GHG ASSESSMENT TOWARDS CLIMATE POLLUTION CONTROL IN THERMAL POWER PLANTS

A CASE STUDY Neyveli Lignite Corporation Limited Neyveli, INDIA.

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Abstract - Coal based thermal power plants are the major sources in India to meet the ever increasing demand for power and as such there is a need to address the issue of controlling climate pollution by mitigating Green House Gases (GHG) from their emission stack. Technologies like carbon capture and storage (CCS) are widely considered to be a possible technical option to mitigate carbon dioxide from such large-point source. However, the economics of CCS is a major barrier and constrain. This thesis intended to evaluate the feasibility of the carbon credits which can be generated to refinance the costlier schemes of climate pollution control in Thermal Power Plants, through a case study.

Neyveli Lignite Corporation Limited (NLC) is a major coal based thermal power plant having three complexes with 18 numbers of units with a net power generation capacity of 2490 MW. 2014-2015 Power Generation (MU) 19729.13 Annual data as well as the concentration of GHGs, primary, CO_2 with Methane (CH4) and Nitrous Oxide (N_2O).

India can develop Clean Development Mechanism (CDM) project under Kyoto protocol (KP). Any attempt by NLC to "cap and tap" the emission will enable to develop a CDM project which will eventually generate Certified Emission Reduction (CER). NLC can process the CER under United Nations Framework Convention on Climate Change (UNFCCC) for Carbon Credits and whose selling revenue will eventually offset significantly the required revenue for implementing CCS toward climate pollution control. Intergovernmental panel on climate change (IPCC) Methodology tool Inventory Software , version 2.17 was used evaluate GHG and it was assessed that net CER of 7195,201 tonne CO_2 equivalent is possible and this additional revenue will strategically allow NLC to venture upon technologies like CCS for preventing climate pollution.

Keywords: (Climate Pollution, GHG, CCS, NLC, CDM, KP, UNFCCC, Carbon Credits)

1. INTRODUCTION

Climate Change is the most significant environmental challenges of our time with global dimension. The changes and variability in the global climate change are visible with unprecedented rains, sea level raise, drought, etc., that are continuously daunting the live ability of vulnerable areas of the planet itself. The rain of November, 2015 which devastated Chennai is one credible example of proof to this concern at national level.

Global initiatives are progressing under the aegis of United Nation Framework Convention on Climate Change (UNFCCC) to control Green House Gases (GHG) emissions to prevent further increase in the global atmospheric temperature. The recently concluded COP-21 at Paris concluded with a pact that every nation shall have its own initiatives to cap and cut such GHG emissions to hold the increase in the global average temperature to below 2°C above pre industrial levels by reducing emission to 40 Giga tones or to 1.5°C above pre industrial levels, for which IPCC is mandated to suggest a methodology by 2018

Coal based Thermal Power plant emissions are the biggest among all anthropogenic industrial sources of GHG, primarily CO_2 .In India, around 65% of electricity is generated by coal based thermal power plants. Coal based power plant are the main producer of flue gas with pollutants of SPM, CO_2, SO_2, NO_X, etc. Quantity of these emissions is dependent on quality and quality of copal .CO_2 is main GHG with more responsibility for global warming due to larger emission and higher concentration .Nearly 21.3% of GHGs are emitted by coal based thermal power plants.

Technologies like carbon capture and storage (CCS) are widely considered to be a possible technical option to mitigate carbon dioxide from large-point sources. National and international political decision-makers devote a growing amount of capacities and financial resources to CCS in order develop and demonstrate the technology and to diminish possible economic and environmental risks. However, the economics of CCS is a major barrier constrain for its application. This thesis indented to evaluate the feasibility of the Carbon Credits which can be generated to refinance the costlier schemes of Climate Pollution Control in Thermal Power Plants

The growing demand for energy and our increasing dependency for coal based thermal power plants is a serious is a environmental issue of our country as emission from such plants is the biggest industrial or more specifically anthropogenic source of GHG. In this thesis, an attempt was made to study the assessment methodologies of GHG from thermal power plants using Inter Governmental Panel on Climate Change (IPCC) tools and to evaluate the possibility of generating Certified Emission Reduction (CER) by mitigation. The evaluation studies also scoped to discuss the concept of Carbon Capture & Storage (CCS) Methodology for mitigation. The generation of funds by selling CER as Carbon Credits will place developed countries like India advantageously to reinvest on technologies like CCS to offset the cost on mitigation of GHG.

2. Study Area

Neyveli, situated in cuddalore district of Tamil Nadu, at 11° 34' N, 79° 28' E, is about 190 km southwest of Chennai . The Neyveli Lignite Corporation (NLC) is a public sector enterprise was established in 1956. Location map of study area was shown in the (**figure 1)** an epitome of Into-soviet collaboration. NLC has three complexes viz ., TPS (Thermal Power Station) –I and TPS-II. Was commissioned with one unit of in May 1962.presently, this power station has 6 unit of 50MWeach and 3unit of 100 MW each. Thermal power station –I Expansion (TPS-I Exp) has a capacity 2 unit of 420 MW (**Figure 2**) thermal power station –II(TPS-II) has been a major source of power to all southern states of India. The 7 unit of 1470 MW capacity power station consists of 7 unit of 210 mw of each (**Figure 3**) at present; NLC is capable of producing a maximum of 2490 MW of electricity.

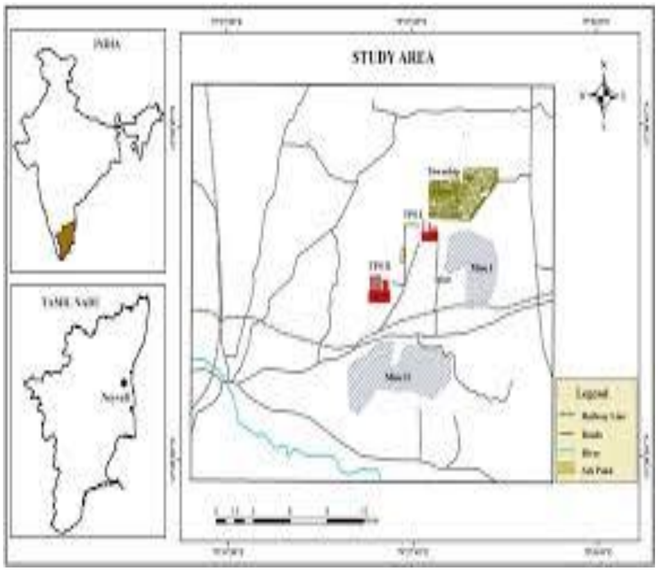

Figure-1 location map

Figure -2 Thermal Power Station -I

Figure -3 Thermal Power Station –I Expansion

Figure-4 Thermal Power Station-II

GHG Emission Inventory Software Analysis

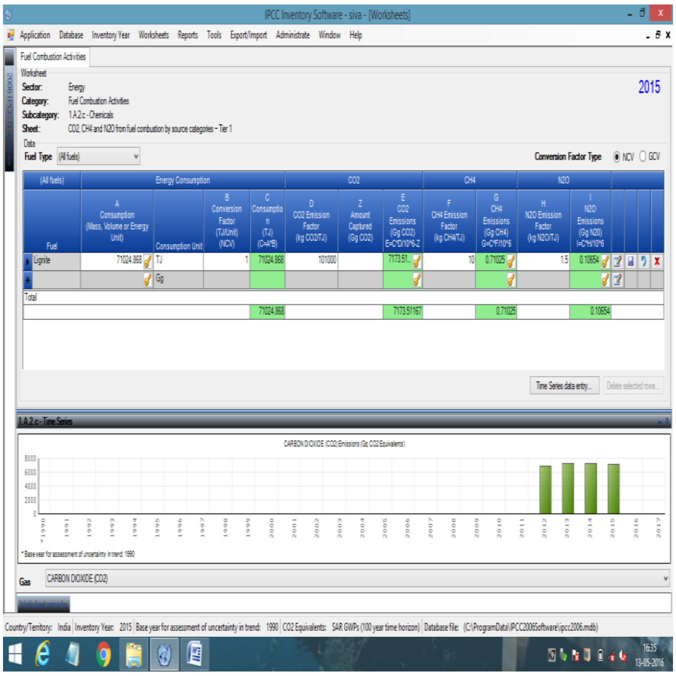

Figure 4 CO_2 inventory assessment tool version 2.17

Coal Combustion –An Over View

Coals are classified by rank as lignite to anthracite according to progressive alteration in the natural metamorphosis. Due to high moisture content and low heat value, the lignite is burned near wear it is mined. Lignite is mainly used for electricity production in power station (USEPA 1998). Lignite –fired power station convert lignite into heat energy but they also emit considerable amount of hazardous emission in the atmosphere. The emission generated from firing lignite include suspended particulate matter (SPM), sulphur oxide (SO_2) Nitrogen oxide (NO_X)carbon monoxide (CO)carbon Dioxide (CO_2)and total organic compounds (TOC), other pollutants generated include greenhouse gages. Trace element and acid gases.

For analysis of pollutant emission and energy efficiency data have been collected from the power plant located in Neyveli. This power station is the Neyveli Lignite Corporation Thermal Power Station (NLC TPS) Neyveli Tamil Nadu. NLC is coal –fired thermal power plant under national thermal power corporation(NTPC) an apox body in India for power production .Analysis of the NLC is performed and then in this power plant the coal is replaced from different Mine-I, Mine-IA and Main –II supply in NLC Thermal power station

3. Energy Content in Coal

The basic function of the power plant is to convert energy in coal to electricity. Energy content of coal is given in terms of Kilojoules (kJ) per Kilogram (kg) of coal as the Gross calorific value (GCV) or the Higher Heating value (HHV) of coal. This value can vary from 10500 kJ/kg to 25000 kJ/kg depending on the quality and type of the coal.

3.1 Energy Conversion Takes Place in Two Stages

- ✓ The first part of the conversion is efficiency of the boiler and combustion. For this example we take 88 % on an HHV basis that is the normal range for a well optimized power plant.
- ✓ Second part is the steam cycle efficiency. Modern Rankine cycle, adopted in coal fired power plants, have efficiencies that vary from 32 % to 42 %. This depends

Mainly on the steam parameters. Higher steam pressure and temperatures in the range of 600 ° C and 230 bars have efficiencies around 42 %. We assume a value of 38 % for our case. The overall conversion efficiency then is (38% x 88%) 33.44 %.

Heat Rate

- ➢ Heat rate is the heat input required to produce one unit of electricity. (1 kw hr)
- ➢ One Kw is 3600 kJ/hr. If the energy conversion is 100 % efficient then to produce one unit of electricity we require 3600 kJ

Coal Quantity

Since coal has a heat value of 20,000 kJ/kg, for producing one kw.hr we require (10765 / 20000) 0.538 kg of coal. This translates to (0.538 x 100 x 1,000) 53800 kg/hr (53.8 T/hr) of coal for an output of 100 MW.

Carbon Capture and Storage

Carbon capture and storage (CCS) is considered as one of the most promising options and one of the evolving technologies available to mitigate atmospheric emission of CO_2 from thermal power plants. Deep saline aquifers, depleted oil and field, and un-minable coal seam are the primary targets for geological storage of CO_2.

In recent years, fundamental research has focused increasingly on the short and long term effect of CO_2 injection into reservoirs to assess the feasibility of CO_2 storage on a commercial scale. Sequestration processes involve different method.

Another major concern of all storage options in the sealing efficiency of low-permeable sequences overlying potential storage reservoir. It has been suggested that any technology used to geological store CO_2 underground should store it for a minimum 1000 year with a leakage rate of less than 0.1% per year. The sealing capacity and long-term integrity of underground, considering different kind of mechanism, is therefore an important issue for site approval and public acceptance. Four different ways in which in which underground can fail have been indentified: diffusive loss through the underground, leakage through pore spaces when capillary breakthrough pressure has been exceeded, leakage through fault or fractures, and well leakage when well degraded or inappropriately abandoned.

Technology

Carbon capture and storage (CCS) is relatively new concept in carbon mitigation. The process is to capture carbon from the point of origin and store safely in storage sites beneath land. The carbon emission sources, which in our study is thermal power plant, is retrofit with proper arrangements to capture CO_2 and transport to storage sites usually deep oceans, depleted oil and gas field, saline aquifers and un-minable coal seams. The method is a promising option to significantly reduce CO_2 emission in a huge scale.

The process of CCS involves three components, namely capture, transportation and storage. (Akorede, et al., 2012)

Capture

Capture is the first process in CCS technology and is located in the emission source sites. This process is physical removal of CO_2 from a mixture of flue gases in the power plant and preparing it for transportation. It involves separation of flue gases, containment and pressurization of CO_2. It is accomplished by three methods viz., Post -combustion capture, pre-combustion capture and oxy-combustion process.

Transportation

The second step in CCS is to transport the captured CO_2 to nearby storage site. For the amount of CO_2 generated in power plants, pipelines are the most likely mode of transport for the captured gas to geologic storage sites.

Storage

Long-term storage requires stringent conditions for sequestration sites to prevent the captured emissions from escaping into the atmosphere. The storage site can handle large amounts of CO_2 depending on its characteristics like depth, thickness and permeability. At present, for long-term storage, deep saline aquifers and depleted oil and gas fields are the most preferable sites.

3.2 Significance of CCS technology

Without CCS technology, mitigating carbon emissions will require significant curtailment in the use of global coal, which is presently not feasible, as it remains the world's most available fossil fuel. The IPCC predicts that CCS could contribute between 10 to 55 percent of cumulative worldwide carbon mitigation effort over the next 90 years. It states "the most important single new technology for CO_2 savings" in power and industry sectors. CCS could potentially capture 90 percent of all carbon emitted by a given plant, compared to a conventional coal plant without it (Akorede, et al., 2012). Nevertheless, it requires 40 percent additional energy to run a CCS coal plant relative to a conventional coal plant.

4. Assessment of GHG – IPCC Methodology

IPCC Methodology toll namely inventory software version 2.17 was used asses the GHG emission on the basis of power generation capacity and the characteristics of the coal.

In the attempt to generalize the calculations and the absence of required dada, generic characteristics of Lignite and the power generation capacity NLC (2490) were used. The resultant windows of the Export system are presented in Fig 4,5and 6.

The net co2 emission is 7173,511 Metric tonnes. Using the Global Warming Potential (GWP) values of IPCC (2007), the net CH4 (GWP-12.4) was assessed for 8,804 Matric tonnes and N2O (GWP-121) is 12,886 Metric tonnes.

The net accountable GHG from NLC stack is 7900,000 Metric tonnes.

4.1 Clean Development Mechanism

The study is not to adopt the approved methodology as an academic interest, only used the Methodology of IPCC and the assessment of net GHG was arrived using Global Warming Potential (IPCC)

The net GHG was assessed at 79,00,000 T CO2 equivalent which can be directly interpreted as 79,00,000 of Certified Emission Reduction ,as per the generic guidelines of CDM Methodology of UNFCCC, for the development of Clean development mechanism (CDM) project.

CDM is an initiative to promote organization to opt for project that emission reduction with highest cost-effective options. In such case, India is a destination that offers lower investment cost, quicker permit and high improvement potential owing to low efficiency of Indian Power Plants. Since carbon mitigation is a global concern, industrialized countries have options through CDM to invest in clean projects in developing nations to achieve their mitigation obligation. Furthermore, India is in the need of institutional and industrial investor to upgrade its ageing power plants. In that aspect ,it is in the industrialized countries to CDM like project. In addition, it will also increase job opportunities and prosper the developing countries.

5. Conclusion

The generation of CER and revenue by selling it under UNFCCC will get additional revenue to NLC and hence it can implement GHG mitigation systems like CCS to control climate pollution from its activities.

Perhaps, the captive mining activities can further be evaluated for generating further CER which will further add the revenue by selling Carbon credits. Nevertheless, this will enable our country to demonstrate its commitment in controlling climate pollution under UNFCCC.

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