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Assessing the impact of Fossil Fuel Subsidy on Environment: A study in Indian Context

Shivani Mehta[1]

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Abstract

Fossil Fuel Subsidy pose a great threat to economic, social and environmental life. Fossil Fuel subsidy are largely undesirable and detrimental to environment and result in increased carbon emissions or environmental damage. India's fossil fuel consumption has increased since 2000 and energy sector in specific is largely dependent on primary energy sources. Therefore, India subsidised its fossil fuels, with petroleum subsidies being the largest of all. But India being a member of G-20 has pledged to remove Fossil Fuel Subsidy in 2009 and reduce the unwanted consumption. Hence, India has taken key steps in pricing reforms to cut Fossil Fuel Subsidy and ensure sustainable consumption and production. The objective of the study is to show that fossil fuel subsidy is responsible for increase in CO_2 emissions and the study proves it by running an OLS regression analysis. The paper also highlights the existence, trends, measures and impact on Fossil Fuel Subsidy with focus on India.

Key Words: Fossil Fuel Subsidy, Environmental Damage, CO_2 emissions, Sustainable Consumption and production, Fossil Fuel Subsidy Reforms.

1. Introduction

Fossil Fuel subsidy are basically a sum of money allocated by government or indirect benefits that promote the use of that commodity. Fossil Fuels basically includes coal, crude oil, petroleum, Liquid Petroleum Gas (LPG), Natural Gas, Diesel etc. OECD Green Growth Studies: Energy (2011), asserts that energy is fundamental to any economic activity and energy sources have been largely changed after the Industrial Revolution. The prevailing energy system is highly dependent on fossil fuels and 20th century has witnessed an increase in consumption of fossil fuels. Combustion from these fossil fuels consumption was responsible

[1] Assistant Professor II,Amity School of Economic, Amity University, Sector 125, Noida, s.mehta@amity.edu

for 84 percent of Global Green House Gas emissions in 2009. Therefore, with increasing energy demand countries subsidies fossil fuels and thus resulted in environmental damage.

Fossil Fuel subsidies have become a major issue internationally with various international institutions like International Energy Agency (IEA), IISD Global Subsidies Initiatives (GSI) and United Nations (UN) pressing on phasing out of such subsidies. According to United Nations Sustainable Development Goals (SDGs), SDG 12 focuses on sustainable consumption and production framework by removing inefficient Fossil Fuel Subsidies. An increase in fossil fuel subsidy lead to increase in fossil fuel consumption and production and it is necessary that we change consumption and production patterns in order to protect the environment.

Strange and Bayley (Chapter 2, 2008), have explained the concept of sustainable development where it is about integration that is developing in a way that benefits the widest possible range of sectors, across borders and even between generations. Moreover, they assert that economic growth alone is not enough as the economic, social and environment aspects are interconnected. The three pillars of sustainable development are society, economy and environment. They have highlighted how sustainable development has changed after entering the public sphere in 21st century. Therefore, it is important that we see the impact Fossil Fuel Subsidies have on environment.

The study aims at examining the meaning of Fossil Fuel Subsidy, the measurement issues in fossil fuel subsidy, economic reasons for having subsidies and motivation behind it, the basic nature of subsidies and the various types of subsidies given out. All this covers the theoretical grounds of Fossil Fuel Subsidies and give us an understanding of the topic. Thereafter, the report studies the impact of fossil fuels on environment and how it is impact the sustainability in today's time. This section of the report also includes the reasons for phasing out or removing the subsidies for better and sustainable environment.

India is running for its development and in the process has seen huge demand of primary sources of energy to support its industrial and manufacturing sector. Along with that it has also pledged for cleaner sources of energy. Therefore, a close look at the fossil fuel demand and in turn at Fossil Fuel Subsidies will tell us need and reasons for such subsidies in developing countries. Moreover, how can developing nations choose to avoid these subsidies for a better and sustainable environment. Along with that this section would also through some light on the general trends in Fossil Fuel Subsidy in world.

The next section of the report examines the linkage between Fossil Fuel Subsidy and CO_2 emissions and for which we use OLS regression technique to find the relationship between them. The empirical study would give some important results and discussions for will give a critical nature of Fossil fuel subsidy on environment. Finally, we follow with concluding remarks and see how the future looks for Fossil fuel subsidies. It also focuses on some key findings and recommendations.

2. Fossil Fuel Subsidy

2.1 Defining Fossil Fuel Subsidy

Fossil Fuel subsidies are investments that go into carbon concentrated fuels like coal, oil and natural gas. They demoralize the use of renewable sources like wind, solar, thermal etc. for the energy purpose (Bast & Doukas, 2016). According to UNEP, Fossil Fuel Subsidies may include various forms like break in taxes, different forms of credit, transfer of risk, import duties and tariffs which make oil and petroleum more cost effective for domestic people, direct fund transfers and government intervention by keeping a regulation on fossil fuel price and use. Another, view on Fossil Fuels is given by IEA, which defines energy subsidies as any government support given in order to bring down the cost of production of energy or give out more revenue to the producers or making consumption of energy cheaper (WEO,2014).

Fossil fuel subsidies to a great extent affect the prices and quantities of fossil fuels which are in turn affected by influencing the demand and supply of these commodities. Moreover, the amount of subsidy given to consumers and producers is in actual practice determined by the demand and supply elasticities of that fossil fuel (Bárány & Grigonyte, 2015).

There also exits a definitional issue in Fossil Fuel subsidy, which is high in case of G-20 countries. It has been noticed that G-20 members keep changing the meaning or explanation of fossil fuel subsidy which results in inefficient subsidies being not included in the definition of fossil fuel subsidies (Hayer. S, 2017). Fossil Fuel Subsidy have wide range of impact on economic, social and environment which are covered in section two of the paper. However, the study would mainly focus on the environmental effects of Fossil Fuel Subsidy.

2.2 Objectives of having Fossil Fuel Subsidy

According to IEA, fossil fuel subsidies are given out for a lot of reasons. Some of which are, for Social welfare where government of poor countries usually give out support to needy households, in order to reallocate resources and income state authorities give funds, one of the important reasons for giving out subsidies are to bring down the dependence on imports, to have a balanced regional and national economic development government provide advantage to home industries and also for boosting the employment (WEO, 2014). Therefore, it can be said that developing nations provide subsidies for promoting development, but this not entirely true. It has been observed that developed and developing both give out subsidies to fossil fuel.

2.3 Forms of Fossil Fuel Subsidy

Subsidies for fossil fuels can be majorly classified as Consumer Subsidies and Producer Subsidies. Consumer Subsidies basically means when the prices are set below the actual price or the effective price and Producer subsidies on the other hand are direct or indirect benefits which increase the profit margin of the manufacturer. Producer subsidy make include tax benefits, budgetary transfers, paying lower prices for raw material etc. (Coady. D, et al, 2015).

Another way of categorizing Fossil Fuel subsidies is Price control which is the most basic and fundamental way of subsidising fossil fuels where we pay low price then actual market price and is regulated, there may be risk transfer from private to government sector or government spending for research and development work (WEO,2014). According to Bárány & Grigonyte in their paper highlight another type of fossil fuel subsidy that is under taxation of fossil fuels even when they have externality cost associated with them and this situation is prevalent in both developed and developing nations. The externalities associated with Fossil fuel subsidy and impact on environment are covered in detail in the section two of the paper.

2.4 Measuring Fossil Fuel Subsidy

Measuring fossil fuel subsidy faces the problem of what actually to include in it. Therefore, different organisations have different methods of calculating subsidy. There are mainly three bodies that give estimates of Fossil Fuels, they are International Energy Agency (IEA), Organisation for Economic Corporation and Development (OECD) and International Monetary Fund (IMF).

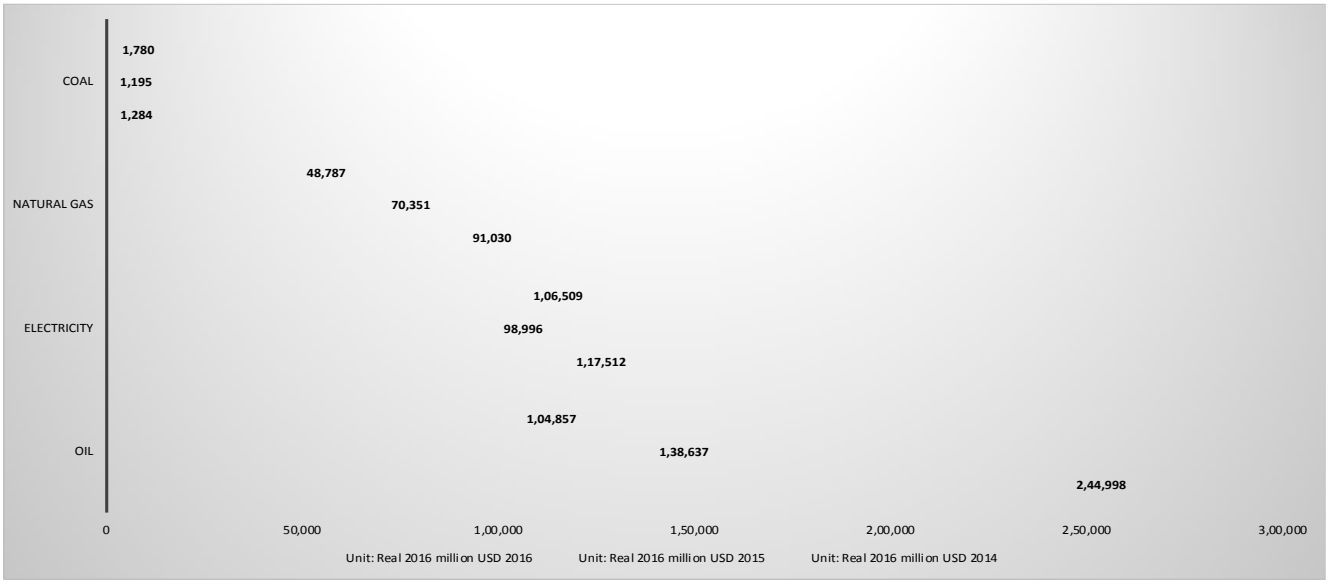
IEA gives out consumer subsidies for fossil fuels annually for about 40 developing nations along with world's major subsidisers included in it. It uses price gap approach for calculating the fossil fuel subsidies where a difference of prices paid by the end user and price determined by free market is taken into consideration.

OECD, on the other hand uses a completely different approach for calculating the fossil fuel subsidies. It uses inventory-based perspective where it takes into account all the government actions and support given for production and consumption of subsidy. I have chosen data on fossil fuel subsidies given by OECD for my empirical study between the fossil fuel subsidy and environmental damage.

IMF, gives two estimates of fossil fuel subsidies viz., Pre-Tax Subsidies and Post-Tax subsidies. Pre-tax subsidies are similar to IEA estimates as they use price-gap approach whereas, Post-tax subsidies include the externality cost associated with the fossil fuel use. It gives estimate for 176 nations.

General Trend in Fossil Fuel Subsidies around the World

Figure 1: Fossil Fuel Subsidies by Fuel type



Source: ***IEA fossil-fuel subsidies database***

The above figure explains the fossil fuel subsidies during 2014 to 2016, which shows a declining trend. This depicts that various initiatives taken like pledge taken by G-20 members in 2009, Asia-Pacific Economic Corporation, EU and Sustainable Development Goals by UN.

It is observed that subsidies in different parts of the countries have come down with the increasing unwanted consumption. It can be said that from 2014 onwards there has been a declining trend in the fossil fuel subsidies, this is largely explained by the economic, social and environmental costs. Moreover, nations have succeeded in bringing down the fossil fuel subsidies because of drop in international oil price during 2014 (Kojima. M, 2016). However, the post-tax subsidies measured by IMF show that there was an increase in these subsidies in both developing and developed nations signifying the damage caused to environment (Coady. D, et al, 2015). Apart from this we see that through fossil fuel consumption subsidies have witnessed a declining trend but they still exist (IEA, 2017). The trends also show that fossil fuel subsidies in developed countries are in greater intensity whereas subsidies to electricity are more prevalent in developing countries.

The following chapter will focus on impact of fossil fuel subsidies, where I will explain the economic, social and some basic impact of these subsidies. The chapter in particular will focus on impact on environment due to fossil fuel subsidies and how they are affect sustainable development. Apart from this the chapter will also give out reasons for phasing out Fossil Fuel Subsidies.

3. Impact of Fossil Fuel Subsidy

Strange and Bayley Chapter 5, (2008), have talked about sustaining consumption and production which are backbone of any economy. They believe that consumption defines the activities or social groups and production has a greater impact on sustainability than consumption. Raw material side of product life cycle can have significant influence on one's quality of life, health and safety. They also explain that economic factors like labor, profit margins, raw materials etc. do not tell the whole story behind fixing price of a good but there are Externalities associated to each good's consumption and production. With increased market transaction, the global consumption and production are not likely to change and thereby increasing externalities which affect the environment. Therefore, in Sustainable Development Goals under the 12th Goal it has been targeted to remove all the inefficient Fossil Fuel Subsidies which cause unwanted increase in consumption.

OECD (2005), asserts that Subsidies distort prices and resource allocation decisions, altering the pattern of production and consumption in an economy. Moreover, they can have negative effect on the environment, expensive, inefficient, and socially inequitable and burden on budget.

Fossil fuel subsidies are a big problem in today's time and pose a great deal of threat. They increase the cost for the taxpayers and results in crowding out of government expenditure, which ultimately do not actually reach out to the targeted group of people. They not only increase the fiscal cost but also distort the market price which results in inefficient investment and consumption decisions which thus results in improper allocation of resources and low rate of economic growth in longer run. Therefore, Fossil Fuel Subsidies are not economically reliable. Moreover, Fossil fuel subsidies cause volatility in world energy prices because a large number of nations have adopted fixed price regime where there is huge difference in the domestic crude oil prices and the international crude oil prices (Bárány & Grigonyte, 2015).

Bridle. R and Kitson. L (2014), in their paper "The impact of fossil fuel subsidy on renewable electricity generation" says that on comparing fossil fuel subsidy and renewable energy subsidy it is seen that renewable energy sector is disadvantaged because of less funding to it. Moreover, once the system of subsidy is imbibed in the economy it becomes difficulty to do away with it, as in case of Indonesia's electricity subsidy.

Fossil fuel subsidy impact public health and has far reaching consequences of it. This is because air pollution and post-tax fossil fuel subsidies cause premature deaths (Coady. D, et al, 2015). Vehicular pollution emits gases that are harmful and coal plants too emit gases like Sulphur dioxide, particulate matters, fly ash etc. which major polluters in the environment. On the other hand, pollution from fuel used for cooking also cause health issues therefore, air pollution can cause serious heart disease and respiratory disease (GSI, ODI & IFC, 2017).

3.1 Effect of Fossil Fuel Subsidy on Environment

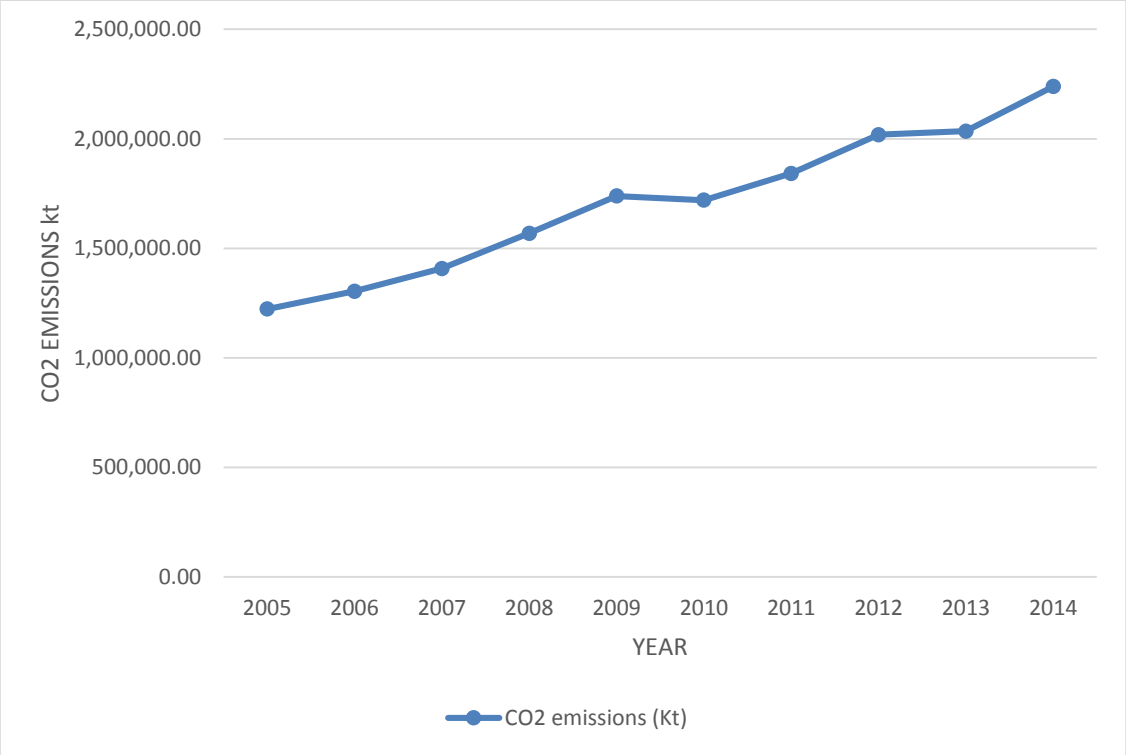
Fossil fuels when burnt emit harmful gases like carbo dioxide (CO_2), Methane (CH_4), Nitrogen dioxide, sulphur, etc. All these are called Green House gases and are quite harmful for the environment and human health. Therefore, with increasing fossil fuel consumption the Green House Gases (GHG) increases and I have studied the linkage betweenCO_2 emissions and fossil fuel subsidy which is has a maximum share in GHG emissions. This results in local air pollution and resource depletion. The perfect example of this is India where free electricity to agricultural

sector has led to overuse of ground water via tube wells and agricultural water pump sets, which in turn has resulted in decline in water tables (GSI, TERI & IISD, 2012).

Fossil Fuels cause harm even when they are obtained that is, during the extraction of fossil fuels they require more energy and emission intensive. Many nations provide for subsidies for extraction of fossil fuels like coal, oil and natural gas which cause huge threat to environment and people (Whitley. S & Van der Burg. L, 2015). As we know that subsidies are ways and means to increase the consumption to that particular product and fossil fuel subsidies are one of those type which leads to increase in undesirable consumption. The increased combustion of fossil fuels results in acid rain and damage of material infrastructure.

Fossil fuel when burnt emit greenhouse gases and according to Ministry of Environment, Forest and Climate change out of the total emissions from the energy about 54 percent of them are from electricity generation this is because electricity generation in India is dominated by coal and which in turn emits harmful GHG's (GSI, ODI & IFC, 2017). Moreover, there are problems related to water consumption and pollution caused by use of fossil fuels. They are for instance in electricity generation plants which are run on coal fire require huge amount of water and about 14TWh electricity was lost because of water shortage in 2016. Apart from this coal washing requires water to improve its quality and Indian coal has high content of ash when burnt which pollutes water bodies. Furthermore, Fossil fuels results in land degradation mainly from coal mining where forest land are used for it which results in cut down of forest, also, coal mining waste are dumped in land which are very hazardous and lastly ash from coal burning is disposed in ash pounds which contaminates ground water (GSI, ODI & IFC, 2017).

Figure 2: CO_2 Emissions (Kt) in India



Source: World Bank Data

Figure 2 depicts the Carbon Dioxide emissions for India from the year 2005 to 2014. It is clear from the graph that Carbon dioxide emissions in India have been increasing over the years. This can be explained because of many factors like fossil fuel consumption which is one of the most important factor, deforestation, Land-use change etc. Other than this many industry use fossil fuels which contributes towards carbon emissions, these include Electricity, mining, refineries/ chemicals, fertilizers production, cement manufacturing, agricultural processing, ethanol production, petroleum etc.

3.3 Reasons for Phasing out Fossil Fuel Subsidy

According to Merrill. L, et al., in their paper "Making the Switch: From fossil fuel subsidies to sustainable energy" asserts that nations over worldwide show a huge loss of opportunities for government to help in Sustainable Development Goals. It reveals that there is sustainable energy access finance gap, about 11 times more funds toward fossil fuels than basic education finance gap, 13 times higher than the health care gap, moreover three times higher than the renewable subsidies and a huge sum of about 22 times higher than that going towards climate

change. Therefore, it is important that government of various countries should shift away from Fossil Fuel subsidies and need to switch to cleaner and greener sources of energy.

Emerging and developing Asia witnessed about half of the post-tax subsidies in 2013 which are largely because of coal use and subsidy on it. A removal of post-tax fossil fuel subsidies can ensure reduction of premature death (Coady. D, et al, 2015). Removal of fossil fuel subsidies can ensure that there is no economic cost associated with the environmental damage and stop poor management of natural resources, where environment and productive growth can move hand in hand with new market and industry opportunities (OECD & IEA,2011).

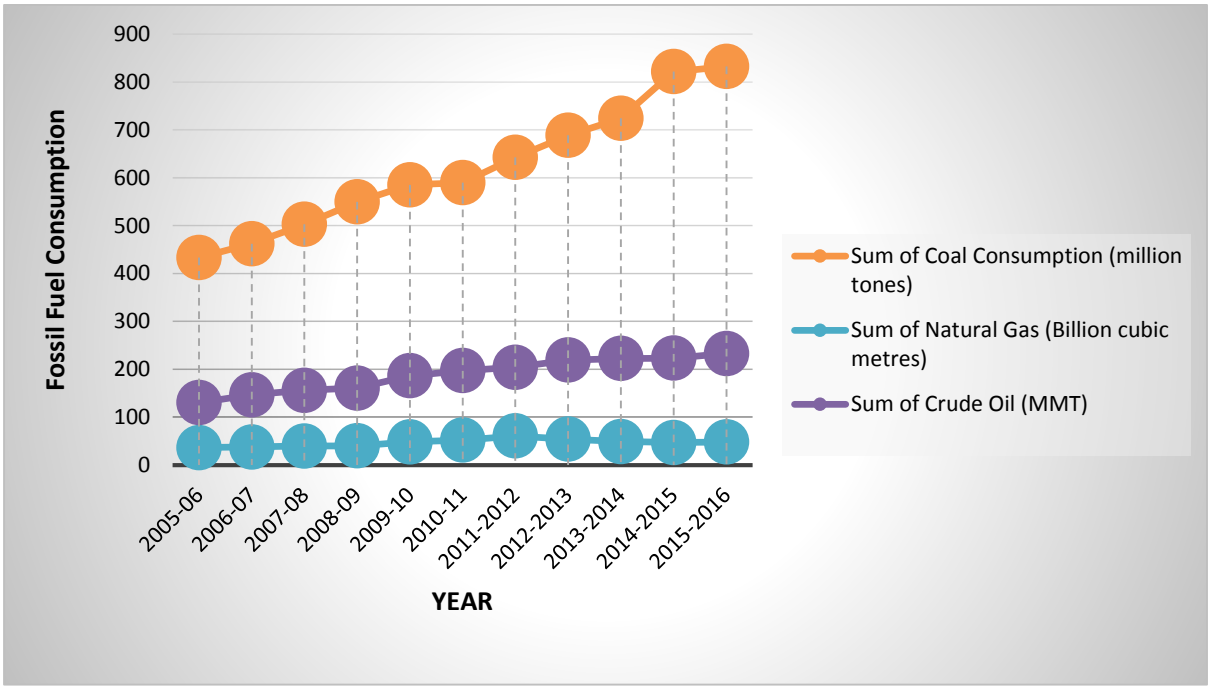
Therefore, it can be said that with increasing environmental damage, sustainability has been questioned and moreover, such fossil fuel subsidies are highly undesirable because of the externality costs. The next chapter highlights the Fossil Fuel subsidies in India and what changes have been noticed over the years. It would also cover the fossil fuel consumptions and a touch upon energy sector to understand the fossil fuel subsidy.

3.4 Fossil Fuel Subsidies in India

India in past and even today subsides its energy sector to ensure that everyone gets energy and fuel at an affordable price. India has seen changes over the years with fossil fuel subsides being seen as harmful for sustainability. India being home to about 18 percent of the world population and its primary energy demand grown double since 2000 is expected to grow in future (WEO, 2015). Therefore, India is likely to witness and has witnessed a huge demand of fossil fuels. All this can be explained by India focus on expanding the access to energy over the country where about 240 million people lack electricity access (IEA, 2015).

India energy demand in case of electricity to large extent is dependent on coal and India in 2016 was the third largest consumer of oil after China and United states (GSI, ODI & IFC, 2017). This signifies that fossil fuels are more in use then renewable sources.

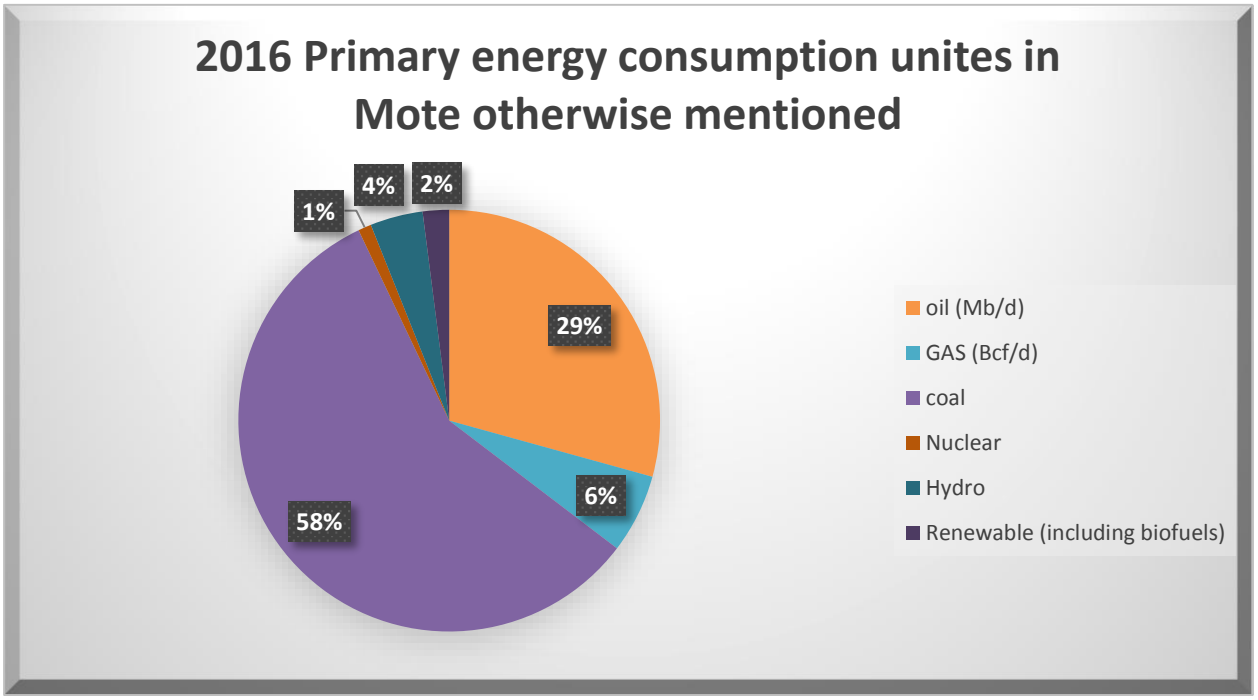
Figure 3: Fossil Fuel Consumption in India



Source: Energy Statistic, MOSPI, 2017

Figure 3 shows the consumption of different fossil fuels in India from 2005-06 to 2015-16. From the figure it is clear that coal consumption in India is very high and crude oil has also grown but not with same intensity as coal. Natural gas has stable. Figure 4 on the other hand shows the energy demand by fuel that is what percent of fuel is used in production and consumption. The pie chart shows that 58 percent of energy demand is met by use of coal in India and followed by 29 percent by oil, in addition to that Gas, Hydro, Renewable and Nuclear contributing a very share of 6%, 4%, 2% and 1% respectively. The two figures tell us a great deal about the fossil fuel use in India and how it is affecting the energy scenario in the country. From this we can also say that the country is heavily dependent on coal which is quite harmful and has externality cost associated with it.

Figure 4: Primary Energy Consumption by fuel type.



Source: BP Energy Outlook country & Regional insight, 2018

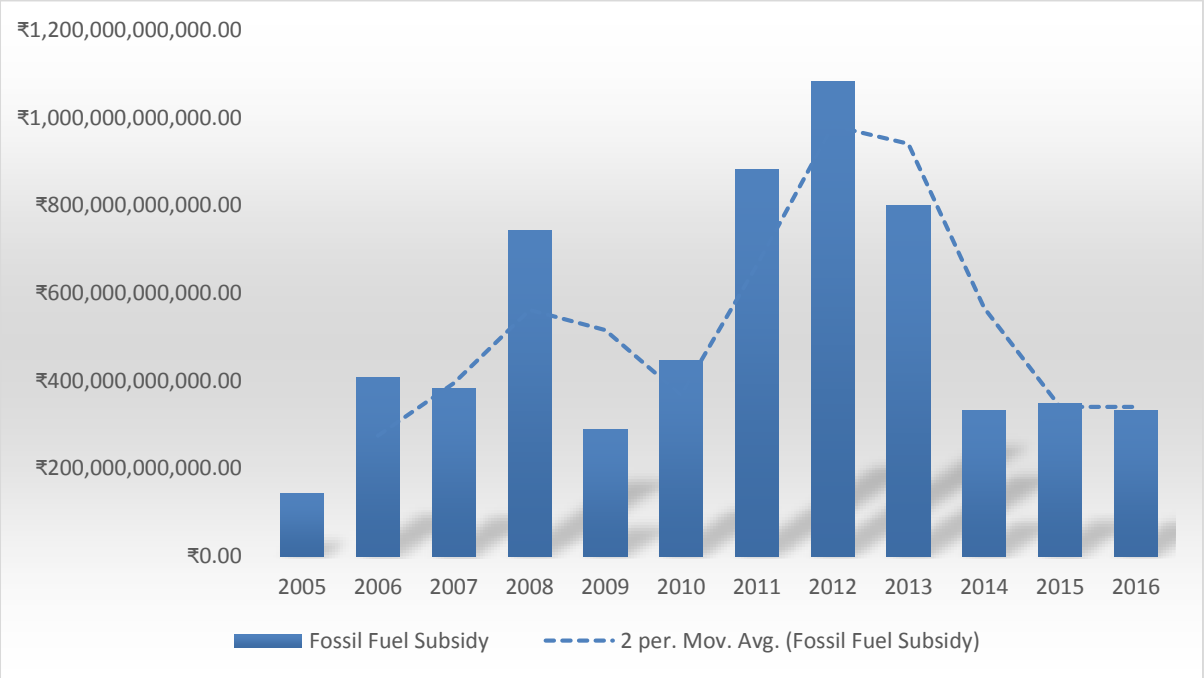
Furthermore, when we look deep into the fossil fuel subsidies in Indian context we find that subsidies are given for four categories namely Coal, Oil and Gas, Electricity and Renewable. It observed that coal subsidies include various supports for identification of additional sources and exploration. Oil and gas subsidies are largely dominated by LPG and Kerosene, along with natural gas for remote areas and to North-Eastern part of the country. Electricity subsidies are more or less for transmission and distribution where grids and utilities are supported. Renewable sources include support for production and consumption of hydro, solar, wind, biofuels and thermal pants (GSI, ODI & IFC, 2017).

India in past has protected and subsidised its energy and fossil fuels from international prices and which a social motive. However, India has witnessed a change in its fossil fuel subsidies with the pledge at G-20 in 2009 and with the Paris Agreement on Climate Change. India has committed to removing of all the inefficient fossil fuel subsidies at G-20 and reducing its emissions at Paris Agreement (GSI & TERI, 2012). Therefore, India has moved towards

phasing out of subsidies largely by pricing reforms. The two most important pricing reforms are deregulation of petrol prices or gasoline in 2010 and diesel prices in 2014 (GSI, ODI & IFC, 2017). Therefore, India has witnessed declining subsidies between 2014 and 2016.

A shift in fossil fuel subsidies is shown in the figure 5, which shows that fossil fuel subsidies witnessed an increasing trend till 2012 and thereafter it shows a declining trend. The reasons for the same is explained above.

Figure 5: Fossil Fuel Subsidy in India



Source: Calculated from the data given in Appendix 1

Indian Fossil Fuel Subsidy shows another remarkable trend that is depicted by Table 1. The table shows subsidy by fuel type in India and it can be inferred from the table that oil subsidies are the maximum with about 78 percent fossil fuel subsidy accounting for oil with a decline in the year by year value. Another fact to be noticed is that electricity subsidies have gradually grown in India from 9 percent in 2014 to about 18 percent in 2016.

Table 1: Fossil Fuel Subsidy in India

	Unit: Real 2016 million USD		
Fuel Type⁄ Year	2014	2015	2016
Oil	27,859.0	14,346.0	10,240.3
Electricity	3,413.0	2,635.1	2,369.4
Gas	4,588.3	1,551.2	743.0
Coal	-	-	-
Total	35,860.3	18,532.3	13,352.7

Source: IEA Fossil Fuel Subsidy Database

We can say that with the time fossil fuel subsidies in India have come down but fossil fuel consumption on the other hand have been rising. Also, oil are subsidised maximum with a declining trend in India largely because of two reasons, firstly because of decrease in world oil prices and secondly because of reforms in India. The next section of the paper shows empirical linkage between fossil fuel subsidy and CO_2 emissions, in order to know the environmental damage.

3.5 Linkage between Fossil Fuel Subsidy and Environmental Damage

The chapter focuses on relationship between fossil fuel subsidy and CO_2 emissions which is taken as the measure of environmental damage in India. It is observed that India has been witnessing an increasing energy demand and a large portion of which is met from the fossil fuels and therefore there has increasing CO_2 emissions in India which has been supported by the literature as well. Although India has been focusing on Fossil Fuel Subsidy Reforms where diesel and gasoline prices were deregulated in 2014. However, there are coal and electricity subsidies in India and moreover, because of not many alternatives to fossil fuels there has been a positive correlation between fossil fuel consumption and CO_2 emissions, which shows that CO_2 emissions have been increasing even after a decline in fossil fuel subsidy. The Appendix 2 in the report highlight the causal relationship between fossil fuel consumption and CO_2 emissions.

The available literature on fossil fuel subsidy depict that such subsidies have a negative effect on environment and thus create an externality cost which is harmful for sustainable development. In case of India, which being a developing nation has tried to provide energy for consumption and production at an affordable rate therefore, provide subsidies for petroleum, crude oil, Liquid Petroleum Gas (LPG), PDS Kerosene, Natural Gas, and Coal. The study will focus on bringing out an explanatory nature of Fossil fuel Subsidy in context to India and help in understanding the environmental damage from CO_2 emissions.

4. Empirical approach and theoretical Model

In order to show the relationship between Fossil Fuel subsidy and CO_2 emissions I have chosen to form an econometric model using the OLS method of estimation. For testing of hypothesis, I have taken two variable regression model with one being dependent and other being independent variable. In my study CO_2 emissions are taken as dependent variable and Fossil Fuel Subsidy as independent variable. The functional relationship as shown as below,

CO_2 emissions = *f (*Fossil Fuel Subsidy*)* ……. …….. ………. …….. …… (1)

On the basis of literature available we can infer the functional form mentioned in equation (1). The study has a single regression model for India and it run for around eight years from 2005 to 2006. Following is the regression model,

Emissions = $\beta_0 + \beta_1$ FFS + u_i ……. ……. ……. ……. ……… …… ……… (2)

Equation (2) shows linear regression model with emissions depicting CO_2 emissions and FFS showing Fossil Fuel Subsidy. The positive intercept shows that there has been increase in CO_2 emissions due to the increase in the fossil fuel subsidy. Moreover, the magnitude of coefficient shows the extent of increase in emissions from the explanatory variable.

4.1 Data

The regression analysis for the study require two sets of data that is, on CO_2 emissions and on fossil fuel subsidy. I have taken data on the basis of availability and as per my objective of study. The data on CO_2 emissions is collected from World Bank data for the years 2005 to 2012. The data on emission is measures Carbon dioxide emissions from the burning of fossil fuels and the manufacture of cement. Moreover, it includes CO_2 from gas fuels and gas flaring. Data availability on Fossil Fuel Subsidy faces the problem of definitional errors and problems

in measurement of Fossil Fuel subsidy. This is largely because of different organisations measuring it differently and I have taken subsidy data from OECD.stat. Data on subsidy in India basically includes Budgetary transfers and tax expenditures. It is also observed that non-OECD countries have a lot of governmental supports and schemes which give out subsidies. Under these two heads the government has given subsidies to different fuels namely coal, petroleum and natural gas. Some of these consumer support estimates and producer support estimates under the budgetary transfers include PDS Kerosene and Domestic LPG Subsidy Scheme, Freight Subsidy Scheme to Remote Areas, Compensation for Under-recoveries Incurred by Downstream Oil Companies, Indian Strategic Petroleum Reserves Ltd, R&D funding to specific projects – OIDB, Subsidies to Oil Companies for Transporting Natural Gas to the North-eastern Region, Coal Research and Development Programme, etc. Similarly, there are tax expenditures for fossil fuels which account for subsidies. I have taken a sum of all these schemes and supports to calculate the final value of Fossil Fuel Subsidy and this is shown in Appendix 1. The summarised data on Subsidies and CO_2 emissions is given below in the table.

Table 2: CO_2 emissions and Fossil Fuel Subsidy

YEAR	**CO2 emissions (Kt)**	**FFS**
2005	12,22,563.13	₹1,43,27,87,49,569.13
2006	13,03,717.51	₹4,06,69,10,45,130.51
2007	14,07,607.29	₹3,81,74,14,25,614.29
2008	15,68,379.57	₹7,41,54,16,70,387.57
2009	17,38,645.71	₹2,89,60,17,40,654.71
2010	17,19,690.99	₹4,46,03,85,21,700.99
2011	18,41,776.42	₹8,81,07,26,43,788.42
2012	20,18,503.82	₹10,81,45,70,60,515.82

Source: OECD.stat and World Bank data.

5. Results and Discussions

According to the literature on Fossil Fuel Subsidy the increase in Fossil Fuel subsidy leads to increase in the environmental damage. Therefore, regression analysis of dependent variable (CO_2 emissions) on independent variable (FFS) as given in equation (2).

Estimating the regression mode shows that with increases in fossil fuel subsidy there is a increase in CO_2 emissions. The estimated regression equation as given in the box below shows that both regression coefficient (intercept and slope) are significant at 5 percent level of significance, which depict that a change in fossil fuel subsidy brings about variation in dependent variable that is, CO_2 emissions.

$$\text{Emissions} = \underset{(8.816293231)}{1241916.913^*} + \underset{(2.921784468)}{6.600957^*}\,\text{FFS} + e_i$$

Table3: Regression Statistic

Multiple R	0.766325721
R Square	0.587255111
Adjusted R Square	0.518464297
Standard Error	191904.4111
Observations	8

Source: Compiled by author

Table 4 : Anova

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	3.14388E+11	3.14388E+11	8.536824475	0.026569524
Residual	6	2.20964E+11	36827302991		
Total	7	5.35352E+11			

Source: Compiled by author

Table 5

	Intercept	FFS
Coefficients	1241916.913	6.600957
Standard Error	140866.1078	2.25922E-07
t Stat	8.816293231	2.921784468
P-value	0.000118233	0.026569524
Lower 95%	897229.964	1.07284E-07
Upper 95%	1586603.861	1.21291E-06
Lower 95.0%	897229.964	1.07284E-07
Upper 95.0%	1586603.861	1.21291E-06

Source: Compiled by author

The regression analysis shows that there is robust relation between increase in fossil fuel subsidy and increase in CO_2 emissions. As we know R^2 which coefficient of determination is, explains the variations in dependent variable and the closer the observation the better is goodness of fit, however, adjusted coefficient of determination is a better statistical measure and therefore, we see adjusted R^2 for our study. The adjusted R^2 in our model is 0.5184 which shows that about 51.84 percent of variation in dependent variable (CO_2 emissions) is brought about by Fossil fuel subsidies.

This brings us to the conclusion that Fossil Fuel Subsidies are harmful and undesirable for environment, which in turn lead to unsustainable development and thus impacting humankind. Therefore, it is desirable to phase out fossil fuel subsidy and move towards alternative sources of energy and government should encourage the use of renewable sources.

6. Conclusion

Sustainable Development being the need of hour, has led to huge emphasis on environmentally friendly policies all around the world and therefore environment needs to be considered everywhere because Sustainable development is not about jus human kind but it is about every

life in the ecosystem. This is because, every individual is dependent on each other for survival. Fossil Fuel Subsidy are environmentally harmful because they pose great threat to climate, health, etc.

From the study it can be said that fossil fuel subsidy was started with a motive to develop and grow but it has changed its objective of supporting the energy sector because of threat that it poses on sustainable consumption. The theoretical understanding of the study tells us that there are problems in the measurement of fossil fuel subsidy and India also suffers from the issue of reporting of fossil fuel subsidy. Moreover, the most basic form of fossil fuel subsidies are price controls which have resulted in volatile prices therefore, Kojima. M suggests frequent adjustment in prices and not having a fixed price regime for fossil fuels.

The paper highlights the detrimental effect of fossil fuel subsidy on environment, where increase in fossil fuel subsidy can lead to increase in Carbon dioxide emissions. It shows that every nation needs to phase out these inefficient fossil fuel subsidies. Henceforth, Merrill. L et al, 2015 in their work shows that Fossil Fuel Subsidy Reforms is a cost-effective way of reducing the emissions.

With the various impacts of fossil fuel subsidy which cause environmental damage, it needed that we ensure fossil fuel subsidy reforms and work out all the challenges in the way of reform. Following are some of the reforms that government can ensure for a sustainable future. The government should rethink on its taxation policies towards fossil fuel subsidy, as it is observed from the literature that fossil fuels are under taxed and are associated with externality costs. For phasing out of fossil fuel subsidies one of the most important steps that must be ensured is to carry out institutional reforms where energy prices should be depoliticised and an automatic price mechanism is established.

With having analysed the fossil fuel subsidy trend in world and particularly in India it tells us that though fossil fuel subsidies have fallen worldwide but there still exits support which needs to be removed. It is observed that developed and developing nations are both giving out subsidies. When we talk about the Indian scenario the energy demand is rising and is expected to continue growing till 2040 (BP Energy Outlook, Country and regional insights, 2018). In context of India it is noticed that fossil fuel subsidies have fallen since 2013 but the fossil fuel consumptions are rising. Moreover, oil and gas are given out most subsidies and electricity production has been witnessing rising trend in subsidies lately where there is a dominance of coal fired plant in electricity generation. Apart from this the carbon dioxide emissions have

been increasing and continues to grow in India. Therefore, it can be concluded that even with fall in subsidies the carbon dioxide emissions have continued to grow. This is because of the high positive correlation between fossil fuel consumption and carbon emissions. Moreover, electricity subsidy increasing and coal dominating that sector signifies that emissions have increased. Also, it can be inferred from this situation that India can shift its subsidies to renewable sources of energy.

It can also be said from the Indian case study that though it is a developing nation it is still working towards phasing out of fossil fuel subsidy, therefore, other developing nations too should reduce and work in this direction.

References

Organisation for Economic Corporation (2012), Energy, *OECD Green Growth Studies, OECD* Publishing. Available at: http://dx.doi.org/10.1787/9789264115118-en

Strange. T and Bayley. A. (2008) "*Sustainable Development Linking economy, society, environment*" OECD., pp. 20-29.

Strange. T and Bayley. A. (2008) "*Sustainable Development Linking economy, society, environment*" OECD., pp. 76-96

United Nations Development Programme. (2015) "*Sustainable Development Goals Booklet*" UNDP, available at: http://www.undp.org/content/undp/en/home/librarypage/corporate/sustainable-development-goals-booklet.html

United Nations. (2015) "*Goal 12: Ensure sustainable consumption and production patterns*" available at: http://www.un.org/sustainabledevelopment/sustainable-consumption-production/

United Nations. (2015) "*Transforming Our World: The 2030 Agenda for Sustainable Development*" A/RES/70/1

Appendix

Data on Subsidies

The various subsidies given by Indian Government basically includes of two types. They are:

1. Budgetary Transfers:

Table: PDS Kerosene and Domestic LPG Subsidy Scheme

year	PDS Kerosene and Domestic LPG Subsidy Scheme	
	Liquefied petroleum gases (LPG)	Other kerosene
2005	₹16,05,00,00,000.00	10,57,00,00,000
2006	₹15,54,00,00,000.00	₹9,70,00,00,000.00
2007	₹16,63,00,00,000.00	₹9,78,00,00,000.00
2008	₹17,14,00,00,000.00	₹9,74,00,00,000.00
2009	₹18,31,00,00,000.00	₹9,61,00,00,000.00
2010	₹19,91,00,00,000.00	₹9,36,00,00,000.00
2011	₹21,55,00,00,000.00	₹8,68,00,00,000.00
2012	₹19,89,41,00,000.00	₹7,41,15,20,000.00
2013	₹19,04,00,00,000.00	₹6,76,00,00,000.00
2014	₹0.00	₹0.00
2015	₹0.00	₹0.00
2016	₹24,30,18,00,000.00	₹8,62,81,70,543.00

Source: ***OECD.stat***

Table: Freight Subsidy Scheme to Remote Areas

Year	Freight Subsidy Scheme to Remote Areas	
	Liquefied petroleum gases (LPG)	Other kerosene
2005	₹15,00,00,000.00	₹6,00,00,000.00
2006	₹17,00,00,000.00	₹9,00,00,000.00
2007	₹22,00,00,000.00	₹6,00,00,000.00
2008	₹16,00,00,000.00	₹6,00,00,000.00
2009	₹16,00,00,000.00	₹6,00,00,000.00
2010	₹17,00,00,000.00	₹5,00,00,000.00
2011	₹18,00,00,000.00	₹5,00,00,000.00
2012	₹18,00,00,000.00	₹5,00,00,000.00
2013	₹16,00,00,000.00	₹5,00,00,000.00
2014	₹16,51,00,000.00	₹4,33,00,000.00
2015	₹0.00	₹0.00
2016	₹0.00	₹0.00

Source: ***OECD.stat***

Table: Compensation for Under-recoveries Incurred by Downstream Oil Companies

Year	Compensation for Under-recoveries Incurred by Downstream Oil Companies			
	Liquefied petroleum gases (LPG)	Motor gasoline excl. biofuels	Other kerosene	Gas/diesel oil excl. biofuels
2005	₹29,45,73,00,000.00	₹7,82,86,25,000.00	₹41,35,40,00,000.00	₹36,36,01,00,000.00
2006	₹52,26,45,00,000.00	₹9,90,00,27,740.00	₹87,34,20,00,000.00	₹91,70,35,00,000.00
2007	₹71,02,97,00,000.00	₹33,55,01,00,000.00	₹87,40,58,00,000.00	₹1,60,91,40,00,000.00
2008	₹1,21,47,30,00,000.00	₹35,75,91,00,000.00	₹1,94,81,10,00,000.00	₹3,60,87,70,00,000.00
2009	₹80,49,38,00,000.00	₹29,08,21,00,000.00	₹98,03,57,00,000.00	₹52,38,84,00,000.00
2010	₹1,14,16,60,00,000.00	₹11,67,77,00,000.00	₹1,02,16,80,00,000.00	₹1,81,98,80,00,000.00
2011	₹1,80,79,50,00,000.00	₹0.00	₹1,64,85,30,00,000.00	₹4,89,35,20,00,000.00
2012	₹2,45,65,80,00,000.00	₹0.00	₹1,82,63,80,00,000.00	₹5,71,70,40,00,000.00
2013	₹2,35,07,20,00,000.00	₹0.00	₹1,54,70,10,00,000.00	₹3,17,94,80,00,000.00
2014	₹1,38,13,70,00,000.00	₹0.00	₹93,64,87,00,000.00	₹41,29,39,00,000.00
2015	₹1,53,34,10,00,000.00	₹0.00	₹1,09,66,90,00,000.00	₹0.00
2016	₹1,21,33,00,00,000.00	₹0.00	₹75,95,00,00,000.00	₹0.00

Source: ***OECD.stat***

Table: Rajiv Gandhi Grameen LPG Vitrak Yojana

Year	Rajiv Gandhi Grameen LPG Vitrak Yojana
	Liquefied petroleum gases (LPG)
2005	₹0.00
2006	₹0.00
2007	₹0.00
2008	₹0.00
2009	₹0.00
2010	₹0.00
2011	₹1,00,00,000.00
2012	₹1,00,00,000.00
2013	₹0.00
2014	₹0.00
2015	₹0.00
2016	₹0.00

Source: ***OECD.stat***

Table: Indian Strategic Petroleum Reserves Ltd

year	Indian Strategic Petroleum Reserves Ltd
	Crude oil
2005	₹0.00
2006	₹0.00
2007	₹0.00
2008	₹0.00
2009	₹0.00
2010	₹2,20,00,000.00
2011	₹9,04,59,00,000.00
2012	₹5,79,76,00,000.00
2013	₹7,95,72,00,000.00
2014	₹5,76,83,00,000.00
2015	₹15,29,71,00,000.00
2016	₹23,73,35,00,000.00

Source: ***OECD.stat***

Table: R&D funding to specific projects - OIDB

year	R&D funding to specific projects - OIDB	
	Crude oil	Natural gas
2005	₹0.00	₹0.00
2006	₹0.00	₹0.00
2007	₹0.00	₹0.00
2008	₹0.00	₹0.00
2009	₹0.00	₹0.00
2010	₹5,19,08,300.00	₹5,78,91,700.00
2011	₹1,25,45,305.00	₹1,25,54,695.00
2012	₹1,39,13,150.00	₹1,19,86,850.00
2013	₹16,55,526.00	₹12,44,474.00
2014	₹2,81,77,769.00	₹2,02,22,231.00
2015	₹23,22,58,869.00	₹16,32,41,131.00
2016	₹23,22,58,869.00	₹16,32,41,131.00

Source: ***OECD.stat***

Table: Subsidies to Oil Companies for Transporting Natural Gas to the North-eastern Region

Year	Subsidies to Oil Companies for Transporting Natural Gas to the North-eastern Region
	Natural gas
2005	₹0.00
2006	₹0.00
2007	₹0.00
2008	₹0.00
2009	₹0.00
2010	₹4,44,73,00,000.00
2011	₹4,58,00,00,000.00
2012	₹6,26,87,00,000.00
2013	₹6,25,00,00,000.00
2014	₹6,61,00,00,000.00
2015	₹6,60,00,00,000.00
2016	₹7,45,00,00,000.00

Source: ***OECD.stat***

Table: Regional Exploration, Promotional Exploration and Detailed Drilling in Non-CIL Blocks & Coal Sector Information Technology and Coal Controller

year	Regional Exploration, Promotional Exploration and Detailed Drilling in Non-CIL Blocks	Coal Sector Information Technology and Coal Controller
	Hard coal (if no detail)	Hard coal (if no detail)
2005	₹0.00	₹0.00
2006	₹0.00	₹0.00
2007	₹0.00	₹0.00
2008	₹0.00	₹0.00
2009	₹0.00	₹0.00
2010	₹0.00	₹0.00
2011	₹17,31,70,000.00	₹1,93,30,000.00
2012	₹20,13,00,000.00	₹2,28,20,000.00
2013	₹0.00	₹0.00
2014	₹0.00	₹0.00
2015	₹0.00	₹0.00
2016	₹0.00	₹0.00

Source: ***OECD.stat***

Table: Coal Subsidies

Year	Coal Research and Development Programme		Coal Environmental Measures and Subsidence Control	
	Coking coal	Other bituminous coal	Coking coal	Other bituminous coal
2005	₹0.00	₹0.00	₹2,15,34,556.00	₹26,48,65,444.00
2006	₹0.00	₹0.00	₹57,28,435.00	₹7,42,71,565.00
2007	₹93,44,125.00	₹11,92,55,875.00	₹2,05,04,759.00	₹26,16,95,241.00
2008	₹70,19,533.00	₹9,29,80,467.00	₹70,19,533.00	₹9,29,80,467.00
2009	₹96,07,154.00	₹10,03,92,846.00	₹0.00	₹0.00
2010	₹99,75,735.00	₹9,00,24,265.00	₹2,99,27,205.00	₹27,00,72,795.00
2011	₹1,09,26,630.00	₹9,52,73,370.00	₹0.00	₹0.00
2012	₹1,09,19,118.00	₹10,30,80,882.00	₹0.00	₹0.00
2013	₹1,24,62,604.00	₹10,40,37,396.00	₹42,790.00	₹3,57,210.00
2014	₹1,83,04,838.00	₹16,11,95,162.00	₹0.00	₹0.00
2015	₹1,86,06,654.00	₹16,13,93,346.00	₹4,65,166.00	₹40,34,834.00
2016	₹1,03,37,030.00	₹8,96,62,970.00	₹5,16,852.00	₹44,83,148.00

Source: ***OECD.stat***