



BEHAVIOURAL CHANGE AS AN ADAPTIVE MEASURE FOR MITIGATING CARBON DIOXIDE EMISSION FROM ENERGY SECTOR

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ABSTRACT Climate change is deliberated to be one of the biggest negative externality over world resources. Among the GHGs, carbon dioxide contribute maximum to the global warming. Maximum contributor of carbon dioxide is estimated from power generation sector. India is rated as the 3rd largest contributor of CO₂ emissions globally. Emissions of CO₂ growth in India continue largely because it is still dependent heavily on coal based thermal power plants for electricity generation. This paper analyzes the growing trend of carbon dioxide emission in India and globally. Nationally and internationally focus on energy sector for climate change mitigation is at an all-time high It also tries to review the literature on the role of energy sector in attributing adverse effects of climate change. And also stress on the need for changing human energy behaviour for sustainable and long lasting solution to tackle adverse effects of climate change.

KEYWORDS : Climate change, CO₂ emissions, India, Energy sector, Energy behaviour, Energy efficiency.

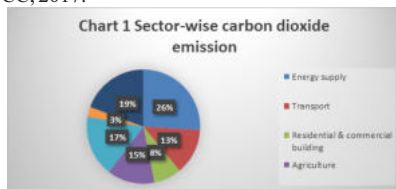
INTRODUCTION

Climate change is deliberated to be one of the biggest negative externality over world resources. An increase in the concentration of GHG is likely to increase the mean atmospheric temperature subsequent in a higher incidence of natural disasters and catastrophes (such as drought, flood and heat waves), higher mortality rate and a substantial loss of bio-diversity (IPCC). Economic and environmental cost of it is huge and transnational. Among the GHGs, carbon dioxide contribute maximum to the global warming. More than half (65 per cent) of the carbon dioxide emissions are from fossil-fuels use. [IPCC 5th Assessment report] Among the fossil fuels, coal is said to be the prime culprit for carbon dioxide emissions. As a result policy makers all over the world are inculcating 'climate change, cost and its mitigation' as one of their major growth policy.

Table 1 Sectorial Contribution of Global CO₂ Emission (2017)

Sector	Share (in %)
Energy supply	25.90%
Transport	13.10%
Residential & commercial building	7.90%
Agriculture	13.50%
Forestry	17.40%
Waste & wastewater	2.80%
Industry	19.40%

Source: IPCC, 2017.



Energy sector is the only sector where close to zero emissions is possible and this could enable close to zero emissions for much of transport. This would require radical changes to the source and use of energy, including much greater energy efficiency.

Trends in Global Carbon Dioxide Emission

Global Carbon dioxide emission from energy sector increased by 1.4% in 2017, an increase of 460 million tonnes (Mt), and reached a notable high of 32.5 Gt which was against the goal of reduction in emission according to the Paris Agreement on climate change. This increase in emission had happened after a flat and steady emission for the past few years. The three major factors contributed for pushing up global energy demand were vigorous global economic growth of 3.7%, lower fossil-fuel prices and weaker energy efficiency efforts. [Global energy and CO₂ status report – 2017]. Table 2 depicts the trend in carbon dioxide emission over a span of 17 years globally.

Table 2 Trends in Global Carbon Dioxide Emission from 2000 to 2017

Year	Carbon dioxide emission (in Gt)
2000	24.1
2005	26.2

2010	30.2
2015	31.1
2017	32.5

Source: Global Energy and CO₂ Status Report - 2017

More than 170 countries signed Paris Agreement to cut down their emissions to fight climate change which would represent 80 per cent of global emission. Top emitters emit nearly three quarters of global emission (Johannes Fredrich, Mengpin Ge and Andrew Pickens). In this, China alone is responsible for one quarter of emissions. India is the third biggest carbon dioxide emitter in world. Table 3 shows top 5 carbon dioxide emitters in world.

Table 3 Top 5 Fossil fuel Carbon Dioxide Emitters in World(2017)

Country	CO ₂ emission in Kt
China	10,432,751
US	5,011,687
India	2,533,638
Russia	1,661,899
Japan	1,239,592
World Total	35,753,306

Source: EDGAR, 2017.

While most major economies saw a rise in carbon emissions, some others experienced decline. Such reduction efforts were overshadowed by Asian economies which accounted for two-thirds of the global increase in carbon emissions. Emissions are rising in Asia, because of fast growing developing economies like India, China and Indonesia who heavily dependent on fossil fuels. China's CO₂ emissions in 2017 reached 9.1 Gt, almost 1% higher than their 2014 level (World Energy Outlook). Emissions from coal-fired power plants make matters worse because coal is cheaply available within their boundaries and are familiar with technology with which plants can be erected quickly.

Carbon Dioxide Emission in India

India experienced growth in CO₂ emissions which show an increase of 5.9 percent per annum since 1950. At present India is rated as the 3rd largest contributor of CO₂ emissions. However, the per capita CO₂ of 1.8 tonnes per annum is well below the world average of 4.2 tonnes per annum. Average growth rate of emissions has been 6 per cent over the past decade. It is quite clear from the table 4 that the CO₂ emission in India has been showing an increasing trend in comparison with the rate of growth of Indian economy. As a responsible nation, India cannot take the back seat in mitigating GHG emission. Moreover India is highly vulnerable to climate change as its economy is heavily reliant on climate sensitive sectors like agriculture and forestry.

Table 4 Per capita Carbon Dioxide Emission in India-1990-2017

Year	Per capita (in Tonnes)
1990	0.711
1991	0.741
1992	0.771
1993	0.783
1994	0.811

1995	0.844
1996	0.901
1997	0.919
1998	0.921
1999	0.962
2000	0.979
2001	0.971
2002	0.967
2003	0.992
2004	1.024
2005	1.068
2006	1.121
2007	1.192
2008	1.309
2009	1.431
2010	1.396
2011	1.475
2012	1.597
2013	1.59
2014	1.729
2015	1.773
2016	1.836
2017	1.706

Source: Global Carbon Project, UN

Total emissions have been increasing from 0.71 tns in 1990 to 1.836 tns in 2016 recording its highest emission over the years. In 2017 the per capita emission reduced to 1.7 tns. Table 4 shows Per capita carbon dioxide emission trend in India from 1990-2017.

Emissions of CO₂ growth in India continue largely because it is still dependent heavily on coal based thermal power plants for electricity generation. The Indian electricity sector has been highly carbon intensive and it is the largest contributor to carbon emissions. 55 percent of the total emissions in India come from energy sector (National Inventory of Greenhouse Gases). These include emissions from road transport, burning of traditional biomass fuels, coal mining and emissions from oil and natural gas.

According to International Energy Agency, GHG emission from electricity sector in India during 2015 was 2066.01 MtCO₂. Emissions from the power sector will reach 1180 MtCO₂ in 2030, which is about three times the present emission level. Developing nations like India are desperate for more energy despite heavy shortfall in the actual production. The rising demand for energy has led to the deterioration of environment by giving stress to it even after the full capacity level. There are international compulsions to use clean energy which will not give a free hand for countries to produce unsustainable power. The conventional fuels (oil, coal, coke, natural gas) are finite and the power production using fossil fuels will only continue until these sources are available as well as economical. The future scenario is a matter of great concern because of the high economic growth rates and the continuance of coal burnt thermal power as an abundant source of energy. Thus the Indian power sector has a substantial potential for GHG emission mitigation.

Energy efficiency through behavioural change

Demand Side Management through modifying consumer behaviour is one the least cost solution for prevailing energy crisis. It focuses on the inefficient wastage of energy and outdated technologies used by consumers, and stimulate consumers to act efficiently. This strategy of DSM try to understand electricity consumption pattern less in terms of deliberative processes and more in terms of habits and routines embedded in everyday life. As small change in such everyday behaviour has larger potential to conserve electricity especially in residential sector. Gardner and Stern found that certain everyday behaviours like car-sharing, cutting driving speed, and lowering the thermostat and water heating which they estimated could reduce household carbon emissions by 30%.

Understanding human behaviour is the heart of mitigation and adaptation policy to shrink the growing gap between demand and supply of electricity. People tend to pay less attention to such repeated and frequent everyday habits which end up consuming larger amount of electricity than the purposive usage. Such 'unthinking' habits and routines of everyday life are performed in low conscious monitoring state. Current energy consumption patterns reflect that consumers are

generally not aware of routines and habits (Elizabeth Shove, 2003). Thus Behaviour change can potentially have considerable positive impact on environment.

Energy efficiency and energy conservation are considered as the two major cost effective means for reducing greenhouse gas emissions. Energy efficiency is recognised by the European Union (EU) as the most cost-effective and fastest way to increase security of supply and to tackle climate change (EC, 2012). The Energy Act, 2003 (GOI) describes "Conservation" is any reduction in consumption of electricity as a result of an increase in the efficiency in supply and use of electricity. Energy efficiency means reduction in the energy requirement for a given end-use or level of activity. This can be achieved through technological improvement, demand side management and a conscious change in lifestyles (Pachuri, 2004). Policy makers have neglected the role of behaviour in energy efficiency strategies concentrating only on the supply side options.

Energy saving behaviour can be categorised as two fundamental behaviour. Energy saving actions based on curtailment, and actions based on the adoption of energy efficient technologies (Barr et al., 2005; Stern 1992; Sutterlin et al., 2011). Curtailment behaviour in the focuses on the reduction of energy use in everyday life, such as by lowering the temperature in unused rooms or switching off lights when leaving a room, and requires no, or minimal, structural adjustment (Barr et al., 2005). Behaviour based on the adoption of energy efficient technologies are investment behaviour related to purchasing decisions (e.g., purchases of energy efficient light bulbs or change in insulation) (Gynther et al., 2012).

Nationally and internationally focus on energy sector for climate change mitigation is at an all-time high. Encouraging individuals to curtail their energy use at this stage of development may seriously harm the phase of economic development in India. Even though scientists are working hard to develop alternative energy technologies, only sustainable and economical way out is the use of energy efficiently through demand side management by making certain attitudinal and behavioural change. "A huge step-change in the attitudes to energy efficiency and consumer purchases by hundreds of millions of people worldwide is needed. Governments, through information provision, sound regulation and targeted fiscal incentives, have a key role to play in ensuring that, worldwide, the right decisions are taken to safeguard the future of the energy sector – and of the planet" (IEA, 2009).

Sustainable development requires not only technological innovations but also changes in individual and collective behaviours. Even though lot of efforts that has been made toward addressing issues of sustainability, the problem of unsustainable consumption is growing. Many obstacles stand in the way of adopting sustainable behaviour whether material, financial or psychological. However small, everyday changes in people's behaviour can have significant positive environmental impacts.

CONCLUSION

Emission of carbon dioxide which plays the most important role in global warming is significantly from power generation sector. While analyzing the CO₂ emission in India it shows an increasing trend in comparison with the rate of growth of Indian economy With India being the third biggest carbon dioxide emitter in world it cannot take a back stage while formulating energy policy for mitigating adverse effects of climate change. Nationally and internationally focus on energy sector for climate change mitigation is at an all-time high. Paper focuses on modifying consumer behaviour as one the least cost solution for prevailing energy crisis. Small everyday changes in people's behaviour can have significant positive environmental impacts.

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