

CARBON NEUTRALITY

Possibilities in Pulp & Paper Sector



INTRODUCTION

Pulp and Paper sector is an energy and water intensive sector. The uniqueness of pulp and paper sector is that unlike the engineering or metal sector companies, pulp & paper sector is having an added advantage i.e. raw material of final product can be sustainably grown by the producer. This process is not possible for any other sector. Over 40% of global industrial wood harvest is used to make paper. Many companies strive to do plantation for meeting their raw material requirement, others source it from suppliers.

Impact on final cost of product is significant, if, raw material 'trees', are sourced from suppliers. Sustainability of the source of raw material (i.e. wood) also remain in question, thus the image of producer.

Carbon Sequestration and Carbon Cycle: As forests grow, CO₂ is removed from the atmosphere via photosynthesis. This CO₂ is converted into organic carbon and stored in woody biomass and this is termed as Carbon Sequestration (in plants). Trees release the stored carbon when they die, decay, or are combusted, completing the carbon cycle. The carbon in biomass / wood will return to the atmosphere regardless of whether it is burned for energy, allowed to biodegrade, or lost in a forest fire. The net impact of these processes is that CO₂ flows in and out of forests / organized plantations. Overall, the flow of forest CO₂ is carbon positive when forests / plantations are sustainably managed (ICFPA Steering Committee, 2013¹).

Thus, the possibility to implement the 'carbon sequestration' (in trees) is a viable option to reduce GHG emissions as well as to source the raw material i.e. trees, sustainably which can solve dual can play a major role to reduce GHG emissions from atmosphere, simultaneously providing raw material sustainably.

A paper company produce 45-70% emissions while production, depending on their raw material (wood/biomass/recycled fiber) and fuel usage (coal/natural gas/ bagasse etc). Percentage of emissions from various stages of pulp & paper production may vary due to use of fuel, fuel type, transportation of raw material for production, methane emissions due to anaerobic decomposition of forest products, landfills and various other factors.

Greenhouse gas (GHG) emissions happen throughout the life cycle of any product. In Pulp and paper sector major emissions happen during the manufacturing process. Potential emission areas are :

1. Raw material transportation
2. Transportation of chemicals for process
3. Pulp production
4. Paper production
5. Transportation of final products
6. Effluent treatment - as water usage is extensive
7. Landfills
8. Power production

Areas of potential emissions can be well managed by various technologies or management measures. Thus, decarbonization of pulp and paper sector is viable and can be achieved if managed effectively. Study on decarbonization possibility of pulp and paper sector was done by Confederation of European Paper Industries (CEPI) and detailed in CEPI Roadmap 2050².

Ref.: 1. ICFPA Steering Committee, International Council of Forest and Paper Associations, Carbon Neutrality of Biomass, 2013

2. CEPI 2050 Roadmap, Unfold The Future, The Forest Fiber Industry: 2050 Roadmap to a low carbon bio-economy, 2011

Figure-1 showcase that to achieve 80% emission reductions by 2050, the pulp and paper sector needs to reduce emissions by 48Mt compared to 1990 levels, globally. Continued adoption of best available technologies is expected to contribute 10 Mt to this effort. Continued fuel mix change may reduce emissions by a further 5Mt. Significant decarbonisation of the European power market is expected between 2015 and 2050, such that technologies allowing for heat generation from electricity rather than conventional fuels will also play a leading role. However, known technologies are insufficient. At least 10Mt must come from breakthrough technologies².

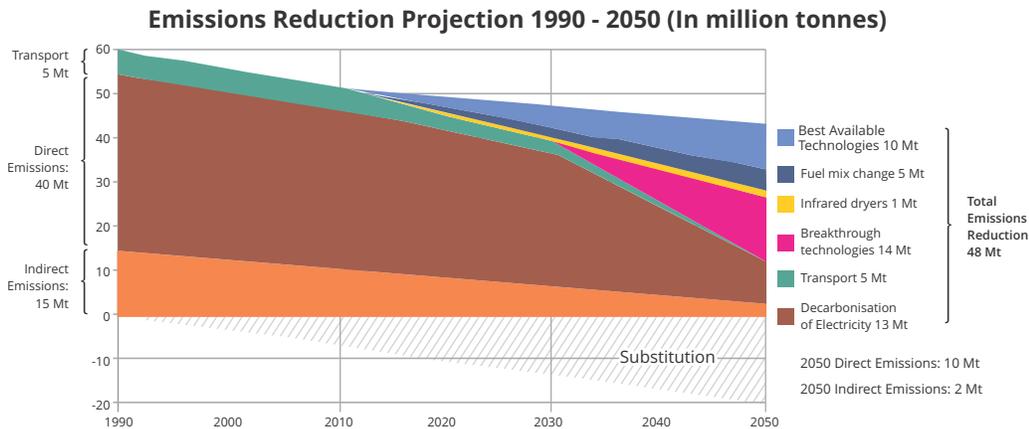


Figure-1 outlines a path to decarbonisation of pulp & paper sector - CEPI Roadmap 20502

The exploration shows that a reduction of 50 to 60% of CO₂ emissions is possible given the right circumstances. To achieve a minus 80% reduction, however, the sector will need breakthrough technologies.

With focus on current climate challenges, climate policies and for the decarbonization of pulp and paper sector, this paper provides the details on measures and technologies that can be assessed and implemented by any pulp & paper sector in India, to achieve 'carbon neutral status'.

PULP AND PAPER PRODUCTION STATUS : INDIA & WORLDWIDE

According to Johnson et. al., 2011³, Indian paper industry rank 15th globally in terms of size but accounts for only 2% of world's production.

Projected Production of Paper (Million tons)

	Wood Resources	Agro Based resources	Recycled Paper	Total Production	Baseline Production
2010-11	3.2	2.2	4.7	10.0	10.1
2011-12	3.4	2.3	5.1	10.9	10.9
2012-13	3.7	2.5	5.7	11.8	11.7
2013-14	4.0	2.7	6.2	12.9	12.5
2014-15	4.3	2.9	6.8	14.0	13.3
2015-16	4.6	3.2	7.5	15.3	14.1
2016-17	5.0	3.4	8.3	16.7	14.8
2022-23	8.0	5.4	14.7	28.0	19.6
2024-25	9.3	6.3	17.8	33.4	22.0
2026-27	10.8	7.4	21.5	39.7	23.5

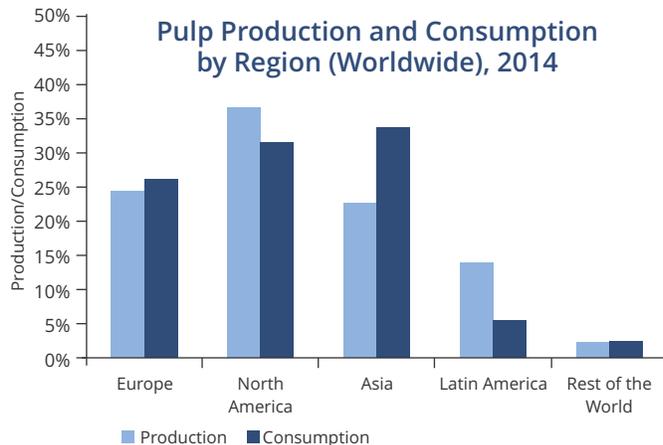
Few Indian industry suggest that 'demand is set to rise from 13 million tonnes (mt) in year 2014 to an estimated 20 mt by 2020. An India Ratings report, 2014⁴ estimates India's per capita paper consumption at nine kg, against 22 kg in Indonesia, 25 kg in Malaysia and 42 kg in China. The global average stands at 58 kg.

Ref.: 3. Johnson et. al., India – An emerging giant in pulp and paper industry, 2011, Beca AMEC
 4. India' Rating Report 2014
 5. Working Group for 12th Five Year Plan for Pulp & Paper Sector Report, 2011

Working Group on Pulp & Paper Sector report for 12th Five Year Plan⁵, India; while preparing the baseline scenario assumed that the growth and availability of raw material will continue same as in past, thus projected growth of pulp & paper sector will be as provided in graph on 'Projected Production of Paper (Million tons)'. Thus, for paper industry, growing own raw material have even more importance to maintain their profits sustainably.

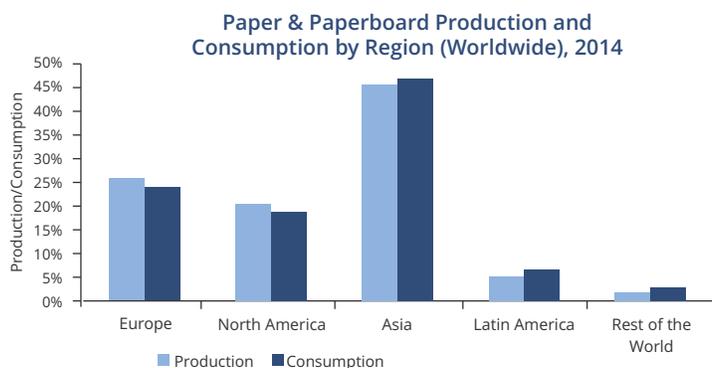
PULP

Globally the production of pulp is led by North America, which accounts for over one-third of the pulp production and generates an excess supply of 5%. Europe and Asia follow, each with close to one fourth of global pulp production (CEPI Key Statistics, 2014)⁶. The overall production of pulp in 2014 equaled 178.5 million tonnes, with total consumption equaling 179.6 million tonnes. Based on a survey by the Food and Agriculture Organization (FAO, 2015)⁷, stable trends for pulp production are expected over the next five years. Specifically, global capacity is expected to increase 5.9%, while European capacity is expected to increase only 1.6%. Global capacity growth is driven largely by Brazil and Russia, which expect a 48% and 18% expansion, respectively. Despite lower European capacity growth as a whole, large capacity growth is expected in France and Spain of 14% and 8%, respectively.



PAPER

Globally, the production of paper and board in 2014 was 406 million tonnes, with 407.6 million tonnes consumed. Asia is the leader in both production and consumption with about 45% in both categories. European production represents 26%. In contrast to the pulp sector, in Europe paper and paperboard production is slightly higher than its consumption. In term of future capacity, future trends in the paper and board industry show a stable production over the next five years (FAO, 2015).

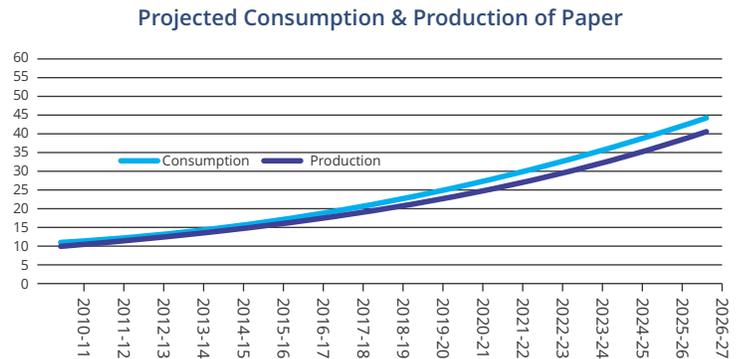


According to Working group of Pulp and Paper Sector, for 12th Five Year Plan⁵ of India, the production of paper is expected to increase to 16.7 million tons in 2016-17 and further to 39.7 million tons in 2026-27 as shown graph 'Projected Consumption & Production of Paper'.

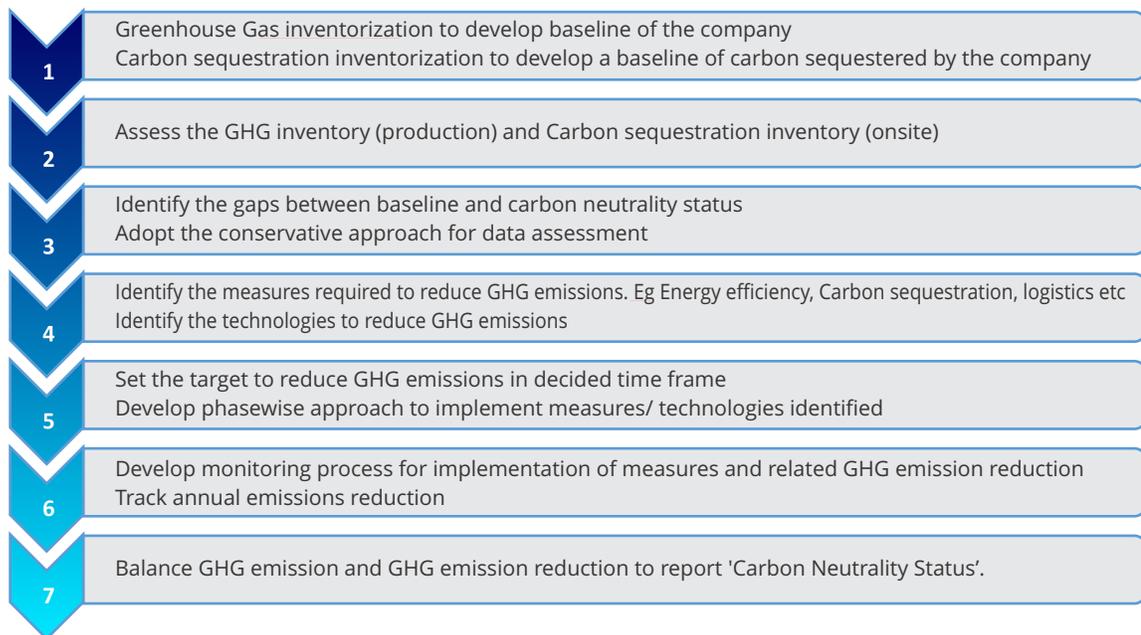
Ref.: 6. CEPI Key Statistics (2014) Key Statistics 2014, Brussels, CEPI.

7. FAO (2015) Pulp and paper capacities survey 2013-2018. United Nations, Food & Agriculture Organization, United Nations

Analysis of pulp and paper production is done by various associations and companies worldwide. Whereas, data of 'raw material grown' by the paper industries for their own use is neither accounted nor the carbon sequestered by the plantations is presented by Paper Associations. Thus, non-accounting of carbon sequestered by the plantations done by the paper industries for meeting their need of raw material is an opportunity that need to be built upon. 'Carbon sequestration accounting' will be a useful tool to measure and analyse the carbon sequestered by the plantations, annually.



STEPWISE PROCESS TO ACHIEVE CARBON NEUTRALITY



CARBON NEUTRALITY: MEASURES AND TECHNOLOGIES REQUIRED

Carbon neutrality can be achieved thru the combination of one or more measures that have potential to reduce GHG emissions. For eg. carbon sequestration, energy efficiency, low carbon technology etc. Each aspect is detailed in this section.

Ref.: 8. America Forest and Paper Association Report, 2014

CARBON CYCLE – PULP & PAPER SECTOR

To understand the 'carbon neutrality' approaches, representation of carbon cycle is provided below. America Forest and Paper Association (AFAP) showcase the carbon cycle for pulp & paper sector, as in figure-2.

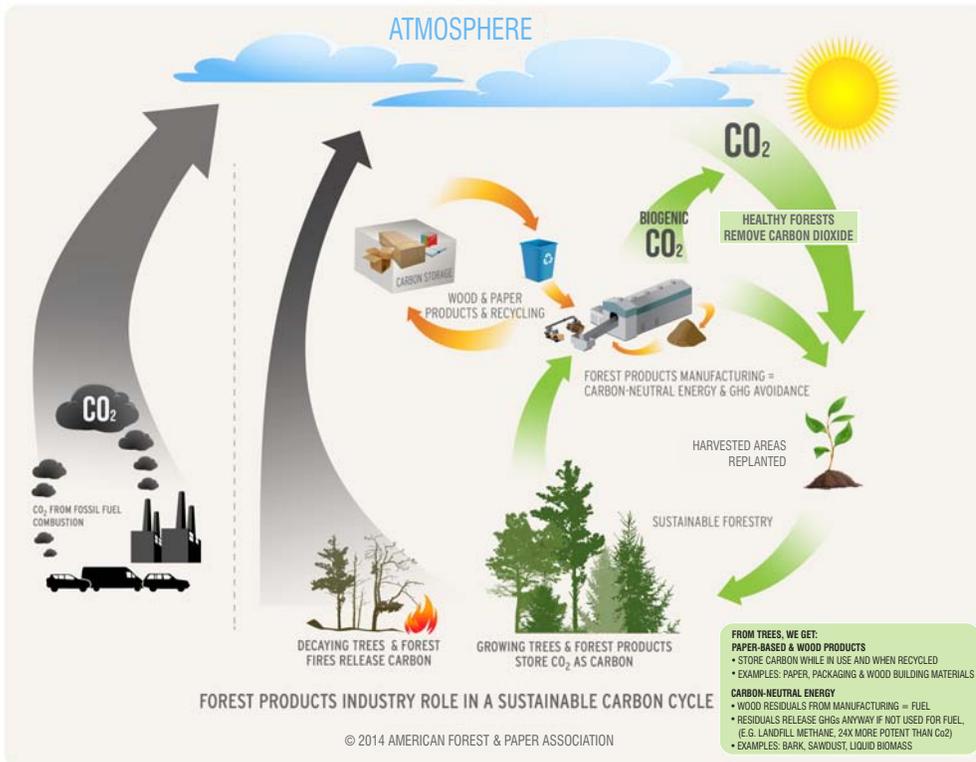


Figure-2: Carbon cycle: Relevance to pulp & paper sector

Figure-3 explains the cycling of carbon thru wood and paper products. Possibilities of emissions from wood are described in this figure. This figure also helps to understand the carbon sequestration in wood and carbon release by wood into the atmosphere.

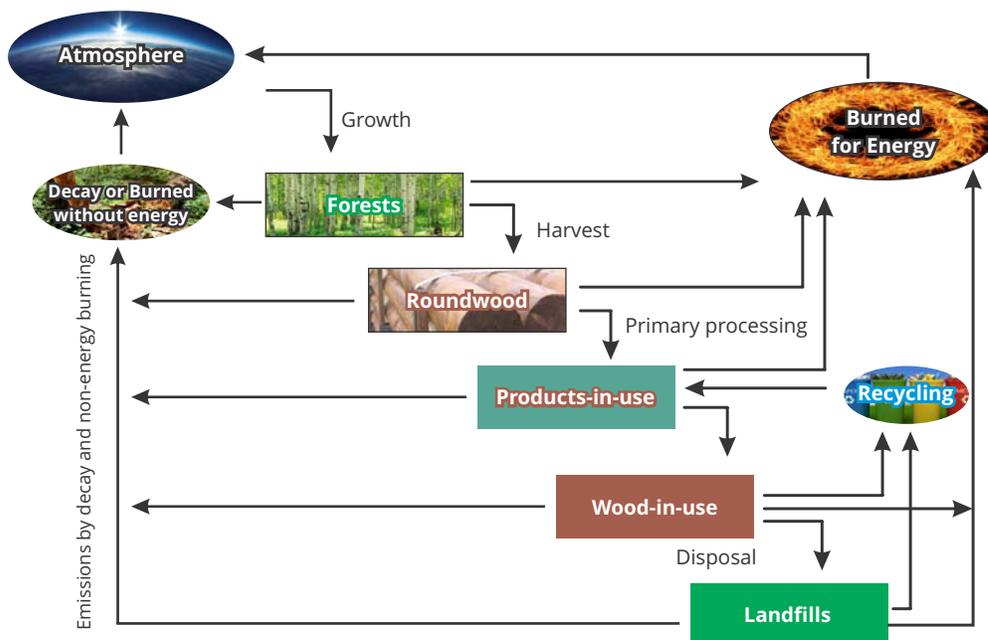


Figure-3: Cycling of Carbon thru wood and paper products

MEASURES

Various measures for CO₂ emission reduction can be assessed during energy audits and GHG emission inventorization. Selected and appropriate measures need to be implemented. Decide the target time frame for announcement of 'carbon neutrality'. Measures can be implemented in phasewise manner within the decided time frame for announcement of carbon neutrality. Few examples are:

1. Energy efficiency
 - i. Improve energy efficiency (TOE/ tone of paper) and assess the impact of 2%, 4% and 6% reductions
 - ii. Efficient lightening system
 - iii. Nansulate for insulation of Paper Machine Dryer ends
2. Renewable Energy
3. Green energy generation enhancement through increased black liquor firing of higher concentration (72-73%)
4. Installation of Biomass based gasification for Lime Kiln
5. Exploration of alternate/biomass based fuel for boilers
6. Installation of Precipitated Calcium Carbonate (PPC) Plant
7. Carbon Sequestration
8. PPC Plant for Carbonate production
9. Focus on Scope-3 inventorization
 - i. Use of electric fork lifts inside the plant
 - ii. Firing of black liquor at higher concentration
 - iii. Exploration of Alternate mode of transport for transport/dispatch of material
 - iv. Green Procurement Policy to reduce scope-3 emissions
10. Logistics improvement
 - i. Improving fleet efficiency for contractor vehicles
 - ii. Use of CNG fuelled buses for employee commute
 - iii. Use of rail transportation for raw material/ product distribution
11. Use pulp produced thru paper recycling
12. Raw material mix improvement
13. Carbon offset
14. Innovation
15. Other option can be identified (depending on the pulp & paper plant)

TECHNOLOGIES

Various breakthrough technologies (Roth et. al., 2016⁹) are explained herewith:

- Deep Eutectic Solvents (DES) Pulping : DES are produced naturally by plants and can break down wood and selectively extract cellulose fibers required in the paper making process. Therefore it offers a new concept for pulping that does not rely on high heat and energy inputs. It is estimated that DES pulping could reduce emissions by 20% .
- Flash Condensing with Steam : Large dry fibers are blasted into a forming zone with agitated steam and condensed into a web using one/thousandth of the volume of water used today. High gas velocities make the paper forming section very short, with little extra heating required for drying, as water content after the process is greatly reduced. The process is most readily applicable to virgin fibres produced with chemical pulping, but can also be applied to recovered and mechanically pulped fibres. Emissions savings come from the greatly reduced water volumes used in the forming process and hence the reduced drying requirements.

- Dry Pulp for Cure Formed Paper : This innovation introduces two technologies that allow for the production of paper without the use of water. First, a new dry pulp technology, where fibres are treated to protect them from shear, and then suspended in a viscous solution at up to 40% concentration. The solution is then pressed out and the thin sheet cured with a choice of additives to deliver the end-product required. The process removes the use of water and therefore eliminates emissions associated with drying and effluent treatment (around 55% total emissions).
- Supercritical CO₂ : can be foremost used to dry paper with vast reductions in energy requirements. Second, it can be used to remove containments from recycled paper and therefore increase utilisation rates.
- Functional Surface: the idea is to reduce the weight of paper without impacting its quality or structure. Advances in sheet formation and new cocktails of raw materials will lead the way to the lightweight papers. Lighter weight paper is then easier and less energy intensive to dry.
- Optimize Steam Use: Use of steam for paper drying process.

CALCULATION FOR CARBON SEQUESTRATION

Generally, the trees grown for paper production are: Eucalyptus, Subabul, Casuarina. Other plants like cashew, other shrubs etc also can be used for paper production thus, calculation for carbon sequestration can be done as given below:

- A. 1000 ha area x 100 Ton wood/ha = 100000 tons of wood
(average yield 100t / ha --- Based on eucalyptus plantation area & harvest at 4 years tenure)
- B. 100000 Ton wood / 2 (@50% moisture removed) = 50,000 tons wood
- C. 50,000 Ton of wood / 2 (carbon content in wood) = 25000 Ton C
(Ref. UNFCCC default values)
- D. Carbon Sequestration : 25000 Ton C x 44/12 = 91666.66 Ton CO₂ (4 years harvesting period)

Calculation given above is to provide an outline. Various factors are considered while doing the calculation viz. spacing in plantation, above and below ground biomass, soil carbon, sample plotting to assess the volume growth/annum, inventory updates, annual audits etc.

MODELS: ASSESSMENT OF CARBON SEQUESTRATION- PULP & PAPER SECTOR

NAPAP Model: The North America Pulp & Paper Model (NAPAP) Model simulates operation of markets, projects consumption of pulpwood; use, and change of processing technology and consumption of pulp and paper. NAPAP model can project consumption of hardwood and softwood pulpwood, four categories of recycled paper, and production and trade of around 13 categories of pulp and paper.

WOODCARB Model: Companies in USA use this model in combination with Timber Assessment market Model (TAMM) Model. The WOODCARB model is an addition to the TAMM model and tracks carbon in all timber removed from U.S. land plus carbon in net imports of logs and wood and paper products. It can be used to assess the carbon stocks and stock changes in harvested wood products. WOODCARB model can provide projections for:

- i. net carbon sequestered in products in use each year (carbon in minus carbon out)
- ii. net carbon sequestered in landfills or dumps each year (carbon in minus carbon out);
- iii. carbon released by burning where useable energy produced each year
- iv. carbon released by decay or burning without energy produced each year.

Ref.: 9. Roth et. al.; The Pulp and Paper Overview Paper: Sector Analysis for the Climate Strategies Project on Inclusion of Consumption in Carbon pricing, May 2016, Climatestrategies.org

DISCUSSION

A hypothetical example showcasing the approach to assess the 'carbon neutrality' status is provided herewith. Suppose, if a medium scale pulp & paper company emits certain tonnes of CO₂/annum, they can achieve carbon neutrality with measures and corresponding estimates as provided in table below:

Few companies in India and other countries practices 'carbon neutrality' in pulp & paper sector. Various measures can be taken, depending on the status of paper plant, possible measures and technologies that can be implemented in plant, keeping viability and economics at the core of decision making for 'carbon neutrality'.

S. No.	Measures	Results	Possible %age of Emission Reduction
1.	Carbon Sequestered (example of calculation is provided above)	Area of plantation can be decided to meet 100% raw material requirement from own plantation. (Carbon Sequestration in 1 Ha plantation)	~25% emission reduction (~23 tonnes/annum)
2.	Adjust thermostats (office area)	Standard 35-40% energy efficiency can be achieved	~10% emission reduction
3.	Lighting/ Office Equipment/ Ventilation etc. maintained in energy efficient manner	Average 10% energy efficiency can be achieved	
4.	Renewable Energy – Solar/ wind etc 100% Rooftop solar for use in office and Residential colony (other than operations)	Fixed %age of emissions from power generation that otherwise would have been provided to housing colony/office will permanently get reduced	~20% (if provided to office/ housing colony etc)
5.	Energy efficiency – paper machines/ logistics/ employee transportation	A %age target for GHG emissions reduction can be fixed and worked upon phase-wise to reduce emissions	~2% from EE measures within production unit ~8% from all other measures
6.	Technology upgradation	Few advance technologies are detailed under topic 'Technologies'. Ref. Roth et. al	Average efficiency estimated ~30%
7.	CO ₂ absorption in PPS plant	Absorption of emissions produced from kiln	~100% of emissions from kiln get absorbed in PPC plant thus no emission in atmosphere
8.	Fuel switch	Explore the possibilities for fuel switch	If bagasse is used in power plant then equalled %age of fuel switched will offset equivalent emissions
9.	Use Recycled Fiber	Recycled fibers / pulp reduce emission	~ 30-37%
10.	Innovation	Raw material mix can be experimented. R&D required	Can add to CO ₂ emission reduction
11.	Carbon Offset	Left out emissions, if any, can be neutralized thru carbon offset	

Few companies in India and other countries practices 'carbon neutrality' in pulp & paper sector. Various measures can be taken, depending on the status of paper plant, possible measures and technologies that can be implemented in plant, keeping viability and economics at the core of decision making for 'carbon neutrality'.

CONCLUSION

Fact is that 'carbon neutrality' is not a challenging thought any more, for pulp & paper sector. It's a proven fact. Thus, company having their GHG inventory (baseline) and follow the continual development pathway, can achieve 'carbon neutrality' in defined time frame.

The pulp and paper sector will need to be highly energy efficient and innovative in a future that is shaped by ambitious climate and energy policy goals¹. Research on 'low emission technologies', 'process to make paper sector less water intensive', 'dry pulping technologies' and 'grow your own raw material' will shape the future of the sector.

KEY MESSAGES

1. Pulp and Paper Company growing their 'own raw material- trees' can produce in environment and cost efficient manner.
2. Trees sequester carbon thus paper companies have additional scope to achieve 'carbon neutrality'.
3. Few more initiatives like energy efficiency, renewable energy/ fuel switch etc may be required to achieve 'carbon neutral' status.
4. 'Carbon Accounting' i.e. GHG accounting and target setting for GHG emissions reduction are the necessary steps to assess the balance between carbon emissions/ annum and sequestration potential of the company.
5. Business models for raising plantations are viable and successful.
6. 'Carbon Neutrality' is not impossible. It is achievable by Pulp & Paper companies.



WRI India is a research organization that turns big ideas into action at the nexus of environment, economic opportunity and human well-being. WRI India is linked with World Resources Institute (WRI), a global research organization that spans more than 50 countries, with offices in Brazil, China, Europe, India, Indonesia and the United States.



www.wri-india.org

CII is a non-government, not-for-profit, industry led and managed organization playing a proactive role in India's development process. Founded over 118 years ago, India's premier business association has over 7,100 members including SMEs and MNCs. Extending its agenda beyond business. CII assists industry to identify and execute corporate citizenship programs - along with partnerships with civil society organizations to carry forward integrated and inclusive development.



Confederation of Indian Industry

www.cii.in

TERI (The Energy and Resources Institute) is a non-profit, scientific and policy research organization, working in India and globally in the field of climate change, energy, environment, water, biotechnology, forestry, as well as a range of sustainable development issues. The organization was founded in 1974 with the mission of addressing climate and energy issues of concern to the Indian society as well as the world at large. Over the years the Institute has created a dynamic and inspiring environment for developing innovative and cost-effective solutions. TERI has been engaged in forging long-term linkages and partnerships with agencies and organizations, including the government, so that the effort towards a green tomorrow never ceases.



www.teriin.org

P V Kiran Ananth
Senior Counsellor
kiran.ananth@cii.in

Dr Shalini Sharma
Senior Counsellor
sharma.shalini@cii.in

ABOUT INDIA GREENHOUSE GAS PROGRAM

The India GHG Program acts as a 'Center of Excellence' by disseminating regional, sectoral and global best practices to create a culture of inventorisation and benchmarking of GHG emissions in India. To accomplish this, the primary objective of the India GHG Program will be to build institutional capabilities in Indian businesses and organizations.

The program offers a unique threefold proposition – expertise and recognition from three renowned organisations - WRI India, TERI and CII.

The programme builds comprehensive measurement and management strategies to reduce emissions and drive more profitable, competitive and sustainable businesses and organisations in India. The India GHG Program offers businesses public visibility and specialised incentives through improved efficiency and profitability. The India GHG Program also offers businesses opportunities to engage with industry, sectoral and regional peers on a single platform and access to policy makers and civil society to initiate dialog on actions businesses take and challenges they face in reducing GHG emissions. Thus, India GHG Program address the needs to mitigate economic, social and environmental risks while helping businesses remain profitable, competitive and sustainable.

P V Kiran Ananth
Senior Counsellor
kiran.ananth@cii.in

Dr Shalini Sharma
Senior Counsellor
sharma.shalini@cii.in

CII-Sohrabji Godrej Green Business Centre

Survey No. 64, Kothaguda Post, R.R. Dist.,
NearHITEC City, Hyderabad - 500 084.

Fax : +91 40 44185189

www.greenbusinesscentre.com

Programme is supported by :



Federal Ministry for the
Environment, Nature Conservation
and Nuclear Safety



PIROJSHA GODREJ FOUNDATION

based on a decision of the Parliament
of the Federal Republic of Germany