# Carbon Neutrality of Cement Plant

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## Abstract

*Among the foremost environmental challenges that the world is facing today are the issues of global warming and climate change. Emission of greenhouse gases is a major contributor to these issues. To minimize energy consumption and thereby reduce emissions of greenhouse gases, it is very important to ensure source identification for achieving the goal towards sustainable development.*

*Carbon footprint measurement is an effective tool used to calculate the greenhouse gas emissions and its effect on the environment. Objective: This study aims to assess the carbon footprint generated by various emission sources and suggest suitable methods for reducing it. Methodology: Greenhouse gas emissions for an entity in terms of tones of equivalent CO2 generated per year is reported using three basic steps including accounting the data, calculation and estimation of CO2 emitted. The carbon footprint is estimated by accounting direct emission from sources owned / controlled by the entity (scope 1), from indirect emission including essential activities (scope 2) and other outsourced distributions (scope 3). These emissions are converted to CO2 equivalent values taking into account their respective emission factors.*

*Finally, the total CO2 emissions for an entity will be estimated. Direct emissions: Activities of the entity that release emissions straight into the atmosphere. They are direct emissions. Examples of scope 1 emissions include emissions from combustion in furnaces, vehicles etc. Energy indirect: Emissions being released into the atmosphere associated with our consumption of purchased electricity, heating and cooling.*

*These are indirect emissions that are a consequence of activities, but which occur at sources outside the entity. Other indirect: Emissions that are a consequence of our actions, which occur at sources which we do not control, and which are not scope 2 emissions. Examples of scope 3 emissions are travel by means that are not owned, waste disposal, or purchased materials or fuels.*

**Keywords:** *Emissions, greenhouse, global warming, CO2, equivalent values.*

## I Introduction

The company selected for Research & Development (R&D) project is a cement industry, named JSW Cement Limited having manufacturing plant in Maharashtra. JSW cement believes that growth needs to be sustainable and is consciously contributing to creating a self – reliant India. It contributes by manufacturing the building blocks of the Indian development story with its world class cement

JSW entered the cement market in 2009 with a vision to ensure a sustainable future for the country by producing eco-friendly cement, using industry by-products such as slag. JSW cement produces Portland Slag Cement (PSC), Ordinary Portland Cement (OPC), and Ground Granulated Blast Furnace Slag (GGBFS) by utilizing the slag from the JSW Steel plants to produce eco-friendly green cement. By converting industrial by-product into a useful product, it has reduced the carbon footprint of the group. Not only does the ensure optimal utilization of resources but also saves the ecological risk of industrial by-product dumping.

JSW Cement Limited, Khar Karavi, Tal: Pen unit an ISO 9001:2008, ISO 14001:2004, OHSAS 18001:2007 and EnMS 50001:2018 certified company. The company has separate environment department which is taking care of environmental sustainable development not only for the company but also responsible for the surrounding community.

The company has separate environment policy in which vision, mission, goal and implementation strategies well spelt out in the policy document. The plant has displayed all relevant information such as list of, Process Parameters, List of the Raw Materials which are being used for the cement manufacturing, List of the Fuels, Energy consumption pattern, APCS equipment list with the capacity, New imitative for the sustainable development Management is the well aware about the importance of the sustainable development and they take keen interest in

implementation of the objectives stated therein.

The plant has installed latest equipments which are energy efficiency and helpful for carbon neutrality. All conventional lights have been replaced with LED light to reduce the carbon neutrality. The company has set the time bound target to manufacture sustainable product. The preventive maintenance is well scheduled so that power consumption can be reduced and carbon neutrality goals can be achieved. All Air pollution control equipments are designed and installed in a such a manner by which minimum wastage of the raw materials. Third party audit is being conducted on regular intervals so that continual improvement can be happened and carbon neutrality targets can be achieved within the set time frame

Carbon neutrality means having a balance between emitting carbon and absorbing carbon from the atmosphere in carbon sinks. Removing carbon oxide from the atmosphere and then storing it is known as carbon sequestration. In order to achieve net zero emissions, all worldwide greenhouse gas (GHG) emissions will have to be counterbalanced by carbon sequestration.

## II Methodology

Carbon-neutral status can be achieved in two ways, although a combination of the two is most likely required:

**1. Carbon offsetting**

Balancing carbon dioxide emissions with carbon offsets — the process of reducing or avoiding greenhouse gas emissions or removing carbon dioxide from the atmosphere

to make up for emissions elsewhere. If the total greenhouse gases emitted is equal to the total amount avoided or removed, then the two effects cancel each other out and the net emissions are 'neutral'.

**2. Reducing emissions**

Reducing carbon emissions can be done by moving towards energy sources and industry processes that produce less greenhouse gases, thereby transitioning to a low-carbon economy. Shifting towards the use of renewable energy such as wind, geothermal, and solar power, as well as nuclear power reduces greenhouse gas emissions. Although both renewable and non- renewable energy production produce carbon emissions in some form, renewable sources produce negligible to almost zero carbon emissions.

Transitioning to a low-carbon economy would also mean making changes to current industrial and agricultural processes to reduce carbon emissions, for example, diet changes to livestock such as cattle can potentially reduce methane production by 40%. Carbon projects and emissions trading are often used to reduce carbon emissions, and carbon dioxide can even sometimes be prevented from entering the atmosphere entirely (such as by carbon scrubbing).

**3. Process**

Carbon neutrality is usually achieved by combining the following steps, although these may vary depending whether the strategy is being implemented by individuals, companies, organizations, cities, regions, or countries

Large well-known companies like Apple are laying out roadmaps to help these commitments become a reality. Then lesser well-known companies like Kinesis, a supply chain management company, met their net-zero goal in 2020 by fully committing to their carbon emission objectives.

**4. Counting and analysing**

Counting and analysing the emissions that need to be eliminated, and how it can be done, is an important step in the process of achieving carbon neutrality, as it establishes the priorities for where action needs to be taken and progress can begin being monitored. This can be achieved through a greenhouse gas inventory that aims to answer questions such as:

Which operations, activities and units should be targeted?

Which sources should be included (see section Direct and indirect emissions)? Who is

responsible for which emissions?

Which gases should be included?

For individuals, carbon calculators simplify compiling an inventory. Typically, they measure electricity consumption in kWh, the amount and type of fuel used to heat water and warm the house, and how many kilometres an individual drive, flies and rides in different vehicles. Individuals may also set the limits of the system they are concerned with, for example, whether they want to balance out their personal greenhouse gas emissions,

their household emissions, or their company's.

**5. Action**

In starting to work towards climate neutrality, businesses and local administrations can make use of an environmental (or sustainability) management system or EMS established by the international standard ISO 14001 (developed by the International Organization for Standardization). Another EMS framework is EMAS, the European Eco Management and Audit Scheme, used by numerous companies throughout the EU.[citation needed] Many local authorities apply the management system to certain sectors of their administration or certify their whole operations.

**6. Reduction**

One of the strongest arguments for reducing greenhouse gas emissions is that it will often save money. Examples of possible actions to reduce greenhouse gas emissions are:

Limiting energy usage and emissions from transportation (walking, using bicycles or public transport, avoiding flying, using low-energy vehicles, carpooling), as well as from buildings, equipment, animals and processes.

Obtaining electricity and other forms of energy from zero or low carbon energy sources.

Electrification: using electrical energy, ideally from non-emitting sources, rather than combustion. For example, in transportation (e.g., electric vehicles and electric trains) and heating (e.g. heat pumps and electric heating).

Wind power, nuclear power, hydropower, solar power, and geothermal are the energy sources with the lowest life-cycle emissions, which includes deployment and operations.

**7. Offsetting**

The use of Carbon offsets aims to neutralize a certain volume of greenhouse gas emissions by funding projects which should cause an equivalent reduction of greenhouse gas emissions somewhere else, such as tree planting. Under the premise “First reduce what you can, then offset the remainder”, offsetting can be done by supporting a responsible carbon project, or by buying carbon offsets or carbon credits.

Carbon offsetting is also a tool for several local authorities in the world.

In 2015, the United Nations Framework Convention on Climate Change (UNFCCC), following the mandate of the CDM Executive board, launched a dedicated website where organizations, companies, but also private person are able to offset their footprint (https://offset.climateneutralnow.org/) with the aim of facilitating everyone's participation in the process of promoting sustainability.

**8. Evaluation and repeating**

This phase includes evaluation of the results and compilation of a list of suggested improvements, with results documented and reported, so that experience gained of what does (and does not) work is shared with those who can put it to good use. Science and technology move on, regulations become tighter, the standards people demand go up. So the second cycle will go further than the first, and the process will continue, each successive phase building on and improving on what went before.

**9. Direct and indirect emissions**

To be considered carbon neutral, an organization must reduce its carbon footprint to zero. Determining what to include in the carbon footprint depends upon the organization and the standards they are following.

Generally, direct emissions sources must be reduced and offset completely, while indirect emissions from purchased electricity can be reduced with renewable energy purchases.

Direct emissions include all pollution from manufacturing, company owned vehicles and reimbursed travel, livestock and any other source that is directly controlled by the owner. Indirect emissions include all emissions that result from the use or purchase of a product.

**10. Simplification of standards and definitions**

Carbon neutral fuels are those that neither contribute to nor reduce the amount of carbon into the atmosphere. Before an agency can certify an organization or individual as carbon neutral, it is important to specify whether

indirect emissions are included in the Carbon Footprint calculation. Most Voluntary Carbon neutral certifiers in the US, require both direct and indirect sources to be reduced and offset. As an example, for an organization to be certified carbon neutral, it must offset all direct and indirect emissions from travel by 1 lb CO2e per passenger mile, and all non-electricity direct emissions 100%. Indirect electrical purchases must be equalized either with offsets, or renewable energy purchases. This standard differs slightly from the widely used World Resources Institute and may be easier to calculate and apply.

## III Result and Discussion

1. Scope-1 CO2 emissions were calculated using WBCSD CSI V3.1 protocol.
2. Scope-2 CO2 emissions were calculated using CO2 Baseline Database for the Indian Power Sector - Version 18.0 – We have considered "combined margin" emission factor while calculating the CO2 emissions.
3. For scope 3 calculations - WRI, Emission factor from cross sector tool (Apr 2014), GHG protocol, and publically available database was used.

Per ton TCo2 in the FY 2023-24 details is as follows:

| Per ton $TCO_2$ in the FY 2023-24 | | | |
|---|---|---|---|
| Total production | Scope 1 | Scope 2 | Scope 3 |
| 1840054 | 18630 | 63466 | 3 |

### 1. Scope #1 calculations

Activity: - Non – kiln fuels for drying
Fuel Type: - Coal – NA as we are using only BFG, COG, and HSD BF Gas (Blast Furnace Gas)
CO Gas (Coke Oven Gas HSD
(High Speed Diesel)
Fuel Quantity Consumed in the FY 2023- 2024 is as: -

| Sl. No. | Fuel Type | Fuel Qty. (NM3) | Calorific Value (Kcal/ NM3) | $TCO_2$ Factor (T $CO_2$/TJ) | Total $TCO_2$ (T) |
|---|---|---|---|---|---|
| 1 | BF Gas | 21284551 | 800 | 260 | =21284551*800*260*4.18/10^9=18505.64 |
| 2 | COG | 47208592 | 4100 | 260 | =47208592*4100*260*4.18/10^9= 210355.82 |
| 3 | HSD | 45704 | 8800 | 74.1 | =45704*8800*74.1*4.18/10^9=124.58 |

Table 4.2: Scope#1 Calculation Total $TCO_2$

= 18505.64+210355.82+124.58= 228986.04 T

### 2. Scope# 2 calculations

Activity: - Grid Electricity
Grid Electricity Consumed in the FY 2023-2024 is as: -

| Grid Electricity Consumption (KWh) | $TCO_2$ Factor ($TCO_2$/MWh) | Total $TCO_2$ (T) |
|---|---|---|
| 69742677 | 0.91 | =69742677*0.91/1000 = 63465.83 |

Table 4.3: Scope#2 Calculation $TCO_2$ from

Scope#2 during FY 2023-24 is 63465.83

### 3. Scope #3 calculations

Activity: - Out Bond Vehicles engaged in Raw Materials to bring inside the plant List of Raw Materials: - Clinker, Slag, Gypsum
Approximately distance travelled in Km – 3505.5 Km Average per litre – 3Km/lit
Total Diesel consumed to travel 3505.5 km is 3505.5/3 = 1168.5 Km/lit $TCO_2$ = 1168.5*8800*74.1*4.18/ 10^9 = 3.18 T

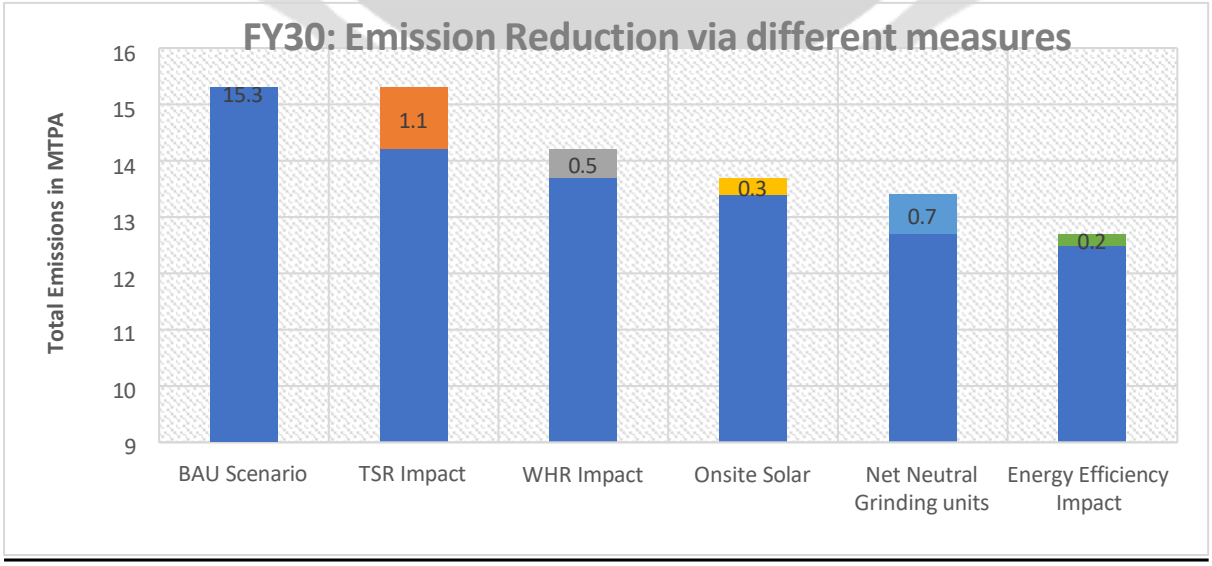
Total $TCO_2$ during the FY 2023 -24 is as: -

| FY | Scope 1 | Scope 2 | Scope 3 | Total $TCO_2$ |
|---|---|---|---|---|
| 2023-24 | 228986.04 T | 63465.83 T | 3.18 T | 292455.05 T |

The case study of this paper is the cement plant use, Macedonia's only cement plant. The Republic of Macedonia, a party of the United Nations Framework Convention on Climate Change (UNFCCC) since 1998 but as a candidate country for EU membership, it is committed to develop inventory of GHG, climate change mitigation and adaptation plans, to undertake climate change related observation and monitoring, research and development, education and public awareness, as well as to report regularly the national climate change activities in National Communications (Taseska et al., 2008).

The kiln process applied in the cement plant use is a dry rotary kiln, with four-stage cyclone pre-heater and a clinker cooler. Calciner is not used in this cement plant; however, the plant operator is planning to increase the cement production while decreasing the CO2 emissions. To ensure both criteria are satisfied, the plant operator plans to improve the kiln process by including the claimer in it.

The CO2 emissions reduction measures considered here are: (a) use of alternative fuels; (b) more efficient kiln process; (c) co-production of synthetic fuels. The selection of the measures was based on the criteria of the ability to decrease CO2 emissions compared to current practice, prospects for realisation, and level of difficulty of implementation. To compare the environmental effectiveness of each measure, the CO2 emissions for last five years from the cement plant use were calculated. The results (see Table 4.5) show that CO2 emissions from cement manufacturing in Macedonia, decreased sharply from 2007 until 2009, due to the decreased cement production during the economic crisis, and after 2009 when Macedonia's economy started to recover, the CO2 emissions from the cement production slowly increase.



The energy efficiency of a particular cement plant is evaluated in a way that the specific energy consumption of that particular cement plant is compared with the specific energy consumption of a benchmark. The specific energy consumption is also used to evaluate the improvements in the energy efficiency of the cement production process (Ali et al., 2011). The current average specific thermal energy consumption of a kiln process in the use cement plant is 3.7 GJ/t clinker. It can be noted that there is still space for certain improvement of the energy efficiency of the use cement plant, and that the next step in improving the energy efficiency would be the addition of a calciner prior to the rotary kiln.

## IV Conclusion

Reduction of CO2 emission in cement industry is one of the most important measures for achieving the EU climate targets for 2020 and beyond. The three considered measures were: Use of alternative fuels, More efficient kiln process, and Co-production of synthetic fuels. It should be noted that the recycling of CO2 into synthetic fuels will open the door to renewable energy in the cement industry sector. The integral CO2 emissions reduction potential of the three measures shows that approximately 0.2 million tons of CO2 can be avoided in 2020, which is around 1.7 % of Macedonia's current GHG emissions, or around 40 % of total CO2 emissions of the cement plant Use.

**Key Findings:**

**Carbon emissions projections**

| | **FY20** | **FY30** | **FY30*** |
|---|---|---|---|
| Cement Production (MTPA) | 4.6 | 40.3 | 40.3 |
| Net Scope-1+2 Emissions(MTPA) | 1.69 | 12.23 | 15.3 |
| Net Scope-1+2 Emissions Intensity (kg CO2/T Cement) | 367 | 303 | 380 |
| Net Scope-1 Emissions Intensity (kg CO2/T Cement) | 298 | 294 | 326 |
| Net Scope-2 Emissions Intensity (kg CO2/T Cement) | 69 | 10 | 54 |

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