Global Warming, GHG emissions, CO<sub>2</sub>, Consequences, GHG emission control techniques.

## 1. INTRODUCTION

Climate of Earth has evolved millions of years ago but since the last two centuries it has been changing rapidly and scientist believed that this change is not natural but humans are playing major role in it [1]. Gases released from industries, motor vehicles and majorly from the combustion of fossil fuels e.g. coal, oil and gas are contributing to GHG gases which trap sunlight and increase the surface temperature of Earth [2].

Pakistan is situated between 24-37°N latitude and 66-77°E in South Asia and it is the home of three largest mountains i.e. Himalayas, Hindu Kush and Karakorum, meet Pakistan through northern areas. These "Water Towers of Asia" are responsible for feeding Indus river basin through many tributaries and according to Glaciers inventory done through GIS/RS techniques in 2005, about 2500 glacier lakes are formed because of glacier melting. Among them, more than 1500 are prone to Glaciers Lake Outburst Flood (GLOF) in Pakistan [3].

Hindukush-Karakoram-Himalayas (HKH) contain about 60,000km<sup>2</sup> of glaciers. The temperature of HKH has increased to about 1.5oC in the last 30 years. The scarcity of meteorological, hydrological and glaciological data due to its terrain presents difficulty to evaluate the influence of climate variation on glaciers. Inadequate study is conducted to identify the behavior of Glaciers at Upper Indus Basin (UIB) because it aids agricultural, domestic and hydroelectric power production determinations. This review will present the changes in cryosphere of HKH due to climate change.

Global warming is responsible for decrease in cryosphere [2]. Pakistan is blessed with 7,253 glaciers which are under threat of climate change specially those, present at lower elevation [4]. Researchers attributed it to climate change and acknowledged that if temperature is increasing rapidly than by 2035, there will be no glaciers left behind [5]. "The maximum temperature of most of mountains never cross 30oC but now it surpasses 40oC in summer" said by Deputy Director Ministry of Climate Change Muhammad Saleem Shaikh [6].

Global warming results from the release of Green House gases (including CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O), releasing from fossil fuel combustion, deforestation, land use etc. making the Pakistan 7th most vulnerable country to climate change which, in turn, cause glaciers melting, drought etc [7]. Energy sector is major producer of GHG in Pakistan. Therefore, baseline grid emission factors are designed to calculate GHG emissions. Moreover, Standardized baseline grid factors are determined to initiate, propagate and promote clean energy alternatives. because clean energy sources i.e. solar, wind, biogas, fluidized coal combustion and Integrated gasification combined cycle (IGCC) can cause reduction in GHG emissions [8].

Present review-based study has been conducted by using published research articles from Journal of Faculty of Engineering & Technology, Journal of renewable and sustainable energy, Environmental sciences and Pollution research etc.

## 2. MATERIALS AND METHOD

The methodology used in this study for collection of data is based on secondary data that is basically a literature review.

Information and Communication Technology (ICT) is important for monitoring climate change conditions and observing glaciers melting in northern areas of Pakistan [9]. The use of ICT in different ways like modification, mitigation and monitoring climate change discussed and emphasis using ICT by developed and developing countries to reduce the impacts of climate [10]. ICT technologies includes Geographical Information System (GIS), Wireless Sensor Networks (WSN), Mobile Technology (MT), Web based applications, Satellite Technology, Remote Sensing (RS) [11,12]. ICT based application can help in reducing climate changes impacts on environment and play important role in world [9].

## 2.1 Case Study: Passu Lake in Pakistan (candidate pilot project)

According to International Centre for Integrated Mountain Development (ICIMOD) inventory (2005), 52 dangerous lakes from HKH mountain ranges were identified in Pakistan by using GIS and remote sensing

techniques. According to this, because of 37mm rainfall for about 2 hours and glaciers melting for 14 days led to Passu glacier eruption and results in damage to houses in its vicinity and a bridge at Karakorum Highway [13].

## 2.2 Case study: Darkut Glacier

The climate-based data (temperature, incidence of solar radiations and precipitation trends) for the past 16 years of Darkut Glacier, situated in Yasin valley, has been taken from WAPDA and PMD and analyzed to find trends in them. GPS system was used to find the coordinated proboscis.

The mean maximum temperature from 1990 till 2015 ranges from 18-20°C and mean minimum temperature ranging from 0.3-1.2°C respectively [14].

It has been found that Pakistan have more glaciers than almost anywhere on Earth. But climate change is a threat to them. The major GHG is CO<sub>2</sub> that is destroying our environment by causing greenhouse effect. CO<sub>2</sub> emissions per capita for Pakistan were 0.92 metric tons in 2016 [15]. Figure 1 shows the percentage of sources used to produce electricity in Pakistan 2012-2013 [16]. Figure 1 shows the production of CO<sub>2</sub> from 2005-2016.

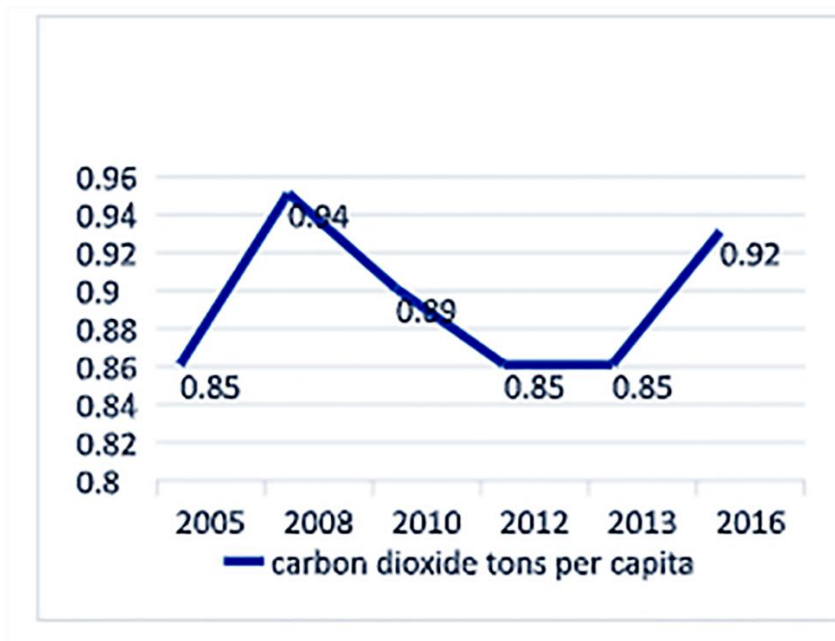


Figure 1: Production of CO<sub>2</sub> from 2005-2016

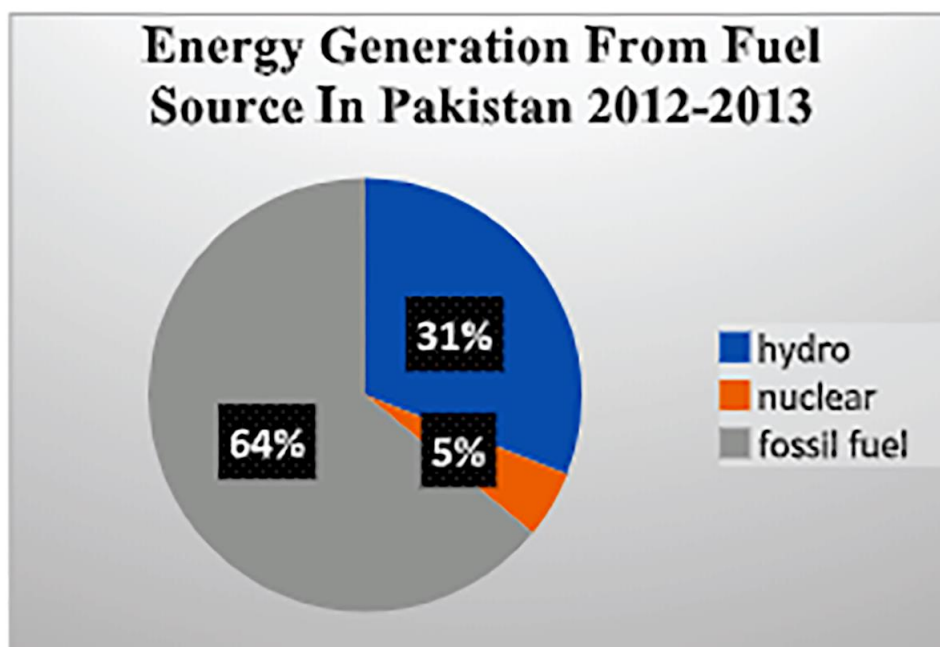


Figure 2: Energy production from Fuel sources

Data on electricity generation, fuel consumption, low heating and gross heating values and effective CO<sub>2</sub> emissions from each source is taken from Pakistan's energy years book [17,18]. Moreover, baseline emission

factor is also determined. Greenhouse gas emissions from various sectors are shown in table 2 [19].

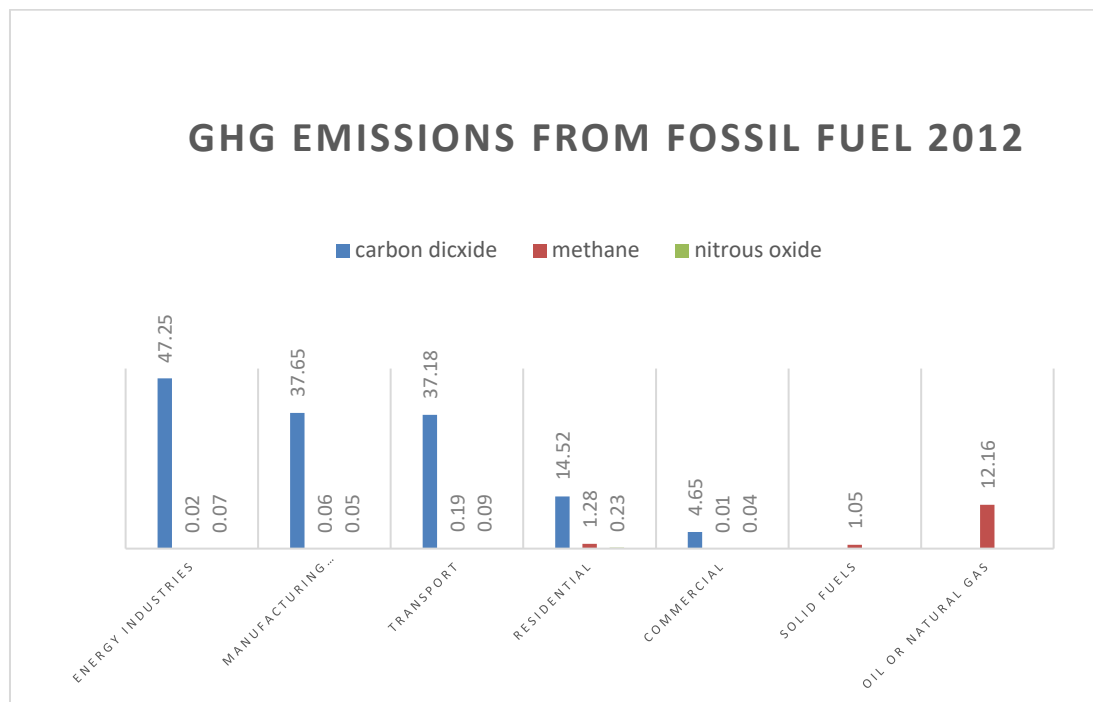


Figure 3: GHG emissions from Fossil Fuel 2012

To transfer to solar energy production as a cleaner energy, sunshine based data was collected from various places of Pakistan through meteorological department. Minimum and maximum temperature is collected during sunshine hours. Moreover, biogas can also be installed to generate electricity in Pakistan [20].

### 2.3 Technologies in Coal Fired Plants

In Coal Fired plants, two technologies can be used to decrease CO<sub>2</sub> and other GHG emissions.

#### 2.3.1 Integrated gasification combined cycle (IGCC)

Power plant technology has producing electrical power from the IGCC power plants have the potential of generating electricity from fuel such as coal. That's why; there is a need to introduce new technology which can use mixture of different varieties of coal (lignite, bituminous & subbituminous). Contribution of coal for production of energy has enhanced from 6.5 percent to 7.6 (2003-11). Approximately 100000MW electricity produced from coal in Pakistan [21].

#### 2.3.2 Fluidized Bed Combustion

A technology in which a bed is formed by solid particles of fuel and air is passed through it in upward direction. By increasing the velocity of air. A high degree of turbulence is created, causing mixing of particles by giving appearance of bubbles in boiling liquid [22].

## 3. RESULTS AND DISCUSSION

After observing the consequences of global climate change on glaciers in the form of reduction in ice cover and taking GHGs as the culprit, the solution is proposed to transform the energy generation from fossil fuel to alternative energy sources which will help to reduce GHG emissions in the atmosphere specially CO<sub>2</sub>. The potential of alternative energy resources is described below;

### 3.1 Solar Radiation Potential in Pakistan

After taking the data on solar intensity in different part of Pakistan, following result is deduced; (shown in figure 4). The data shows that we can generate 45-83 MW of energy in an area of 100m<sup>2</sup> in a month because solar radiation above than 200 W/m<sup>2</sup> can be observed in Sindh, Punjab, Khyber Pakhtunkhwa, Azad Kashmir and other northern areas, Balochistan [23].

#### 3.1.1 Future perspective

Many developed nations are investing in the development of renewable

energy markets and almost 33 solar power plants are in developing stage in Pakistan in which many power plants are in CPEC project [24]. (see figure 4).

### 3.2 Wind Energy Potential in Pakistan

Pakistan has both, government and private units for power generation i.e. WAPDA, IPPS, PEPCO, K-Electric. According to a study, Pakistan can generate power through wind power plants which is cost effective and through this 50MW wind power plant, the emissions of GHGs through fossils and their effects can be reduced [25,26].

Pakistan is in an area where it has plenty of locations to install wind power plant. In collaboration with USA, the working map of wind power plant of Pakistan has made by National Renewable Energy Laboratory (NREL).

According to this map it is estimated that 346MW energy can be produced from wind power plants in Pakistan in which alone 50MW can be generated alone by wind corridor, in Sindh [16].

According to a study the total energy production in the year 2012-2013 was 96122GWh, that was produced from the sources with shares shown in table 1.

Table 1: Energy Production in Year 2012-2013

ENERGY PRODUCED IN YEAR 2012-2013	
Sources	Energy
Gas	2.8%
Nuclear	5%
Coal	0.1%
Hydro	31%
Oil	36%

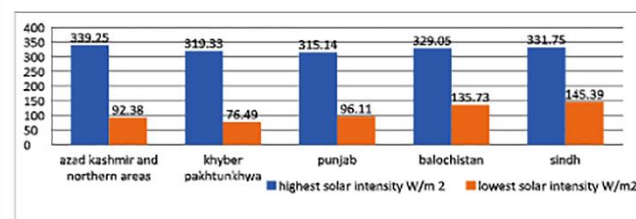


Figure 4: Solar radiation intensity in all provinces of Pakistan

Emissions of GHGs: Baseline grid emission factor estimation is used to evaluate the emissions of GHGs from fossils fuels based powerplants in absence of proposed renewable power plants [16]. (see table 2).

**Table 2:** CO2 Emissions from Each Fuel Source

Fuel type	CO2 emissions (ton/TJ)
Gas	56.152
Furnace oil	77.649
Diesel	74.29
Coal	101.49

### 3.2.1 Reduction in the emissions

The wind power plant in Pakistan works 8760 hours per year with the potential to generate 110GW energy. Baseline grid emission factor estimation has estimated that CO2 emissions have been reduced up 63620 tons annually. This reduction in carbon dioxide emission can play a vital role in removing the global warming, climate change and their significant impacts on the environment [27]. Installation of large and small windmills have many benefits to the companies like HESCO [28-33].

### 3.2.2 Future perspective

This wind energy plan is very favourable in terms to deal with climate change. The government should provide incentives that attract the investors to invest more in the wind energy projects. Also, in future as moving with time we need more software advancement, tools for construction new and installed machinery and so on. Moreover, efforts are made to increase wind energy production from 250MW to 1530MW by establishing 22 windmills in Pakistan [34]. 10,000 MW of energy is happened to generate in this year though wind energy [35].

## 3.3 Biogas potential in Pakistan

Biogas is a process in which animal waste is converted into methane gas which is an odorless gas. It can be used for multiple purposes like domestic, industrial, heating etc. By using biogas, as an energy source, the energy crisis can be overcome and can be used as a renewable alternative to combat Climate change. Biogas plant is a way cheaper and beneficial in mitigating eye and respiratory diseases.

The Pakistan government has formed “Pakistan council for renewable energy and technology (PCRET)” that is council responsible for working and maintenance of biogas plants in Pakistan.

PCRET is working in Pakistan and it has installed almost about 5357

biogas plants in different localities with net generation of 14395 M3/day. The biogas plant has saved an average of rupees 37925 million per month in terms of oil, wood, LPG, biofertilizers etc.

### 3.3.1 Biogas plant models in Pakistan

In Pakistan by year 2007 – 2012, PCRET has installed biogas plants in all provinces i.e (see table 4).

**Table 3:** Provinces with number of biogas plants

Province	Number of biogas plants installed
Islamabad	30
KPK	155
Punjab	1700
AJK	50
Baluchistan	80
Sindh	300

The installation of these models depends upon different factors like weather conditions, budget, usage, working of present models etc. depending upon these, the models that are currently in Pakistan are: [36], (see table 5)

- Floating gas holder type plants
- Fixed dome shaped biogas plants
- Chamber type biogas plants

**Table 4:** Level of Pollution govern before and after installation of biogas plants: [37].

	Pollution before use of biogas plant	Pollution after use of biogas plant
Severe	72.20%	4%
Moderate	13.40%	8.70%
Minimal	8.70%	17.70%
No pollution	5.70%	75.60%

### 3.3.2 Future perspective

Biogas plant has no environmental hazards and as such handling aspects. It is profitable because it is a renewable energy source. It is cheaper hence it is best fit for the alternate energy source. In future, biogas plant is going to be beneficial for rural areas as well as urban areas.

After observing the production capacities and capabilities of solar, wind and biogas power plants, the following results are observed; (chamber of Commerce and Industry) (see table 6)

**Table 5:** Characteristic difference between solar, wind and biogas power plants

Characteristics	Solar power plants	Wind power plants	Biogas power plants
Plants in Pakistan	Upto 45	29 (under development)	5357
CO2 reduction	60gt CO2 reduction	0% emissions	CO2 will be used to produce biogas
Energy production	100,000 MW	110GW per year	14395 M3/day

Total electricity consumption in Pakistan is increasing day by day and it will reach to 49078MW till 2025 (international energy agency) and to fulfill the energy demand, that was 56,194 GWh in 2011, a lot of GHGs are emitted in atmosphere. To reduce the production of GHGs emissions in atmosphere, we should adopt Alternative energy sources to give a clean environment to our future generation which is the objective of UNFCCC (United Nations Framework Convention on Climate Change). Alternative Renewable energy source will reduce our dependence on fossil fuel consumption thus reduce the import cost and protect our glaciers from melting after combating the climate change.

Climate change is an inflexible and contemporary danger with harmful effects on the survival and living examples of humankind. Pakistan positions seventh among the most antagonistically influenced nations by

environmental change on the Worldwide Atmosphere Hazard List 2017 [38]. Pakistan had experienced 141 outrageous climate occasions like twisters, storms, surges, Icy Lake Upheaval Surges (GLOFs) and heatwaves, and so forth [39]. Pakistan itself contributes almost no to the general outflows of the ozone depleting substances, yet it stays a standout amongst the most extremely hit nations of the world by the procedure of a dangerous atmospheric devotion. Pakistan has been affected by global warming in the form of floods, glacier’s melting, drought conditions etc. The greenhouse gases and the human activities causing a havoc of climate change that in return affecting the health and environment badly [40].

There are some technologies that are used in coal fired power plants and character of those plants in reduction of GHG emission are given in table 7.

**Table 6:** Technologies in Coal Fired Power Plants to reduce GHGs emissions

characteristics	IGCC	FBC
Energy generation	100,000MW	5360MWh [41]
GHG emissions	90% Sulphur and CO <sub>2</sub>	Nitrogen oxides are emitted based on Nitrogen content. Carbon oxides are reduced by 30%depending upon biomass fuel [22].



Thus, The Thar coal reserves mostly contain lignite and present in large amount. Thar coal are lignite type coal with an estimated reserve of 175 billion ton, which is 2nd largest in the world. The desert of Thar, 410 km from the Karachi, Sindh in which coal can easily convert into syngas by Integrated Gasification Combined Cycle (IGCC). This contains atmosphere clean process to reduce 90% Sulphur and CO<sub>2</sub> in the air also known as called green technology.

IGCC technology has following advantages clean process, syngas can be purified from impurity, before it is used to run turbine, can obtain different variety of products, can eliminate CO<sub>2</sub> pre-combustion, gas used to run turbine will frequently consist of H<sub>2</sub>, removed fraction of CO<sub>2</sub> can be used to extract oil from wells. Due to higher amount of that technology this is not implementing all over the Pakistan.

In 1970, FBC technology is introduced with the ability of fuel burning, emission performance efficiency and includes reuse of by-products like gypsum etc. Due to its merits, first time this technology has been introduced in Pakistan by installing power plant at Khanote. This technology is also installed at NFC-IET, Multan for analyzing the pyrolysis behavior of low-grade coals [42].

#### 4. CONCLUSION

Observing the phenomena on of climate change and its affects in the form of glaciers melting and getting to know that we are the last generation to solve the problem of climate change, there is a potential need to take effective measures. Glaciers are more important water resource because Indus river basin is originated from it and if we would unable to protect it somehow, we will lose our main water source. Therefore, there is an urgent need to take effective measures and shifting to renewable energy resources like solar, wind and biogas to reduce GHG emission and using technologies like IGCC and FBC are relatively appropriate technologies used in Coal firing power plants.

#### 5. RECOMMENDATIONS

- There should be 100% transformation to renewable energy resources to permanently avoid GHG emissions.
- Coal power plants should be installed after proper EIA and effective techniques should be installed.
- Guidelines should be developed to regulate emissions and penalties must be imposed in case of violation.
- New projects should be designed on renewable resources to generate power.
- Waste should be used to generate electricity.
- At individual level, one must aware about the importance of energy and its cost, so that it takes measures at its own level to reduce energy consumption, in return participate in protection from climate change.

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