# Mobilizing Climate Finance for Pakistan's Development Agenda

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## 1. Introduction

Climate change has resulted in significant loss of lives and livelihood and calls for immediate actions and financial resources for mitigation and adaptations to changing environment. Climate finance is defined as, "……resources that catalyze low-carbon and climate-resilient development by covering the costs and risks of climate action, supporting an enabling environment and capacity for adaptation and mitigation, and encouraging research, developing and deployment of new technologies.". [UNFCCC]. Alternatively, it can be defined as "resources that catalyze low-carbon and climate resilient development" (IMF and World Bank 2011). These resources are needed to cover the cost and risk of climate action; cost of supporting an enabling environment; create capacity for adaptation and mitigation and cost of research and development and deployment of new technologies.

Generally speaking, climate finance can be mobilized though various public and private and bilateral and multilateral instruments. This paper focuses on the options available to a resource scarce country like Pakistan. Climate financing for Pakistan's social, environmental and economic development has not received significant attention of the government and international communities. The country started with receiving ~USD 5 million for disaster risk reduction activities from Global Climate Fund (GCF) few years ago and the resource flow still remains around US$38 million. Certainly, it is insufficient against the climate related disasters faced by Pakistan. Ausubel (1991), Raynor and Malone (1998) and Munasinghe (2000) argued that the implications of climate variation or change remain contingent to the change itself and on the characteristics of the society exposed to it. But lack of consistent data has restricted Pakistan readiness to face climate change, which has reinvigorated financial losses in terms of adaptation that cost the country about 3.0 percent of its annual Gross Domestic Product (GDP).

According to UNFCCC (Ref), the yearly climate change financing commitment from international community was around $ 30 billion for the period 2010-12 and is expected to rise to $ 100 billion by 2020. In addition, the innovative solutions for resource generation are needed. (World Bank 2011). Among these sources, private profit-oriented behavior is helpful in taking least cost options for adaptation and mitigation. The public policy-based incentive structure can complement the climate financing needs. Reduction in subsidies in the energy and transport sectors can also help create fiscal space for climate finance. Development of comprehensive carbon pricing policies and emission trading are also options for future. Development of these national and international linkages can help provide access to clean technologies and international capital market. According to IMF and World Bank (2011), a globally coordinated price of $ 25 per ton of $CO_2$ on aviation and bunker fuel could generate $40 billion by 2020 and could cause about 5 percent reduction in emissions. However, legal and regional issues are major bottlenecks in implementation of such options.

Like other developing countries, Pakistan has to devise clear and comprehensive package for benefiting from these funds. So far, very little work has been done on developing an agenda for mobilizing climate finance for Pakistan as country would go nowhere in absence of clear directions. The purpose of this paper is to develop such a strategy based on GHG emissions from energy and agriculture sector. The focus on these two sectors is purposive. While the GHG contribution of energy sector is declining over the years, that of the agriculture, transport and other sectors is on rise. Within agriculture sector, the methane emission from livestock dung is the major contributor to the GHG emission. The use of fossil fuel in transport sector and the rising demand for private vehicles, improved credit availability for car financing are the major reasons in many countries.

The rest of the study is organized as follows: A situation analysis has been done based on a brief overview of total emissions and in two major sectors, viz., energy and transport is discussed in Section 2; measures to reduce emissions are discussed, in section 3; resource mobilization issues are dealt in section 4, whereas conclusions are drawn in section 5.

## 2. *Situation Analysis*

Pakistan stands top on the list of countries most vulnerable to climatic changes despite the fact the country's own contribution in global GHG emissions has been insignificant so far. Hagler Bailly (1995) first time prepared GHG inventory for Pakistan in 1989-90 under "*the Asia Least-cost Greenhouse Gas Abatement Strategy* (ALGAS)" project. According to this study, contribution of GHG emissions of Pakistan was 212.9 million $MtCO_2$. The energy, land use change and forestry sector contributed 132 million MtCO2 (62%) and 72.4 million MtCO2 (34%), respectively, in the total GHG emission in Pakistan. Hagler Bailly (1998) prepared the second inventory GHG emission for the1993-1994 with a broader coverage having sectors like energy, agriculture, industry and waste and land use change separately. It reported that the GHG emissions of Pakistan have declined to 181.7 million MtCo2 but energy sector still contributed 47.2 percent in total emissions followed by agriculture sector 39.4 percent. However, the contribution of industrial and waste, land use change and forestry sector was only 7.3 and 6.1 percent, respectively. The report was submitted to UNFCCC as a part of initial communication of Pakistan for negotiation with international community.

Applied System Analysis Division (ASAD) and Pakistan Atomic Energy commission (PAEC) used IPCC 2006 guidelines to prepare the third GHG inventory for Pakistan (GOP, 2010). Accordingly, Pakistani economy emitted 309.4 million tons of GHG emissions, with energy and agriculture being the major contributing sectors with 50.7 and 38.8 percent respectively; whereas, the industrial and land use change and forestry sector stood only 5.8 and 4.7 percent, respectively in total GHG emission. The Fourth GHG inventory report for Pakistan was developed by Global Climate Impact Study Center (GCISC), Ministry of Climate change in 2012 under the revised guidelines of IPCC (1996). Reportedly, the total emission increased to 374.1 million MtCO2 with the contribution of energy and agriculture sector standing at 45.8 and 43.5 percent, respectively (GCISC, 2012). Whereas, industrial waste contributed only 2.8 percent and land use change and forestry contributed 2.6 percent in the total GHG emissions (Table 1).

Table 1: Green House Gas (GHG) Inventory

| Sector | GHG inventory in million MtCO2 (%) | | | | | |
|---|---|---|---|---|---|---|
| | 1989-90 | 1993-94 | 2010 | 2012-13 | 2015 | 2030 |
| land use change | 132 (62) | 11.1 (6.1) | 14.5 (4.7) | (2.6) | 10.39(2.57) | 29 (1.81) |
| forestry | 72.4 (34) | | - | | | |
| Energy | - | 85.8 (47.2) | 156.9 (50.7) | (45.8) | 185.97 (45.9) | 898.0 (56.0) |
| Agriculture | - | 71.5 (39.4) | 120 (38.8) | (43.5) | 174.56 (43.09) | 457.0 (28.51) |
| Industry | - | 13.3 (7.3) | 17.9 (5.8) | (2.8) | 21.85 (5.39) | 130.0 (8.11) |
| Waste | - | | - | | 12.29 (3.03) | 89.0 (5.55) |
| Total | 212.9 (100) | 181.7 (100) | 309.4 (100) | 374.1 (100) | 405.07 (100) | 1603 (100) |
| Sources: | Baily (1995) | Bailly (1998) | (GoP, 2010) | GCISC, 2012 | (GoP, 2018) | (GoP, 2018) |

Considering that there had been consistent methodologies in preparation of these inventories, it is very clear that the total estimated GHG emissions for 2012 have increased over 1994 and 2008 by a magnitude of 212.9 million MtCO2 in 1989 to 374.1 million MtCO2 in 2012. If appropriate measures are not taken to control, four times increase in emissions is expected (from 405 million MtCO2 in 2015 to 1603 million MtCO2 in 2030).

Historically developed countries' contribution in GHG emissions is very high compared to their developing country counterparts. However, the adverse impacts are disproportionately higher for the latter set of countries who argue for a criteria of 'differentiated responsibilities" to provide funding that may enable them undertake appropriate adaptation and mitigation measures. Nevertheless, the mobilization of financial resources for climate action is most complex and controversial as there are multiple sources having their peculiar procedural requirements often leaving countries confused on "what should be done?" Interactive policy framework needs to be formulated by all global, national and local the stakeholders. In addition, current security concerns and increased competition in attracting the scarce global resources for improved and environment friendly processes are major bottlenecks. Given the general scarcity of resource from global financial sources and complexities in accessing these funds, many countries are focusing on resource mobilization form internal sources, i.e., public sector and private sector both. Furthermore, it takes improved planning, budgeting and resource allocation priorities that also require time, finances and trained human resources. Nevertheless, it is difficult for a country like Pakistan facing low Tax-GDP ratio (around 13 percent), unqualified preferential treatment to various sectors like agriculture, debt servicing (around 40 percent) and large informal sector [UNDP (2017)].

As mentioned earlier, we focus on two sectors in this paper: energy and transport. The share of energy sector in GHG emissions is higher but slowing down. The share of transport sector is currently low but it is rising rapidly. Similarly the emissions from agriculture, industrial process (2.4), wastes (22.9 and land use change (2.1) and forestry have also increased over time. This demonstrates that growth of GHG it from waste and agriculture sector remained highest during 2008-2012 (Anwar and Ijaz, 2016). A consistently increasing trend in GHG emissions elevates the temperature and results in adverse impacts. For example, the impacts of climate change on coastal communities are becoming more visible than ever before. The people are struggling to adopted living in hot deserts and consequently farmers and business communities are going to face losses if they fail to adopt within the timeframe permitted by the climatic changes (Gertner (2007). According to experts (References), large amount of financial resources US$300 billion per annum by 2020, and US$500 billion per annum by 2030 is required in developing countries to address climate change mitigation issue alone. This is important to sustain their economic growth and to maintain emissions within limits (450 parts per million of CO2 equivalents to achieve global equilibrium) (Venugopal et al., 2012).

## *2.a: Energy Sector*

A decline in access to alternative energy sources ultimately compel households to use forests to fulfill their everyday energy needs. The economy of Pakistan will face a significant cost of extenuation to climate change because it is often perceived as expensive to fulfill the increasing demand of energy for the increasing population from cleaner sources. Macro level data of GHG emission in Pakistan clearly demonstrates that energy production is the largest source of GHG emission. As an energy-starved country, Pakistan needs to use climate finance as a leverage to diversify its energy mix and move towards renewable energy solutions. To improve the efficiency of the energy sector, the role of private sector in production and delivery system certainly needs consideration. In addition, new business models are required to develop that could help to boost the employment opportunities in the process and contribute to the economy (Memon and Hussain 2018). Pakistan has shown intentions to reduce 20% of its total GHG emission till 2025, which is equal to 1603 million tons of carbon dioxide equivalent but very limited international funds or grants are tapped to support the abatement cost of $40 billion (ADB, 2017).

Pakistan produces electricity from different sources, which include hydro power, thermal (both oil and gas), nuclear power and the renewables (such as wind and solar) are the recent addition in Pakistan’s energy mix. It is critical to set an optimum point to achieve the targeted reduction in $CO_2$ emissions. Reduction in emission could be achieved either by reducing the amount of production or by shifting to cleaner energy sources. Emission reduction by decreasing production is not an option because as per capita energy consumption is already very low in Pakistan and among lowest in the world and reducing it further may result in higher unemployment and reduces the prospect of improving quality of life and reduces peoples’ wellbeing. However, second option of shifting production frontier at a higher level of environmental safety with the help of technology could reduce GHG emission but may be with higher production cost if conceptualized from narrow financial and economic lenses. In any case, reduction in emission from energy production will impose additional cost to society either in terms of lost incomes or in terms of higher prices. However, shifting production frontier with the help of modern technologies such as distributed generation and storage, smart home appliances and block-chain technologies could also help decrease prices and improve efficiencies in the long run ((IEA and IRENA 2017; P. Sioshansi 2017).

The emission reduction could be achieved with inputs composition change and mitigation policies, though we will focus only on mitigation policies in this paper. Mitigation techniques are the strongest tools for the reduction of $CO_2$ emissions from energy sector. Among these includes the shifting of the electricity production from highly polluted sources to relatively cleaner sources from diesel to hydro, solar and wind energy plants etc. According to Yousuf (2014), $CO_2$ emissions from wind and solar power projects were 0.566 ton CO2/MWH while that of the hydro power projects excluding Karachi Electric Supply Company (KESC) were 0.478 ton $CO_2$/MWh. However, emission rate both for wind and solar (0.606 ton CO2/MWh) and hydro power plants (0.505 ton CO2/MWh) are slightly higher after including Karachi electric supply company grid (KESC grid). However, it is observed that these emission factors are within the limit of international standards. We used these emission standards for our analyses presented in the subsequent paragraphs.

**Potential of Renewable Energy and Climate Financing in Pakistan**

In the presence of international climate finance fund, benefit can be harnessed by shifting electricity production from high to low carbon emitting sources like from coal and oil to nuclear, gas and hydro based electricity generation in Pakistan. For this purpose, the first step is to explore physically viable options to shift from polluted to relatively cleaner energy sources. The investigation of literature indicates, Pakistan has huge potential to produce electricity from cleaner sources of production (for wind and hydro potential (see for example Tahir and Asim 2018, Baloch et al., 2016; Mohsin et al., 2018). Currently, small hydro power plants are producing approximately 4500-megawatt electricity in the country (HDIP, 2017). Comparatively, it is cleaner source of production in terms of GHG emissions but it accounts for only 24% of total production. Although largely untapped, Pakistan has huge wind and solar energy potential which it only recently has started to exploit. Recent estimates suggest that with a mean daily solar insolation of 19.0 MJ/$m^2$, the country could potentially produce 175,800 GWh of solar energy per year (Tahir and Asim, 2018) while 120 GW of viable wind energy potential are available along the Sindh coastline and other discrete locations (Baloch et al., 2016; Mohsin et al., 2018). Starting with negligible RES installation capacity in 2013, 438 MW in 2015 and 902 MW by June 2016, Pakistan was able to generate 1,550 GWh of renewable energy from solar, wind and bagasse sources in 2016 (HDIP, 2017). Furthermore, numerous mini-hydro, solar, wind and bagasse power plants are under construction or planned (Kamran, 2018; NEPRA, 2017a).

It is also observed that Bagasse, rice husk, straw, dung, municipal solid waste, has potential of generating 4,000 MW of power in Pakistan. Further, around 34 million hectares of marginal land is available in different parts of the country that is best suited for the purpose to produce 50 million tons of bio-fuels per annum (Ministry of water and power 2014). Some of these potentials are substantiated by various other studies such as Tahir and Asim (2018) who concluded that with a mean daily solar insolation of 19.0 MJ/m2, the country could potentially produce 175,800 GWh of solar energy per year while 120 GW of viable wind energy potential also exists along the Sindh coastline and other discrete locations (Baloch et al., 2016; Mohsin et al., 2018). Starting with negligible RES installation capacity in 2013, 438 MW in 2015 and 902 MW by June 2016, Pakistan was able to generate 1,550 GWh of renewable energy from solar, wind and bagasse sources in 2016 (HDIP, 2017). In our analysis we split this amount to solar (1000GWh) and wind (550 GWh).

Now, If Pakistan decides to shift its energy production from highly polluting sources such as coal and oil to other environment friendly sources of energy production like hydro, solar and wind power plants then it can lead to significant reduction in $CO_2$ emissions and dependency of fossil fuel. According to international market price of $CO_2$ emission, dollars claimed from international climate finance fund which can be used for the developmental purposes. Therefore, it is critically important to estimate and compare the associated costs of energy production from different sources. Shifting to cleaner sources of energy production will require new technologies, financing mechanisms, legal support, physical infrastructures and human resources with new skill set which are certainly not free of cost. Hence, one way to assess the shifting from high polluting to cleaner sources of production is to conduct cost benefit analysis by evaluating each resource at market prices. It requires intensive knowledge about the type, quantity and quality of resources, type and quantity of infrastructure and life span of different resources including the resource depreciation rates. Moreover, it also requires information of wage structure for different level of human expertise and constraints about the availability of these physical and human resources.

To achieve reliable information about the required resources, input-output prices, and to understand the level of risk involved, requires the survey of different markets, though tedious but not necessarily a superior method compared to time and cost attached to it. Alternate option would be to evaluate energy generation from different sources of production at market prices which provides reliable grounds for comparison and may help policymakers in the decision-making. For this purpose, we need prices at production level from each source of generation. We took these prices from other countries whenever unavailable for Pakistan. It allows estimating additional cost incurred on shifting from high polluted to cleaner energy sources.

Data of electricity production for different input mix (coal, gas, hydel, wind and solar) have been taken from Economic survey of Pakistan (GoP, 2018). The electricity generation is reported in gigga watt hour (GWh). Per unit emission (ton/Gwh) and price (US$/Gwh) at the production stage from each source is taken from different sources as given in Table 2.

Table 2. Emission factor and cost of production from different energy sources

| **Energy source** | **Emission Factor** | **Reference** | **Cost Pkr/KWh** | **Reference** |
|---|---|---|---|---|
| Coal | 0.32 | Yousaf (2014) | 3.12 | NEPRA (2012a) |
| Oil | 0.3 | Yousaf (2014) | 8.10 | NEPRA (2016) |
| Gas | 0.21 | Yousaf (2014) | 4.24 | NEPRA (2012a) |
| Solar | 0.021 | Pehl et al. (2017) | 7.15 | NEPRA (2012b) |
| Nuclear | 0.004 | Pehl et al. (2017) | 1.13 | NEPRA (2012b) |
| Wind | 0.000606 | Kamal, M. A. (2014) | 9.12 | NEPRA (2012b) |
| Hydro | 0.000505 | Kamal, M. A. (2014) | 0.16 | NEPRA (2012a) |
| Price per unit (US$/ton) | 36. 3 | World Bank (2018) | | |

Asian Development Bank considers the social cost of carbon in the economic analysis in all their energy and transport related projects as GHG emission reduction strategy. In 2016, a carbon price of US$36.3/ton of $CO_2$ emission was used (World Bank, 2018). A two percent increase per annum in price is suggested due to marginal increase in damages of emission. Since, our energy production data from different sources is for the year 2016-17. We employ the same carbon price of US$36.3/ton in our analysis. First, we estimate the value of emission by multiplying the per unit emission with total electricity generation. Then we converted this into value of emission, simply by multiplying the amount of emission from each source with the international price of emission. [i] Then we attempt to estimate the environmental and economic benefit of shifting 10% of electricity production form high to low polluting sources to identify most economically viable shift from each mode of production. [ii] Prices of electricity production from different sources (coal, oil, natural gas, solar, nuclear, wind and hydro) at the production stage are reported in row 2 and 3 of Table 3 in local currency (Pakistani rupees) and US$, respectively.

Table 3. Amount of energy production from different sources, prices and emission from each source of production

| Variables | Coal | Oil | Natural gas | Solar | Nuclear | Wind | Hydro |
|---|---|---|---|---|---|---|---|
| Price at the production level (Rs./Kwh) | 3.12 | 8.02 | 4.24 | 2.4 | 1.3 | 2.6 | 0.16 |
| Price at the production level (US$./Gwh)* | 25365.85 | 65203.25 | 34471.54 | 19512.20 | 10569.11 | 21138.21 | 1300.81 |
| Production (Gwh) | 54.4 | 38808.8 | 25399.5 | 1000 | 5386.3 | 550 | 38808.8 |
| Percentage share in production | 0.0 | 35.3 | 23.1 | 0.9 | 4.9 | 0.5 | 35.3 |
| CO2 emission (ton/Gwh) | 320 | 300 | 210 | 21 | 4 | 0.606 | 0.505 |
| Total emission tons (tons) | 17398.1 | 11642648.4 | 5333896.6 | 21000.0 | 21545.3 | 333.3 | 19598.5 |
| Value of emission (US$) | 631549.8 | 422628135.2 | 193620448.4 | 762300.0 | 782092.6 | 12098.8 | 711424.0 |
| Value of emission (million US$) | 0.6 | 422.6 | 193.6 | 0.8 | 0.8 | 0.0 | 0.7 |

* US$1=Rs.123

It is observed that prices of electricity production at the generation stage from oil are highest (US$65203.25/gwh) followed by natural gas, coal, wind, solar and nuclear while the prices of hydroelectric power are the lowest among all. However, the carbon emission from coal production is highest (320 ton/gwh) followed by oil, natural gas while it is negligible from solar, nuclear, wind and hydro. If we compare the per unit emission and prices of different modes of power production then both values are lowest for hydro power, implying that hydro is most environment-friendly and economically viable source of production compared to all other available options. On the other hand, if we compare the total emission from different source of electricity production, wind appears having the lowest emission even less than hydro but total production from wind is very small in amount, driving the total emission to the lowest value, besides its feasibility in discrete locations in the country. Total emission estimates are highest from fossil fuel production followed by natural gas. Overall, the solar, nuclear, wind and hydro emerge as cleaner sources of production which has emission less than 25 ton/gwh (Table 2). The prices at the production stage from these sources are also significantly less compared to high polluted sources of production (coal, oil, and natural gas).

Although, coal is most polluted source of production but it contribution in total production is negligible (0.1%). After the completion of project under China-Pakistan Economic Corridor (CPEC), the contribution of electricity production from coal is expected to increase significantly. The percentage contribution of both oil and hydro in total production is the same (35.8%) followed by natural gas (23.4%), and nuclear (5%) but the contribution of solar and wind which are assumed to be cleaner source of production is negligible. However, large potential exists for these modes of production in Pakistan as discussed above. In the presence of such a large potential of solar energy, government needs to motivate for solar rooftops. Although such policy exists in the country, real government interest is lacking and activity in this direction is not noticeable (Memon and Hussain 2018). Interestingly, Memon and Hussain (2018) noted that a lot of good policies, legal and financial mechanism to support net-metering and distributed energy generation in Pakistan already exist and are far better than some European countries but real will and intention to implement such policies is lacking.

We also investigate the environmental and economic benefit of shifting 10% electricity production from high polluted sources to environment-friendly sources. For this purpose we arranged all modes of electricity production from lowest to highest polluting sources, then estimated the environmental benefit of shifting 10% production from the most feasible shift in terms of highest environmental benefit (Table 4). When 10% of electricity produced from coal is shifted to other sources of production then environmental benefits are found to be negligible, ranging between US$0.004 to US$0.063 million per annum. Although coal is highly polluted source of electricity production but its contribution towards environmental benefit in terms of carbon finance is extremely small. It is mainly because it contributes only 0.1% in total production (Table 4). However, when 10% of electricity production is shifted from oil to cleaner sources then environmental benefits in terms of carbon finance are ranging between US$12.7 million (for natural gas) to US$42.2 million (for hydro) per annum. The highest environmental benefits in terms of carbon finance are observed if 10% of electricity produced by oil is shifted towards hydroelectric power followed by wind, nuclear, solar and natural gas. Similarly, if 10% of electricity produced by natural gas is shifted towards cleaner sources then environmental benefits varies between US$17.4 to US$19.3 million. Our results demonstrate that highest environmental benefits are observed; when 10% of electricity produced from oil is shifted towards other environmentally friendly sources. This implies that the nation needs to shift electricity production from oil to cleaner sources (hydro, wind, nuclear and solar) to harness the benefit of carbon financing.

Similarly, the economic benefit of shifting 10% of electricity produced from most to least polluting source is estimated, and results are reported in Table 5. Like environmental benefits, the economic benefits of shifting 10% of electricity produced from the cleaner sources are also small. These small benefits are mainly because of small contribution (less than 1%) of electricity produced from coal in the total portfolio. The highest economic benefits are observed when 10% of electricity produced from oil is shifted to the cleaner sources. The benefits are ranging between US$119.27 (from natural gas) to US$248.00 million (from hydro power) per annum, implying that hydroelectric power is generating highest economic benefit followed by nuclear, solar, wind and natural gas. The price of electricity produced from hydro at the production stage is minimum that leads to drive highest economic benefit. The benefits of shifting 10% of electricity produced by natural gas to the cleaner sources are ranging from US$33.87 (for wind) to US$84.25 million (for hydro), implying that hydro is generating maximum benefit. The difference of benefit between minimum and maximum value is about US$50 million per annum. It is observed that shifting from natural gas to solar is more profitable than to shift towards wind and nuclear is generating more economic benefit than both solar and wind.

Table 4. Environmental benefit of shifting 10 percent from polluted to environmental friendly source of production

| Source of electricity production | | | | | | |
|---|---|---|---|---|---|---|
| Coal | Oil | Natural gas | Solar | Nuclear | Wind | Hydro |
| Shifting 10% of coal production to others | 0.00 | 0.02 | 0.06 | 0.06 | 0.06 | 0.06 |
| | Shifting 10% of oil production to others | 12.68 | 39.30 | 41.70 | 42.18 | 42.19 |
| | | Shifting 10% of gas production to others | 17.43 | 18.99 | 19.31 | 19.32 |
| | | | Shifting 10% of solar production to others | 0.06 | 0.07 | 0.07 |
| | | | | Shifting 10% of nuclear production to others | 0.07 | 0.07 |
| Values are in million US$ (1US$=PAK Rs. 123)<br>Value of emission=US$37.77/ton | | | | | | |

Table 5. Economic benefit of shifting 10 percent from polluted to environmental friendly source of production

| Source of electricity production (Values are in million US$) | | | | | | |
|---|---|---|---|---|---|---|
| Coal | **Oil** | **Natural gas** | **Solar** | **Nuclear** | **Wind** | **Hydro** |
| Shifting from Coal | -0.22 | -0.05 | 0.03 | 0.08 | 0.02 | 0.13 |
| | Shifting from oil | 119.27 | 177.32 | 212.03 | 171.01 | 248.00 |
| | | Shifting from gas | 38.00 | 60.71 | 33.87 | 84.25 |
| | | | Shifting from solar | 0.89 | -0.16 | 1.82 |
| | | | | Shifting from nuclear | -5.69 | 4.99 |

* Negative value indicates lost while positive values indicates gain of shifting

The total net benefits (Environmental + Economic benefit) are reported in Table 6. The pattern of benefits is almost like economic benefits because contribution of economic benefits is dominant. The total benefits of shifting 10% of electricity production from coal to the cleaner sources are negligible and the reason as explained earlier in case of economic benefit. The highest total benefits are observed when 10% of electricity produced from oil is shifted to other the cleaner sources which are ranging between US$132.0 (for gas) to US$290.2 million (for hydro). It is mainly because of highest price of electricity produced from oil at the production stage and major share of electricity produced from oil in the total portfolio of electricity production in Pakistan.

Table 6. Net benefit (Environment +Economic benefit) of shifting 10 percent from polluted to environmental friendly sources of production

| Source of electricity production (Values in million US$) | | | | | | |
|---|---|---|---|---|---|---|
| Coal | Oil | **Natural gas** | **Solar** | **Nuclear** | **Wind** | Hydro |
| Shifting from Coal | -0.21 | -0.03 | 0.09 | 0.14 | 0.09 | 0.19 |
| | Shifting from oil | 131.94 | 216.63 | 253.73 | 213.19 | 290.19 |
| | | Shifting from gas | 55.42 | 79.70 | 53.17 | 103.57 |
| | | | Shifting from solar | 0.96 | -0.09 | 1.90 |
| | | | | Shifting from nuclear | -5.626 | 5.061 |

* Negative value indicates lost while positive values indicates gain of shifting

Despite huge wind and solar potential in the country as mentioned earlier, Pakistan started with negligible renewable energy, Pakistan was able to generate 1,550 GWh of renewable energy from solar, wind and bagasse sources in 2016 and it is expected to expand in future as mini hydel plants, solar, wind and others are planned. (HDIP 2017, NEPRA 2017, Kamran 2018)].Following are some of the developments on Renewable energy that can be claimed for carbon credit:

**Box 1:Alternative Sources of Energy**

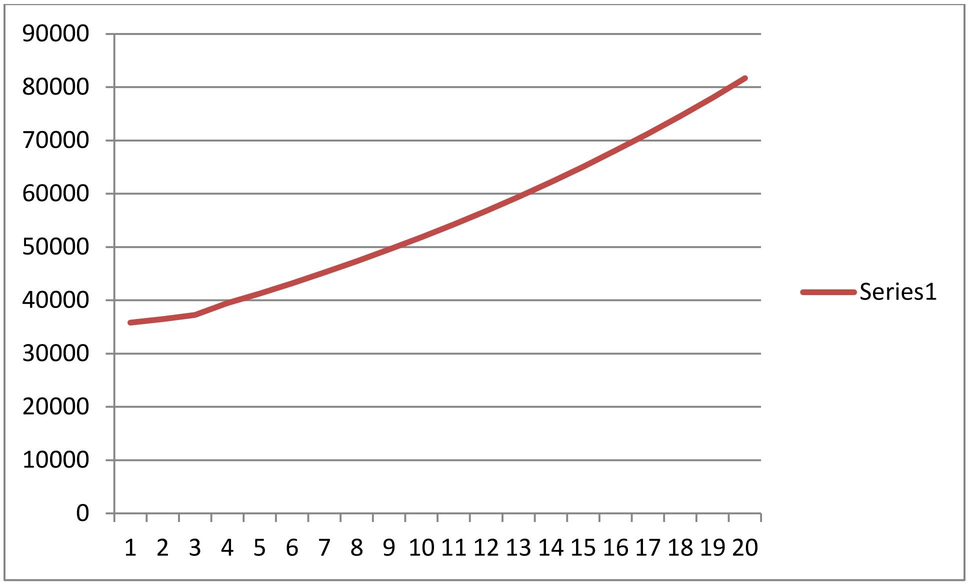
1. Wind parks could be installed mostly along the coastline in Southern Pakistan and owned by the private sector. By 2016, about 27 wind power licenses had been issued for varying installation capacities ranging from 2.5 MW to 250 MW with a cumulative installed capacity of 1,500 MW (NEPRA, 2017).
2. By 2016, total 17 solar power licenses had been issued to solar IPPs ranging from 1 MW to 100 MW installed capacity, with a cumulative installation capacity of 523 MW (NEPRA, 2017).
3. By 2016, 17 co-generation licenses had been issued to sugar mills utilizing bagasse and other biomass for an installed capacity ranging from 9.1 MW to 74 MW, with a cumulative installation capacity of 497 MW. Many of these plants have yet to provide electricity (NEPRA, 2017).
4. By the start of 2018, about 270 distributed generation or net-metering licenses had been issued to various households, universities and other organizations such as the Ministry of Planning, Development and Reforms, and the Parliament. These licenses ranged from 1.6 KW to 800 KW (below 1 MW) with a cumulative capacity of 5.5 MW (NEPRA 2018). An estimated 4 MW of solar power is already fed into the national grid through net-metering (The News, 2018).
5. Encouraging the production and use of biofuels can result in reduction in GHG emissions from and resolve the energy scarcity. Production of biofuel crops can increase the agricultural productivity, bring marginal land and waste land under cultivation. However, measures should be taken to productive use of land under main agricultural crops like rice and cotton and food crops.
6. Latest technology to produce safe nuclear energy and for 'Coal Beneficiation'

Modified from Memon and Hussain 2018

**2.b:** ***Transport* Sector**Climate action often focuses on energy and industrial activity, but the transport sector is often ignored. In this section we discuss transport sector, briefly, mainly for the following major reasons:

1. In this sector is responsible for more than 22 of global energy related GHG emissions and also growing at a faster rate. Figure 1 shows rapidly rising emissions from1998 to 2017.

Figure 1: Emissions in Transport Sector




2. In addition, the transport infrastructure lasts for decades, so the decisions of today will have long-lasting impacts on development (particularly urban development) and on climate. We know that we need to reduce the dependence on motorized travel, shift to the most sustainable mode, and improve existing technologies and systems.
3. Implementing low-carbon transport options can improve air quality and consequently the health of population and help in poverty alleviation. The health cost of air pollution included 3.7 million premature deaths in 2012, and fuel combustion in motor vehicles is linked with up to 75 percent of urban air pollution. Vehicles are major source of air pollution adversely affecting health and ecosystem. Use of biofuels, in transport and other sectors, helps to reduce pollution by 80 percent. (Mofizur et. al., 2015).
4. Climate action in the transport sector is an important opportunity to demonstrate how the interaction between sustainable development agenda and the climate agenda can support the growth of developing economies.
5. Rise in population and rapid urbanization has increased the demand for transportation and of fuels. Promotion of biofuels use in transport will lead to energy saving and leap forward in the carbon market (Liaquat, et. al. 2010)

All these arguments indicate the significance of transport sector in sustainable economic growth, particularly in the long run. The CPEC projects also focus on connectivity by construction of roads and ports. The traffic on these roads and activities along the coasts may accelerate environmental degradation and add in to the GHG emission. Thus, the need is to take measures to improve the situation.

## 3. Measures to Reduce GHGs Emission

The policy focus is adaptation, mitigation, institutional strengthening and on capacity building, particularly at the ministerial level. Various policy measures are suggested in National Climate

Change Policy document to reduce GHG emissions. The measures suggested for the improvement in mitigation efforts, in energy and transport sector, are reported in Table 7. In general, all the measures for improvements in resource use and efficiency depend critically on technology (creation and transfer, both), provision of incentives, capacity building and capability development. These are discussed below:

### *a. Technology*

Technological innovations are driving force for economic growth. These are also linked with a society's cultural values as its survival revolves around innovations. Industrial linkage with the institution of technology transfer and technology creation needs to be developed. Accelerating innovations of environmentally sound and affordable technologies in developing countries should be linked, for effective creation, with clearly defined property rights. Technological innovations are also critical in achieving SDGs. It can help in developing integrated carbon markets to reduce GHG emissions (SDG-13), develop clean energy infrastructure (SDG-7 and SDG-11), water harvesting, desalination, water use efficiency and waste water treatment technologies (SDG-8). Upgraded technological capabilities can help introduce intelligent transport system. (UNDP 2018). Global community should ensure equal access to environment-friendly technologies to all developing countries. How and who will determine the appropriateness of a technology is for a given country? How "targeted" technologies are defined? Is it sector specific or industry specific? Which sector/industry in Pakistan should the policies focus? All these are critical questions and need to be answered through in depth research. In addition, research and development of technologies should also be complemented with efforts for their "adaptation and diffusion".

Table 7: Policy Measures for Mitigation  for Selected Sectors

| | Sector | Policy Options |
|---|---|---|
| 1 | **Energy** | • Give preferential status to the development and promotion of hydropower generation;<br>• Ensure that the negative impact of hydropower projects on the environment as well as local communities are properly assessed and addressed;<br>• Promote the development of renewable energy resources and technologies such as solar, wind, geothermal and bio-energy;<br>• Promote futuristic building designs with solar panels for energy self-sufficiency, especially in public sector buildings;<br>• Plan the necessary expansion of nuclear power for Pakistan's energy security while ensuring the highest safety standards;<br>• Explore the possibility of obtaining technological know-how and its transfer for installation of clean coal technologies such as Pressurized-Fluidized-Bed-Combustion (PFBC) and Near-Zero Emission Technology (NZET) for the vast coal reserves in the south of Pakistan, |

| | | |
|---|---|---|
| | | and their inclusion in future pulverized coal Integrated Gasification Combined Cycle (IGCC) systems;<br>• Ensure that new coal-fired power stations perform at high-efficiency level and are designed in such a way that they can be easily retro-fitted for Carbon Dioxide Capture and Storage (CCS);<br>• Install plants to generate power from municipal waste;<br>• Consider introducing carbon tax on the use of environmentally detrimental energy generation from fossil fuels;<br>• Promote and provide incentives for activities required for increasing the energy-mix and switching to low-carbon fossil fuels, and develop indigenous technology for CO2 Capture and Storage (CCS); Waste Heat Recovery, CO2 generation; Coal Bed Methane Capture; and Combined Cycle Power Generation;<br>• Give priority to the import of natural gas, Liquefied Natural Gas (LNG) and Liquefied Petroleum Gas (LPG) over import of oil and coal, except for meeting specific fuel requirements, e.g. liquid fuel for transportation, cooking coal for the steel industry. |
| | | |
| 2. | Energy Efficiency and Energy Conservation | • Strive to conserve energy and improve energy efficiency in all energy using devices and processes;<br>• Examine the gradual introduction of "Green Fiscal Reforms" in different sectors of the economy, including energy, water and waste/sewage, to achieve the objectives of carbon emission reductions;<br>• Incentivize CDM projects in the field of energy efficiency and energy conservation;<br>• Enact and enforce energy conservation legislation and audit standards;<br>• Ensure high quality management of energy production and supply, including reduction in transmission and distribution losses;<br>• Improve energy efficiency in building by standardizing building and construction codes and legislating/creating incentives for retrofitting, maximum use of natural light, better insulation and use of energy efficient lights, boilers, appliances and groundwater pumping units;<br>• Promote and gradually make it mandatory to specify the energy efficiency/fuel consumption rates of energy using equipment and devices of common use. |
| | Transport-Aviation | • Encourage the national airline to give due consideration to new fuel efficient aircrafts, causing minimum carbon |

| | | |
|---|---|---|
| | | emissions, while planning fleet upgradation;<br>• Support the International Civil Aviation Organization's (ICAO's) initiative for carbon emission reduction through improved air traffic management, which includes improved weather services and free flight air routes, instead of defined routes, that hold the potential for reduced flight time and thus fuel consumption;<br>• Participate actively in ICAO's activities and initiatives and ensure that new strategies and policies of ICAO do not hurt the economic interests of developing countries' aviation industries. |
| | Transport-Railway | Ensure the provision of an efficient railway system in the country; Upgrade and expand the railway network in the country, as the advantages of railway over road travel in terms of carbon emissions are well recognized. |

Source: National Climate Change Policy-2012.

Furthermore, a technology action plan needs to be developed. For the technology action plan: specific actions and timelines for the first three years are critical for subsequent sustainable economic growth and on emission reduction. Given the initial conditions in Pakistan, the initial time period may be extended to five years, after the finalization of the action plan. In addition, technology action plan will classify the technologies as: public domain technologies, patented technologies and know-how, future technologies and more importantly, how Pakistan can be part of all three? The answer depends on capacity building and capability development. Technology information and deployment mechanism should be developed. However, the information is costly. The developing countries can check for the availability of technology through institutional setup of COP. Regional Cooperative Actions are critical for technology creation and transfer. How Pakistan can participate and benefit from the regional R & D efforts?

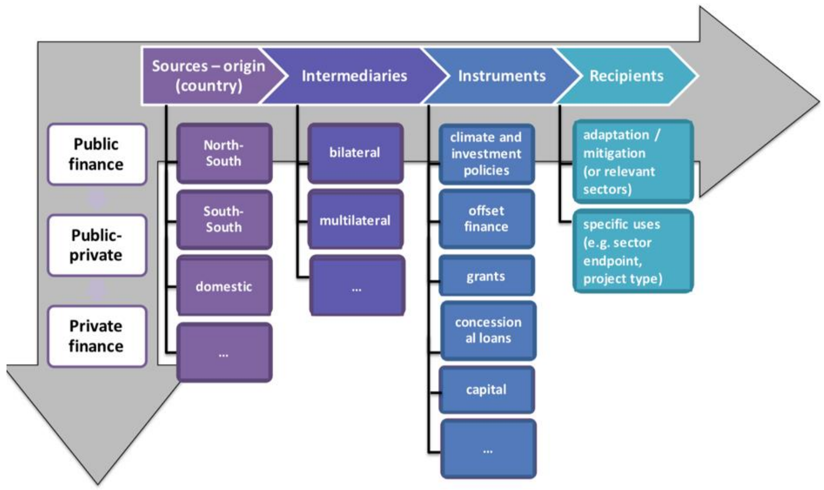
### Capacity-Building and Institutional Arrangements

National and international coordination is needed for capacity building. Issue-based capacity building is needed (for adaptation, mitigation, REDD and others). Institutional arrangements and financial needs should be clearly worked out. Since climate change affects all segments of the society and economy, the "Institutional Arrangements" can play an important role in meeting these challenges. Pakistan needs to take steps to develop multidimensional cooperation among national and international institutions.

## *4. Resource Mobilization*

The options for reducing GHG emissions require financial resources that are scarce in the developing countries. Given the scarcity of the resources Pakistan, like other developing countries, needs to prioritize short- and long-term options for climate financing. Figure 3, identifies the dimension of climate finance. The resource flow form international and international sources could be in the form of investment, grants and loans. Different sources will have different financial implications.

**Figure 3: The Dimensions of Climate Finance**




Source: Buchner, Brown and Corfee-Morlot (2011), cited in IMF and World Bank (2011)

This will be helpful in development of measurement, reporting and verification financial framework across a variety of sources. As an illustrative example, Box 2 identifies the possible sources of finances and potential from these sources. The box also indicates that carbon pricing, at $ 25 per ton $CO_2$, has potential to generate climate finance flow equaling $ 25-50 billion by 2020, fossil fuel subsidy reforms can generate $ 4-12 billion. The potential of private flows is highest equaling $ 100-200 billion. These investment flows in the low carbon growth strategies will have long-term implications for the sustainability of livelihood in developing countries like Pakistan.

### 4.a: Fiscal

Similar framework will be developed for Pakistan based on the discussion in the subsequent sections. Like most of the developing countries, Pakistan is facing problems of debt burden, twin deficits and other problem in formulation and implementation of reforms. Fear of deindustrialization and inefficiency in resource use are affecting productivity in the public and private sector. The reform in subsidies structure should be the priority area to improve economic efficiency and raise revenue to provide for climate change financing. The discussion indicates that resource generation in the public sector is major source of finance. However, due to the resource crunch faced by the governments the resource generation in the private sector has become important. Based on the principle of 'differentiated responsibilities' the external (bilateral and multilateral) resource inflow has also become an important source of climate change financing. Each option is discussed below:

**Box 2: Potential Elements of International Climate Finance Flows in 2020**

| | Revenue Base ($ billion) | Illustrative Climate Finance Allocations (%) | Climate Finance Flow ($ billion) |
|---|---|---|---|
| **Sources of Public Finance** | | | |
| Carbon Pricing ($ 25 per ton $CO_2$) in Annex II countries | 250 | 10[(a)]-20 | 25-50 |
| MBIs for International aviation maritime fuels ($25 per ton $CO_2$) | 22[(b)] | 33[(a)]-50 | 7-11 |
| Fossil Fuel Subsidy Reform© | 40-60 | 10-20 | 4-12 |
| **Instruments to Leverage Private and Multilateral Flows** | | | |
| Carbon Offset Market Flows (various scenarios)[(d)] | | | 20-100 |
| Private flows leveraged by public policies and instruments[(e)] | | | 100-200 |
| MDB finance-pooled arrangements and/or capital[(f)] | | | 30-40 |

(a) Consistent with AGF assumptions of 10 percent allocations for carbon pricing and 25-50 percent for MBIs.
(b) Revenues accruing to developed countries only.
(c) As discussed in section 2.1.3, not all support mechanisms are necessarily inefficient and in need of reform. Precise revenue will potential depend on demand effects of reforms and interaction among tax expenditures, among other factors.
(d) $ 20 billion consistent with $20-25 per ton $CO_2$ scenario; $100 billion with 2 degree pathway scenario, as per section 3.1 in main text
(e) Gross foreign private flows to developing countries as per scenario in Table 3 and section 3.2 in the main text.
(f) Reflects assumption discussed in section 3.3 in the main text that every $ 10 billion I additional resources can be leveraged 3-4 times in additional MDB climate flows.
(g)

**4.b: Public Sector**

**Government** allocates resources to various activities which are not classified allocations for climate control or to control environmental degradation but these activities are contributing to environmental improvements and air and water pollution reduction. (see Table 8).

Table 8: Climate-relevance classification as per the Pakistan CPEIR study 201712

| | **Indicative Examples** |
|---|---|
| Climate relevance weight 75% + | Clean energy generation (e.g., renewables, hydropower and nuclear) and improving energy efficiency to reduce GHG emissions<br>• Disaster risk reduction and enhancing disaster management capacity, particularly actions targeting flood and drought risk reduction<br>• Forestation and conservation of protected areas for climate change management<br>• Research, management and construction of water |

| | |
|---|---|
| | resources and infrastructure to combat increasing climate induced variability in droughts and floods<br>• Community/Village planning and relocation to protect from climate stresses (droughts, floods and sea level rise)<br>• Health care and research for managing climate-sensitive diseases and health impacts (e.g. malaria, heat strokes)<br>• Building institutional capacity to plan and manage climate change impacts, including early warning systems and monitoring mechanisms<br>• Climate change awareness raising, research and technical capacity building. |
| Climate relevance weight 50–74% | • Forestry and agro-forestry schemes that are motivated primarily by economic or conservation objectives but have strong climate change mitigation potential<br>• Waterworks rehabilitation, water efficiency, irrigation and canal lining – activities motivated primarily by agricultural or rural and urban supply objectives but which also have potential to address problem of climate induced water shortages<br>• Biodiversity and conservation activities that are not explicitly aimed at increasing resilience of ecosystems to climate change impact but which have good potential to deliver these objectives nonetheless.<br>• Civil defence facilities enhancement that can contributes to disaster risk management<br>• Land-use planning and zoning<br>• Improvement to industrial production and management technologies and efficiency standards<br>• Education and research in agriculture, veterinary and animal sciences and environmental sciences. This can contribute to food security under climatic stresses.<br>• Improvements to energy distribution system |
| Climate relevance weight 25–49% | • Sanitation and sewerage development schemes that are not explicitly designed for the purpose of reducing climate induced disaster risk<br>• Marine research<br>• Roads reconstruction with disaster proofing elements |

| | |
|---|---|
| | • Livestock management research<br>• General public planning capacity enhancement, either at national or local level, unless<br>explicitly linked to climate change, in which case relevance would be high.<br>• Livelihood and social protection programmes motivated by poverty reduction (zakat,<br>Poverty Alleviation Fund, Benazir Income Support Programme [BISP]), but building<br>household reserves and assets and reducing vulnerability<br>• Food security research and planning<br>• Mass transit systems, railways<br>• Technological advancements; satellite programmes |
| Climate relevance weight less than 25% | • Trade diversification<br>• Education and health programmes that do not have an explicit climate change element but generally improve access to information, health care and resources for peop<br>• Development of roads and communication networks to enhance general mobility and access<br>• Social uplift and income support schemes and programmes |

Source: Khan and Usmani (2018) [Table 1]

For public resource generation, specifically for climate financing, following options are noteworthy:

***1. Taxation and Subsidies:***

***Energy:*** Taxation and subsides are important pillars of public policy. The evidence shows that carbon/energy taxes and energy efficiency improvements, jointly, reduce emissions. Energy taxes reduce emissions and GDP both. But the efficiency improvements reduce emissions and affect GDP positively. Thus, simultaneous application of the two policies has implications for the sustainable development of the country (Mahmoood and Marpaung 2014). In the electricity bills for consumers, various surcharges (fuel adjustment surcharge, F. C. surcharge, N. J. Surcharge and others) and taxes (GST, GST on fuel price adjustment, excise duty on fuel price adjustment and others) are levied. Allocating 50 percent of these receipts or introducing a climate tax to be collected through electricity bills for climate financing can be an important source for renewable energy. In general, the electricity sector is still an important recipient of subsidies. The share of WAPDA and KESC, in total subsidies announced in different Budgets, was 0.77 percent and 0.14 percent, respectively, in 2014/15. However, these shares changed to 0.68 percent (WAPDA) and 0.16 percent (KESC) in 2016/17. (see Table 9).

**Table 9: Subsidy to Energy Sector**

| | 2014-15 | 2015-16 | 2016-17 |
|---|---|---|---|
| Total Subsidy (Rs. Mln) | 203248 | 137603 | 140600 |
| Subsidy to WAPDA/PEPCO | 156100 | 98000 | 95400 |
| Subsidy to KESC | 29000 | 20000 | 22600 |
| Share (percentage) | | | |
| Subsidy to WAPDA/PEPCO | 0.77 | 0.71 | 0.68 |
| Subsidy to KESC | 0.14 | 0.15 | 0.16 |

Source: Budgets (various issues)

Given the resource scarcity, it is difficult to allocate additional resources for the carbon emission mitigation strategies. The resources saved by reducing the subsidies and from tax receipt should be used to adopt emission reducing strategies and technologies.

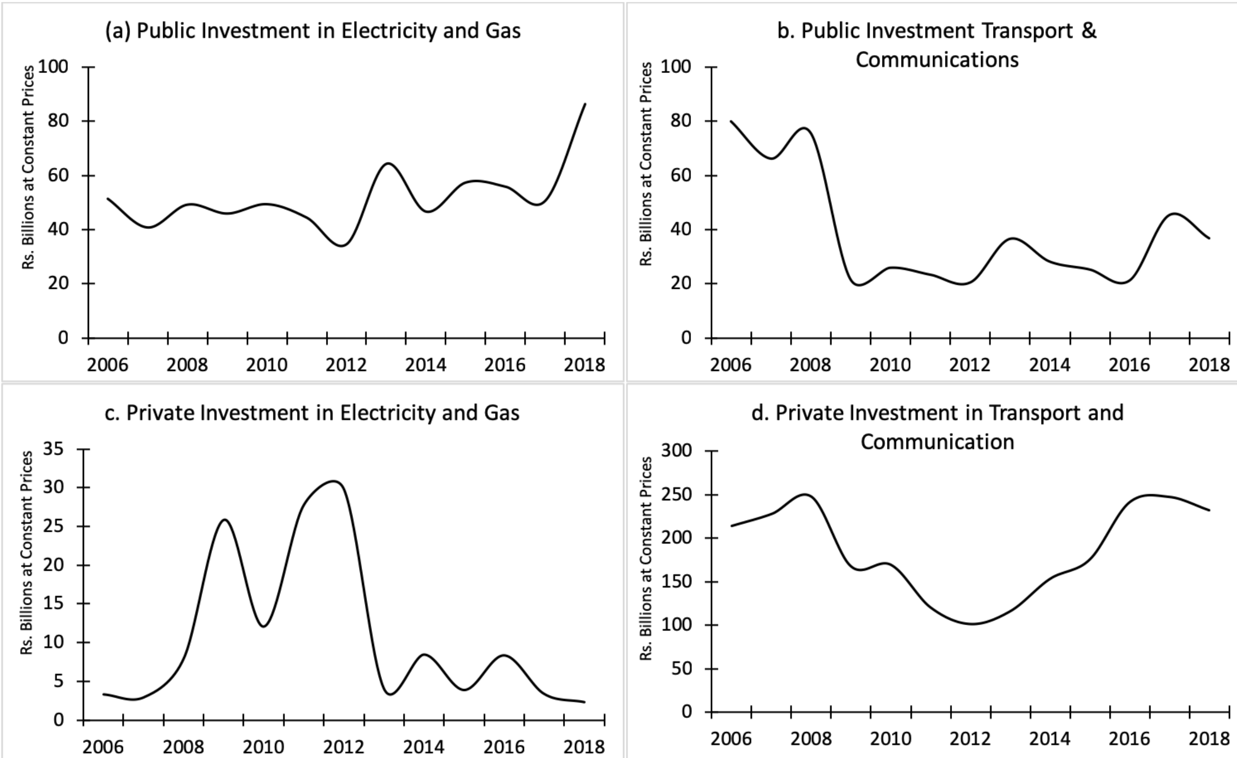
***Trade:*** Trade taxes are also important. A climate surcharge can be imposed on trading products. The rate could vary between 0.5-2.0 percent depending on the carbon intensity of the product. For example, implementation of environmental levy on air and maritime transport needs to be studied carefully to understand the implication for developed and developing countries. It can include "transportation of goods and services", particularly the carbon intensive goods and services. The levy of USD 2 is linked with higher than per-capita emission 1.5/2.0 tonnes of CO2 should be linked with the need of the resources.

***1. Gross fixed capital formation (Investment)-Public***

Gross fixed capital formation (public investment) addition to a primary factor of production, viz., capital. It is also an important source of transfer of technology. Public investment in electricity and gas, though increased, varied significantly over time. (See Figure 2). But in the transport sector Table 10 shows that public investment increased from Rs. 94651/- mln in 2009 to Rs. 146186/- mln in 2017/18. The share of electricity and gas increased, from 57 percent in 2009/10 to 59 percent in 2017/18 and the share of transport and communications declined from 28 percent to 25 percent in this period. The need is redirect/promote the investment in environment friendly capital stock or the installation of machinery and equipment that results in lower or no pollution. Few examples are:

a. Zig Zag technology in the production of brick kilns
b. Supercritical technology for coal use in electricity generation
c. Technology to control water pollution, particularly ground water pollution.

*Figure 1: Public and Private investment in Electricity and Gas and Transport and Communication*




Note: Based on data reported in Pakistan Economic Survey (2017/18)

**Table 10: Public Gross Fixed Capital Formation (2009/10-2017/18)**

| | **2009/10** | **2017/18** | **Growth Rate (2010-2018)** |
|---|---|---|---|
| Total Public Investment (Rs, Mln) | 94651 | 146186 | 5.43 |
| | Share in total | | |
| Total Public Investment | 100 | 100 | - |
| Electricity and Gas | 57 | 59 | 6.97 |
| Transport | 28 | 25 | 4.38 |

As mentioned earlier the emissions in transport sector are rising in most countries and Pakistan is no exception. In Germany, emissions are declining in most sectors, except for the transport sector where they are rising at smaller pace. In order to control GHG emissions, improve energy efficiency and initiate and implement additional measures, to reduce traffic flows and emissions Germany is encouraging mass transit system to reduce vehicular emissions further. [Liaquat, et. al. (2010)]. In Pakistan, surprisingly the capital formation in transport and communication slowed down in recent years. [see Figure 2]. This is the result of slowing down of public involvement and rising share of private activities in communication subsector. However, for the energy efficiency, the use of hybrid car is increasing. More recently, globally the use of electric cars is rising and Pakistan is also exploring this options. However, it requires provision of infrastructure for battery recharging and other activities. The new public investment should be directed towards provision of this infrastructure. This is expected to encourage private and public use of electric vehicles that are relatively more environment friendly.

2. ***Reforms to Redirect Resources:***

Reforms to redirect resources towards the mitigation activities in different sectors of the economy can be more effective in reducing emissions. However, a detailed study is required to identify the cost and benefits of possible redistribution of resources. For example, the carbon pricing policies like implementation of environmental levy on air and maritime transport needs to be studied carefully to understand the implication for developing countries including Pakistan. It can include "transportation of goods and services", particularly the carbon intensive goods and services. Another option is imposing a carbon quota on the commodity producing sector. It can be implemented as:

a. First decide the national target for carbon reduction. For example, the target is 1 % percent reduction in emissions annually for the next ten years.
b. Rank all the activities in terms of carbon intensity.
c. Impose the target on all activities.
d. These activities can be given incentive in terms of tax rebates or tariff exemptions on the imported inputs, if any. Alternatively, concessional loans can be given for these activities to import environment friendly technologies. However, these incentives should be time bound and properly monitored.

This mechanism could be industry based and within an industry the environmentally efficient firms can be given incentives in terms of taxation and access to credit.

**3. *Institutional development***

Institutional analysis and development is critical for effective implementation of policies. The issue of carbon financing is critical and complex. First we need to develop the capacity of existing institutions to identify the activities and get access to the required financing from the national and international sources. These institutions should provide the following:

a. Pakistan Climate Change Council is established to assess Pakistan's capability to meet its international obligations under international conventions on climate change.
b. Identify the financing needs of the activities. Priority should be given to carbon sequestration.
c. Provide information to the relevant stake holders about the option (particularly about technology). Provide information about the funding/financing options nationally and internationally and prioritizing the options of climate financing
d. In KPK share of climate related funding increased from 7.2 percent in 2011-12 to 9.7 percent in 2015-16. How effective these allocations have been? In order to improve the

accountability it is suggested the role of Parliament has been emphasized. Member of the Parliament have to ensure that climate change planning and budgetary allocations are in line with the development priorities of the Province.

e. For the public sector it is important to design an incentive structure also, focusing on resource generation, directly and indirectly.

**4.b: Private/Community**

**1. *Carbon Markets***

Private sector involvement through 'carbon markets' and other measures can be helpful in provision of finances and in emissions reduction. Carbon pricing can also help deal a negative externality and improve economic efficiency. According to IMF and World Bank (2011), carbon pricing can help to:

> "…..generating substantial domestic revenues for fiscal consolidation, reduction in less efficient taxes and other desirable policy objectives."

However, the creating 'carbon markets' is complex. The initiative is taken, mainly, in developed countries and as pilot in some developed and developing countries. [see Table 11]. The initiative, taken in 1990s by EU and other developed countries, is followed by various developed and developing countries. China is taking this as pilot for local level implementation. Pakistan can also initiate at sectoral and provincial level implementation, starting with energy sector. However, to implement carbon prices, we need to develop valuation, information mechanism, and implementation mechanism with a time frame.

***2. Gross fixed capital formation (Investment)-Private***

As mentioned earlier, due to resource crunch the focus of the financing efforts is now towards private sector. Private flows for climate mitigation and adaptation related investment in developing countries have grown rapidly but remain hampered by market failures and other barriers. Recent investments in renewable energy are not part of the carbon finance. However, they can be classified as investment to reduce emissions if it leads to change in energy mix, i.e., raising share of renewable in total. Pakistan's investment trends in energy and transport sectors are not encouraging. It declined to Rs. 4828/- million in 2013/14 from Rs. 12075 million in 2009/10 and increased to Rs. 19252/- million in 2014/15 and reduced to Rs. 2310/- million in 2017/18. This shows that, in real terms, the investment has been fluctuating and has in fact declined in the recent years. However, the rising trend in public investment and the focus on renewable energy raises the issue of substitutability/complementarity between public and private sector. The investment in the transport has a U-shaped pattern implying that in the early phase private investment was smaller as compared to later years (after 2012). The reason lack of investment opportunities in other sectors and rise in bank financing for the transport sector.

**Table 11: Carbon Financing**

| | Carbon Tax | | Emission Trading System | | CaT | |
|---|---|---|---|---|---|---|
| | **Country** | **Year** | **Country** | **Year** | **Country** | **Year** |
| 1 | Finland | 1990 | EU | 2005 | Tokyo | 2010 |
| 2 | Poland | 1990 | Switzerland | 2008 | California | 2012 |
| 3 | Norway | 1991 | New Zeeland | 2008 | Quebec | 2013 |
| 4 | Sweden | 1991 | Saitama | 2009 | Ontario | 2017 |
| 5. | Denmark | 1992 | Kazakhstan | 2013 | | |
| 6. | Slovenia | 1996 | Shengen Pilot | 2013 | | |
| 7. | Estonia | 2000 | Shangai Pilot | 2013 | | |
| 8. | Latvia | 2004 | Beijing Pilot | 2013 | | |
| 9. | Switzerland | 2008 | Guandong Pilot | 2013 | | |
| 10. | Lichtenstein | 2008 | Tianjin Pilot | 2013 | | |
| 11. | BC | 2008 | Hubei Pilot | 2014 | | |
| 12. | RGGI | 2009 | Korea | 2015 | | |
| 13. | Iceland | 2010 | China National | 2020 | | |
| 14. | Ireland | 2011 | | | | |
| 15. | Ukrain | 2011 | | | | |
| 16. | Japan | 2012 | | | | |
| 17. | France | 2014 | | | | |
| 18. | Mexico | 2014 | | | | |
| 19. | Spain | 2014 | | | | |
| 20. | Alberta | 2017 | | | | |
| 21. | Colombia | 2017 | | | | |
| 22. | Argentina | 2019 | | | | |
| 23. | South Africa | 2019 | | | | |
| 24. | Singapore | 2019 | | | | |

Source: World Bank (2018)

**Table 12: Private Gross Fixed Capital Formation (2009/10-2017/18)**

| | **2009/10** | **2017/18** | **Growth Rate (2010-2018)** |
|---|---|---|---|
| Total Private Investment (Rs, Mln) | 1041102 | 1346310 | 3.21 |
| | Share in total | | |
| Total Private Investment | 100 | 100 | - |
| Electricity and Gas | 1.16 | 0.17 | -20.47 |
| Transport | 16.32 | 17.31 | 3.95 |

A carbon levy of 0.5 percent can be imposed on those who are using gasoline/diesel for their vehicles. This can be charged at the petrol pumps and transferred to the local authorities for the providing the facilities/testing of the vehicles for emissions. Provision of Mass transit facilities and encouraging its use can lead to substantial reduction in emissions. The public resources can be allocated to provide the infrastructure and the regulations on use of vehicles.

**4.d: Bilateral and Multilateral Institutions for Funding**

The international carbon financing fund is a great opportunity to reduce emission by adopting new production technologies with lesser emission in the energy sector. It could significantly help the transition from highly polluted sources of energy production to environment-friendly options and can contribute significant amount of economic gains to Pakistan (Memon and Hussain 2018). Being the major emitting sectors (CO2 equivalent), the potential of climate financing can be observed in energy and agriculture specifically. Nevertheless, here we are focusing only on energy and transportation sector in this report. The rationale for resource flow from developed to developing countries comes under the principle of *common but differentiated responsibilities and respective capabilities* of Parties to the UNFCCC. Initially, $100 billion for the period 2010-12 and mobilize $ 100 billion by the year 2020. Key International climate funds are:

Green Climate Fund (GCF); Adaptation Fund (AF); Climate Investment Fund (CIF); Global Climate Change Alliance (GCCA); Global Environment Climate Fund (ICF); International Climate Initiative (ICI); Least Developed Countries Fund (LDCF); Nordic Climate Fund (NCF); UN-REDD Program.

Most of these agencies provide funding for projects proposed by different national and international entities in the country.

To attract climate finance from international and national, the developing countries like Pakistan need to determine their development priorities. The international agencies provide new and additional resources for adaptation and mitigation activities in developing countries. In Pakistan **GCF** funding of $12 million in grant and $37 million in loan will supplement $442 million loans from ADB. The financing from Asian Investment Bank will help to build a 30-kilometers long state-of-the-art “third generation” bus rapid transit system including bicycle lanes, a bike sharing system and improved pedestrian facilities directly benefiting 1.5 million for the residents of Karachi. The project also includes the construction of a plant to produce biogas from cattle waste for use with zero greenhouse gas emission biomethane-hybrid buses. The REDD+ project is initiated by funding provided by UN, World Bank, and others. The focus of the programme is on increasing the forest cover.

Various projects, approved by PSDP, were undertaken in 2017-18, with the internal and international sources. [see Table 13]. The projects are pursued under Green Pakistan Programme. Reverse linkage project is initiated with Marmara Research Centre to enhance local capacity to predict disasters, like flood and earthquakes.

Table 13: PSDP Funded Projects

| | Name of the Project | Source of funding | Estimated Cost (Rs. Million) |
|---|---|---|---|
| 1 | Establishment of Geomatic Centre for Climate Change and Sustainable Development | | 48.90 |
| 2. | Green Pakistan Progamme-Revival of Forestry Resources in Pakistan | | 3652.14 |
| 3. | Green Pakistan Programme-Revival of Wildlife Resources in Pakistan | | 738.90 |
| 4. | Sustainable Land Management Project to Combat Desertification in Pakistan: SLUM-II | | 105.43 |
| 5. | Construction of Boundary wall of Zoo-cum-Botanical Garden | | 90.10 |
| 6. | Green Pakistan Programme-Strengthening Zoological Survey of Pakistan undertaking immediate inventory of endangered wildlife species and habitats across Pakistan | | 76.73 |
| 7. | Generating Global Environment Benefits from Improved Decision Making Systems and Local Planning in Pakistan | | 193.55 |
| 8. | Glacier Lake Outburst Flood in Northern Areas | GCF | 3920.18 |
| 9. | Establishment of Flood Forecasting and Warning System for Kalpani Nullah Basin, Mardan, Khyber Pakhtunkhwa | | 230.0 |
| 10. | Establishment of Specialized Medium Range Weather Forecasting Centre (SMRFC) and Strengthening of Weather Forecasting System | JICA | 2502.50 |
| 11. | Installation of Weather Surveillence Radar Karachi | JICA | 1580.0 |
| 12. | Reverse Linkage Project Between Pakistan Meteorological Department and Murmara Research Centre (MRC), Turkey | IDB | 101.0 |

Source: Table 16.1, Pakistan Economic Survey 2017/18

Another source of financing is the Multilateral Development Banks. In case of Pakistan, the initiative can be taken at two levels. First, a group of domestic banks can be formed to allocate a small fraction (i.e., 2-4 percent) of their profit for climate financing. Second, a group of banks, like Islamic Development Bank and other Banks in other oil rich countries can form a consortium to develop and import of green technologies. Issue of country ownership/involvement is also important. It is suggested that it should be based on clear and verifiable/quantifiable targets to measure the success of the programs.

## *5.Conclusions*

Given its development status, Pakistan needs substantial resources to combat climate change and GHG emissions. Total outlays are huge that Pakistan cannot arrange these from indigenous resources and must look outward towards multilateral and bilateral resources available for this purpose. In addition, diversion of investment funds and fiscal resources, imposition of trade surcharge to finance climate mitigation and adaptation measures are important.

# References:


Adnan, S; Khan, H.A; Haider, S; and Mahmood, R. (2012). Solar energy potential in Pakistan. Journal of Renewable and Sustainable Energy, Vol. 4.

An Overview of Electricity Sector in Pakistan Islamabad Chamber of commerce

Baloch, M.H., Kaloi, G.S., Memon, Z.A., 2016. Current scenario of the wind energy in Pakistan challenges and future perspectives: A case study. Energy Reports 2, 201–210. https://doi.org/10.1016/j.egyr.2016.08.002

Government of Pakistan (various issues), Pakistan Economic Survey, Ministry of Finance, Islamabad, Pakistan.

Government of Pakistan (2017), *Pakistan: Climate Change Financing Framework: A Road Map to Systemically Mainstream Climate Change in to Public and Financial Management;* with UNDP, Islamabad.

Government of Pakistan (2012), *National Climate Change Policy-2012;* Ministry of Climate Change, Islamabad

Gertner, J. (2007). The future is drying up. New York Times Magazine, 21.

Gurung, T. (2017). Climate Change Adaptation policies in Himalayan Region of Nepal. Comparative analysis of INDCs between Nepal, India, and Peru.

Halimanjaya, A. (2015). Climate mitigation finance across developing countries: what are the major determinants? Climate Policy, 15(2), 223-252.

HDIP, 2017. Pakistan Energy Yearbook 2016. Hydrocarbon development institute of Pakistan. Ministry of Petroleum and Natural Resources, Government of Pakistan, Islamabad, Pakistan.

Heidelberg, R., & Klimpel, S. Betting on Global Warming.

IEA, IRENA (2017) Perspectives for the energy transition: Investment Needs for a Low Carbon Energy System

IMF and World Bank (2011), *Mobilizing Climate Finance*, World Bank.

Kamran M (2018) Current status and future success of renewable energy in Pakistan. Renew Sustain Energy Rev 82:609–617. doi: 10.1016/j.rser.2017.09.049

Khan, D., and A. W. Usmani (2018), *Climate Budget Review Guide-KPK* Assembly, (April)

Lefevre, B. and A. Enriquez (2014) *"Transport Sector Key to Closing the World's Emissions Gaps"*, - September 19.

Liaquat., A. M., M. A. Kalam, H.H Maijuki and M. A. Javed (2010), "Potential Emissions Reduction in Road Transport Sector Using Biofuel in Developing Countries", *Atmosphere Environment*, v. 44, issue 32, October, pp: 3869-3877.

Mahmood, A. and O.P. Marpaung (2014), "Carbon Pricing and Energy Efficiency Improvements-Why to Miss the Interaction for Developing Countries? An Illustrative CGE based Application to the Pakistani Case", *Energy Policy*, 67, pp: 87-103.

Memon JA, Hussain A (2018) Consumer Co-ownership in Renewables in Pakistan. In: Energy Transition: Financing Consumer Co-Ownership in Renewables. Palgrave Macmillan

Mir, K. A., & Ijaz, M. (2015). Greenhouse gas emission inventory of Pakistan for the Year 2011-2012. Global Change Impact Study Centre, Islamabad, Pakistan GCISC Interim Research Report RR-19 (Interim).

Mofizur, M., M.G. Rasul, T. Hyde and M. M. K. Bhyia, (2015), "Role of Biofuels on Internal Combustion Engines Emission Reduction", *Energy Procedia*, vol. 75 (2015), pp: 886-892.

Mohsin, M., Rasheed, A.K., Saidur, R., 2018. Economic viability and production capacity of wind generated renewable hydrogen. Int. J. Hydrogen Energy 1–10. https://doi.org/10.1016/j.ijhydene.2017.12.113

Munasinghe, M., Development, Sustainability and Equity (DSE), Draft Guidance Paper for the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), December 1998

NEPRA (2012a). https://www.winnipeg.ca/finance/findata/matmgt/documents/2012/682-2012/682-2012_Appendix_H-WSTP_South_End_Plant_Process_Selection_Report/Appendix%207.pdf

NEPRA (2012b). https://www.nepra.org.pk/Publications/State%20of%20Industry%20Reports/State%20of%20Industry%20Report%202012.pdf NEPRA State of industry report 2012

NEPRA (2012c). https://www.nepra.org.pk/Publications/State%20of%20Industry%20Reports/State%20of%20Industry%20Report%202016.pdf NEPRA State of industry report 2016

NEPRA (2017) State of industry Report 2016. Islamabad Pakistan

NEPRA, 2017a. State of industry Report 2016. Islamabad Pakistan.

NEPRA 2018. Official Website of NEPRA

P. Sioshansi F (2017) Innovation and Disruption at the Grid's Edge. In: Fereidoon P. Sioshansi (ed) Innovation and Disruption at the Grid's Edge: How distributed energy resources are disrupting the utility business model. Academic Press, pp 1–22

Pehl, M., Arvesen, A., Humpenöder, F., Popp, A., Hertwich, E. G., & Luderer, G. (2017). Understanding future emissions from low-carbon power systems by integration of life-cycle assessment and integrated energy modelling. Nature Energy, 2(12), 939.

Tahir, Z.R., Asim, M., 2018. Surface measured solar radiation data and solar energy resource assessment of Pakistan: A review. Renew. Sustain. Energy Rev. 81, 2839–2861. https://doi.org/10.1016/j.rser.2017.06.090

The News, 2018. Pak Power - Progress and Way Forward (Special Report), in: National Seminar

March 5, 2018. Jang Media Group

UNDP (2017), "Financing for Development", *Development Advocate Pakistan*, vol. 4, Issue 1, (March).

UNDP (2018) , "Leveraging Technology for Development", *Development Advocate Pakistan,* vol. 5, Issue 1, (March).

Venugopal, S., & Srivastava, A. (2012). Moving the Fulcrum: A primer on public climate financing instruments used to leverage private capital. World Resources Institute.

Venugopal, S; Srivastava, A; Polycarp, C; and Taylor, E. (2012). Public Financing Instruments To Leverage Private Capital For Climate-Relevant Investment: Focus On Multilateral Agencies. Working paper, World Resources Institute.

World Bank (2018). State and Trends of Carbon Pricing 2018, Washington DC, May 2018.

***End Notes***

[i] Mathematically it can be written as:

$$VE_i = Q_i * E_i * P_e \quad (1)$$

Where,
$VE_i$ = Value of emission from the *i*th source of generation (US$), (i=1, 2, 3, …….6)
$Q_i$= total amount of generation from the *i*th source (Gwh)
$E_i$= per unit emission from the *i*th source of generation (ton/Gwh)
$P_e$=International price of emission (US$/ton)

[ii] Mathematically, environmental benefit of shifting production from source "*i-th*" to "*j-th*" is estimated as,

$$ENB_{ij} = [E_i - E_j](Q_i * 0.1) * P_e \quad (2)$$

Where $ENB_{ij}$ stands for environmental benefit of shifting 10% production from *i*th to *j*th source, $E_j$ is per unit emission from *j*th source and other mathematical symbols are as explained above. The economic benefits of shifting from "*i*th" to "*j*th" source of production estimated by employing equation 3 as below,

$$ECB_{ij} = [P_i - P_j](Q_i * 0.1) \quad (3)$$

Where, $ECB_{ij}$ represents the economic benefits of shifting production from "*i*th" to "*j*th"source and $P_i$.and $P_j$ is per unit price at the production stage from "*i*th" and "*j*th"sources, respectively. Now the total benefit of shifting from "*i*th" to "*j*th" source is estimated just by adding environmental and economic benefits as below.

$$TB_{ij} = ENB_{ij} + ECB_{ij} \quad (4)$$

Where, $TB_{ij}$ is the total benefit of shifting production from "*i*th" to "*j*th"source, $ENB_{ij}$ and $ECB_{ij}$ are as explained above. By employing these equations we estimated the environmental and economic benefit of shifting 10% of existing production from "*i*th" to "*j*th" source. Mathematically, environmental benefit of shifting production from source "*i-th*" to "*j-th*" is estimated as,

$$ENB_{ij} = [E_i - E_j](Q_i * 0.1) * P_e \quad (2)$$

Where $ENB_{ij}$ stands for environmental benefit of shifting 10% production from *i*th to *j*th source, $E_j$ is per unit emission from *j*th source and other mathematical symbols are as explained above. The economic benefits of shifting from "*i*th" to "*j*th" source of production estimated by employing equation 3 as below,

$$ECB_{ij} = [P_i - P_j](Q_i * 0.1) \qquad (3)$$

Where, $ECB_{ij}$ represents the economic benefits of shifting production from "*i*th" to "*j*th"source and $P_i$.and $P_j$ is per unit price at the production stage from "*i*th" and "*j*th"sources, respectively. Now the total benefit of shifting from "*i*th" to "*j*th" source is estimated just by adding environmental and economic benefits as below.

$$TB_{ij} = ENB_{ij} + ECB_{ij} \qquad (4)$$

Where, $TB_{ij}$ is the total benefit of shifting production from "*i*th" to "*j*th"source, $ENB_{ij}$ and $ECB_{ij}$ are as explained above. By employing these equations we estimated the environmental and economic benefit of shifting 10% of existing production from "*i*th" to "*j*th" source.