Carbon Footprint Reduction Strategies And Efforts By TNPL

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ABSTRACT

Indian Paper industries are now constantly working to become more eco friendly by effective utilization of resources such as water, energy and both fibrous and non fibrous raw materials and also reducing emissions, waste and wastewater discharge. In the same line, TNPL initiated many innovative measures to reduce energy consumption and to reduce the carbon foot print. The major efforts and innovations taken by TNPL are Methane Extraction and fuel conservation Project , Commissioning of state-of-the- art energy efficient Paper Machine No: 3, Installation of Energy Efficient Chemical Recovery Boiler, Implementation of new hard wood fibre line, Installation of Shoe press in the paper machine No 1 and 2, Utilization of Renewable fuel in the power boiler, Carbon sequestration through farm forestry and captive plantation and other such as, 35.5 MW wind farm, Replaced all CFC based air-conditioners in the factory, Blow heat recovery system and Energy efficient aerators in wastewater treatment plant. TNPL is also in the process of putting up a satellite PCC plant, biogas reactor for industrial canteen and guest house waste and biomass gasification which can further reduce the GHG emission. Further the company has proposed to replace three old low pressure boiler with a new high capacity boiler and installation of a mini cement plant for utilizing lime sludge generated from recovery cycle and fly ash generated from the power boilers. Apart from the above TNPL has established a Climate Change and CDM Cell in the year 2005 to work in the areas of climate change, CDM and carbon trading and registered a first CDM project in the pulp and paper industry during January 2006.

Introduction

Increasing concentration of green house gases in atmosphere is causing unprecedented change in natural climate system, such as, global warming and sea level rise leading many climate catastrophes which create perceptible influence on physical and biological systems of our environment. Increasing green house effect is expected to affect, freshwater resources, agricultural productivity, loss of biodiversity, industrial output, food availability, human and ecosystem health[1,2,3]. The increased concentrations of key greenhouse gases (GHG) in the atmosphere are due to direct consequence of human activities due industrial revolution and over and above unsustainable exploitation of natural resources. As per Fourth Assessment Report of the Intergovernmental Panel on Climate Change[4] the mean surface temperature the atmosphere has risen by 4-8°C globally in the last 100 years due to increase in concentration of greenhouse gases in the atmosphere(for e.g., CO_2 by 29 percent, CH_4 by 150 percent and N_2O by 15 percent.

Energy production and use play important role, because, energy represents about 65% of global anthropogenic greenhouse-gas emissions. Therefore, reducing emissions must necessarily start with reduced energy consumption and associated emissions from fuel combustion. Worldwide economic stability and development require energy. Global total primary energy supply doubled between 1971 and 2008, mainly relying on fossil fuels. One of the most important developments in the world economy and energy use is due to increasing economic integration of large non-OECD countries, such as, Brazil, Russian Federation, India, China and South Africa represent over one-fourth of world GDP, up by 18% from 1990. In 2008, these five countries represented 31% of global energy use and 35% of CO_2 emissions from fuel combustion. These shares are likely to rise further in coming years due to strong economic performance currently occurring in most of these countries[6]. India emits nearly 5% of global CO_2 emissions, and emissions continue to grow. CO_2 emissions have more than doubled between 1990 and 2008 and it is projected to increase by more than 2.5 times by 2030 from 2008. A large share of these emissions is produced by the electricity and heat sector, which represented 56% of CO_2 in 2008, up by 42% from 1990. Pulp and paper industry is one of the largest consumers of electricity and heat in the world as well as in India.

Methodology

Pulp and paper industry is one of the largest consumers of electricity and heat in the world as well as in India[7]. There is a need for Paper industry to reduce the energy usage, emission norms, water consumption, re-utilize waste products, reburn lime sludge, and recycle water the natural resources where it is possible[8]. By constantly working towards the above aspects Indian paper industry is now marching towards greater sustainability. TNPL being one of the largest exporters and manufactures of the paper in the country recognize increasing importance of climate change and customer preference for carbon neutral products and initiated many measures to reduce its carbon foot print and introduced energy efficient technologies and emission reductions are estimated using standard procedures[9,10]. The major ones are discussed below.

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Results And Discussion

Methane Extraction and fuel conservation Project.

TNPL has installated a closed anaerobic system that will produce and collect consistently high quality methane-rich biogas from bagasse wash wastewater (BWW) generated from bagasse yard and bagasse washing area in pulp mill. The BWW is diverted from TNPL's existing wastewater treatment system, open lagoon under anaerobic conditions, into a closed anaerobic digester. The project activity also includes system for utilization of the collected biogas as a fuel in a lime kiln, which was earlier using furnace oil (fossil fuel). By extracting and capturing biogas, nearly 20,000 m^3 per day, in a closed digester, the project reduces the methane emission that would have otherwise been emitted to the atmosphere from open lagoons. In addition, the use of the collected biogas as a fuel in the limekiln displaces nearly 12,000 litres of furnace oil and associated GHG emissions. This is First CDM project[5] in world of Pulp and paper industry. Biogas generation, Furnace oil saving and associated GHG emission reduction from biomethanation plant are presented in Table 1. It is clear from table that up to March 2010, the implementation of the project resulted in around 17, 835 KL of furnace oil saving and 391,403 MT CO_2 equivalent GHG emission reduction and also 161,956 CERs up to December 2007.

TABLE - 1
GHG EMISSION REDUCTION FROM BIOGAS PLANT AND SAVINGS OF FURNACE OIL

Particulars	Units	2009-10	2008-09	2007-08	2006-07	2005-06	2004-05
Generation of Biogas per annum	M^3	5797777	4689336	5755200	5162300	4908475	3411701
Savings of Furnace oil per annum	KL	3479	2814	3453	3097	2945	2047
Emission reduction of GHG per annum due to CH4 avoidance	MT CO_2e	65062	52623	64584	57931	55082	38286
Emission reduction of GHG per annum due to Furnace Oil saving	MT CO_2e	11281	9124	11198	10044	9550	6638
Total Emission reduction of GHG	MT CO_2e	76342	61747	75782	67975	64633	44924

TABLE - 2
GHG EMISSION REDUCTION OF ENERGY EFFICIENT CHEMICAL RECOVERY BOILER

Particulars	Units	Values
Average steam generation /MT of BLS before RB3	MT	2.78
Average steam generation / MT of BLS after RB3	MT	3.23
Additional steam generation / MT of BLS	MT	0.45
BLS fired per annum	MT	374,030
Additional steam generation per annum due to RB3	MT	169,483
GHG emission reduction per annum due to additional steam generation	MT CO_2e	72,630
Additional power generation per annum due to RB3	MWh	63360
GHG emission reduction per annum due additional power generation	MT CO_2e	59,058
Total GHG Emission reduction per annum	MT CO_2e	131,688

Installation of Energy Efficient Chemical Recovery Boiler

Fibrous raw material, such as, bagasse and wood chips are cooked in digesters in the presence of chemicals to separate the fibre and remove lignin from the raw material to produce pulp and to manufacture paper. During this process, lignin and other organics along with inorganic chemicals are removed as Black Liquor Solids (BLS). The BLS is fired in recovery boilers where the organic content is burnt to generate steam, which is used to produce electricity in TG and also use as process steam for various heating applications. Before mill development plan, TNPL was generating 760 Tonnes per Day (TPD) of BLS that was fired in two existing Recovery Boilers (RBs) of low efficiency and low pressure (45 kg/cm^2) configuration. TNPL has expanded its production capacity under the Mill Development Plan (MDP) resulting in an increase in the chemical pulping capacity from 530 TPD to 800 TPD leading to increase in production of BLS from 760 TPD to 1300 TPD. Additionally, as part of the MDP, the technology of oxygen delignification is introduced, and this also contributed significantly for increase in BLS generation per tonne of pulp produced.

Installation of a new recovery boiler (RB3) and TG with efficiency higher than what would have been installed in the business as usual scenario, the electrical and thermal efficiency of the new boiler would be higher compared to earlier resulting in higher quantity of power and heat generation for the same quantity of BLS fired. The project activity generates around 3.4 - 3.6 tonnes steam at 65 kg/cm^2 per tonne of BLS fired compared to 2.8 tonnes steam at 45 kg/cm^2 generated by earlier old configuration. The incremental electricity and thermal generation would replace the electricity and thermal energy generated from fossil fuel based captive power plant operated in the mill thereby reducing GHG emissions. This is in addition to the local environmental benefits accrued through fugitive dust and pollution control by implementation of modern and best commercially available technology, in comparison to the existing practices. The project is operational from 2008. The GHG emissions reduction from this project activity is presented in Table 2.

Implementation of new hard wood fibre line

TNPL has installed a 300 tpd modern hard wood fibre line with Super-batch® cooking, Oxygen delignification followed by Elemental chlorine free (ECF) bleaching sequence in place of conventional kraft cooking and chlorine based bleaching. In the old HW pulping system, pulp from the

digesters was transferred under pressure which paved way for the generation of malodorous gases during pulp blowing. The new pulping stream has been provided with Super-batch® digesters for cooking. With the Super-batch® digester, the pulp from the digesters are transferred through atmospheric pumping which reduces the emission of malodorous Organo sulphur compounds during blowing, coupled with preservation of the inherent strength of the fibre for improved quality at a lower chemical dosage and energy consumption.

The project activity involves two energy efficiency initiatives: 1. The project replaces conventional batch technology with super batch digester technology to reduce specific consumption of Medium Pressure (MP) steam production of unbleached pulp during cooking process. 2.The project involves implementing medium consistency bleaching in place of low consistency bleaching to reduce specific consumption of LP steam and specific electricity consumption per tonne of bleached pulp produced.

Therefore, the project activity essentially reduces specific consumption of LP, MP steam and power which leads to savings in equivalent quantity of fossil fuel coal in the utility boilers. The project is hence responsible for reduction of Greenhouse Gas (GHG) emissions. By implementation of Super-batch® digesters and medium consistency ECF bleaching sequence, the specific utility requirements, such as, energy, steam and water has been reduced considerably resulting in the reduction of carbon footprint and results are presented in Table 3 and 4.

TABLE - 3
STEAM SAVING AND IT'S ASSOCIATED GHG EMISSION REDUCTION DUE TO IMPLEMENTATION OF NEW HARD WOOD FIBRE LINE.

Particulars	Units	Values
Power consumption after MDP / MT of pulp	kWh	253
Power consumption before MDP / MT of pulp	kWh	399
Power savings per tonne of pulp	kWh	146
Pulp production per annum	MT	94787
Power saved tonne per annum	MWh	13801
GHG emission reduction per annum	MT CO_2e	12864

TABLE - 4
STEAM SAVING AND ITS ASSOCIATED GHG EMISSION REDUCTION DUE TO IMPLEMENTATION OF NEW HARD WOOD FIBRE LINE.

Particulars	Units	Values
Steam consumption after MDP/MT of unbleached pulp	MT	0.94
Steam consumption before MDP/ MT of unbleached pulp	MT	1.81
Steam savings per tonne of unbleached pulp	MT	0.87
Bleached Pulp production per annum	MT	94787
Steam saved per annum	MT	82772
GHG emission reduction per annum	MT CO_2e	35471

Installation of Shoe press in the paper machine.

In the normal tri-nip press in the paper machine, the contact area of the nip sheet web is very short. The improved and specific design and technology in the shoe press increase the contact area of nip with paper web. This improves the dryness of the paper web by 5 - 6% that enters into the drier section. This enabled to increase paper machine speed and reduction in the steam and indirectly the power and associated GHG emission are presented in Table 5 & 6.

Utilization of Renewable fuel in the power boiler

TNPL generates its power and steam from its captive power plant. The fossil fuel such as coal is partly substituted by renewable fuels like bagasse pith, agro fuels and the in-house waste like secondary sludge which is carbon neutral and contributes to GHG emission reduction. The data for the last three years is presented in the Table-7.

TABLE - 5
STEAM SAVING AND ITS ASSOCIATED GHG EMISSION REDUCTION DUE TO IMPLEMENTATION SHOE PRESS IN THE PAPER MACHINE.

Particulars	Units	PM 1*	PM 2
Steam consumption / MT of paper after shoe press	MT	2.14	1.651
Steam consumption / MT of paper before shoe press	MT	2.08	1.76
Steam saving / MT of paper	MT	-0.06	0.11
Avg. Production per annum after shoe press	MT	121725	135491
Avg. Production per annum before shoe press	MT	91876	104134
Production increase due to shoe press per annum	MT	29849	31357
Steam saving per annum	MT	-7266*	14938
GHG emission reduction per annum	MT CO_2e	-3114	6402

*Increase in steam consumption is due to the production of more surface sized paper after installation of shoe press then the before.

TABLE - 6
POWER SAVING AND ITS ASSOCIATED GHG EMISSION REDUCTION DUE TO IMPLEMENTATION OF SHOE PRESS IN THE PAPER MACHINE.

Particulars	Units	PM 1	PM 2	
		PWP	PWP	NP
Power consumption / MT of paper after shoe press	kWh	536	589	540
Power consumption /MT of paper before shoe press	kWh	594	620	624
Power saving / MT of paper	kWh	58	31	84
Avg. production per annum after shoe press	kWh	121725	132382	3109
Avg. production per annum before shoe press	kWh	91876	52871	51263
Production increase due to shoe press per annum	kWh	29849	31357	
Power saving per annum	MWh	7015	4113	
GHG emission reduction per annum	MT CO_2e	6539	3834	

TABLE - 7
GHG EMISSION REDUCTION DUE TO USAGE OF RENEWABLE FUEL IN BOILERS FOR CAPTIVE POWER GENERATION

Fuel type/year	2009-10	2008-09	2007-08	Total	GHG Emission Reduction
Agro fuel MT	4254	8984	23747	36985	37389
Secondary sludge MT	28003	6880	15500	50383	34635
Bagasse Pith MT	35031	95193	61385	191609	193701

Carbon sequestration through farm forestry and captive plantation

TNPL promoted the captive plantation and farm forestry to meet the pulp wood requirement that can absorb the CO_2 from atmosphere and fix it as biomass. TNPL started the plantation activity in the year 2004 - 05 onwards and as on March 2010 TNPL promoted 51,220 acres of farm forestry and 4,468 acres of captive plantation and it is expected to absorb around 5,00,000 tonnes of CO_2 from atmosphere per annum. TNPL plan to reach 1, 00,000 acres of plantation by 2013.

Other effort of TNPL to reduce GHG emission reduction

TNPL as leader in implementing renewable energy project commissioned its first 15 MW wind farm during 1994 and today TNPL has 35.5 MW wind farm and generate about 60 million units of green energy and reduce nearly 55,000 tonnes of CO_2 equivalent every year. Apart from the above TNPL has implemented many energy efficiency projects to reduce the Carbon foot print.

1. Replaced all Chloro Fluro Carbon based air-conditioners in the factory.
2. Blow heat recovery system,
3. Energy efficient aerators in wastewater treatment plant.

Future projects of TNPL to reduce GHG emission reduction

The efforts taken by TNPL to move towards greater sustainability are due to upcoming projects of TNPL:

1. Installation of satellite Precipitated Calcium Carbonate plant
2. Biomass gasification to replace furnace oil in lime kiln
3. Biogas reactor from Canteen and quest house waste
4. Installation of a mini cement plant for utilizing lime sludge generated from recovery cycle and fly ash generated from the power boilers.
5. TNPL proposes to replace three 44 ATA boilers and three turbo generators (TGs) of capacity 36.5 MW with a new high efficiency 105 ATA boiler and 41 MW TG system to reduce the energy losses and decrease fossil fuel consumption. All these efforts will further reduce the GHG emission by around 80,000 tonnes of CO_2 equivalent every year.

Climate Change and CDM Cell

TNPL has established a Climate Change and CDM Cell in the year 2005 to work in the areas of climate change, CDM and carbon trading and registered during January 2006, a first CDM project in the pulp and paper industry. Executives from Climate Change and CDM Cell were trained in the areas of greenhouse gas auditing and reporting and sent to both national and international conferences to gain knowledge in these areas

Conclusions :

TNPL is reducing CO_2e Emission reduction of GHG per annum by its Methane Extraction and Fuel Conservation Project, Installation of Energy Efficient Chemical Recovery Boiler, Implementation of New Hard Wood fibre line, Installation of Shoe Press in the paper machine and Carbon Sequestration through Farm Forestry and Captive Plantation, Utilization of Renewable fuel in the power boiler. Future projects of TNPL like Energy Efficient Power Boiler, Biogas from canteen waste etc also reduces GHG emission reduction. By constantly working towards the above aspects and by establishment of Climate Change and CDM Cell, TNPL is now marching towards greater sustainability and taking care of **Energy, Environment and Ecology 3 E' of Paper Industry**

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References :

1. IPCC WGII Fourth Assessment Report, Summary for Policymakers Climate Change Impacts, Adaptation and Vulnerability Summary for Policymakers Implications of proposed CO2 emissions limitations. IPPC Technical Paper 4. www. IPPC.org; April 6th, (2007).
2. Opposing Viewpoints Resource Center. Detroit: Thomson Gale, 2005. From Opposing Viewpoints Resource Center.
3. Climate Change 2001: Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press, Cambridge, 2001b.
4. Climate Change 2001: The Scientific Basis, Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press, Cambridge, 2001a.
5. http://cdm.unfccc.int/Projects/DB/DNV-CUK1131389672.69/view
6. CO_2 Emissions from Fuel Combustion (I E A Statistics, 2010 Edition), International Energy Agency, 9 rue de la Fédération,75739 Paris Cedex 15, France (2010).
7. Energy Efficient Technologies and CO_2 Reduction Potentials in the Pulp and Paper Industry: A Workshop in the Framework of the G8 Dialogue on Climate Change, Clean Energy and Sustainable Development In collaboration with WBCSD - Final version 24 October (2006).
8. Forest Products Industry Technology Roadmap. www.agenda2020.org.
9. Estimating Greenhouse Gas Emissions from Pulp and Paper Mills (Version 1.1), A Project of The Climate Change Working Group of The International Council of Forest and Paper Associations (ICFPA) Prepared by: National Council for Air and Stream Improvement, Inc. (NCASI) Research Triangle Park, NC, USA July 8, (2005).
10. Revised IPCCC Guidelines for National greenhouse gas inventories, Reference Manual, (1996).