

# Clean Development Mechanism: Case Assessment of Wind Power Site at Maharashtra

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**Keywords:** CDM, Sustainable Development, Economic, Clean, Wind, Power.

**Abstract:** A market-oriented approach aimed at addressing climate change, the clean development mechanism (CDM) aims to decrease greenhouse gas emissions. However, there exists an uneven distribution of these projects in developing nations, despite their increasing popularity. Consequently, it remains uncertain whether these projects genuinely make a substantial contribution to both environmental and economic sustainability in underdeveloped countries. To assess the impact of CDM on the sustainability of the Indian energy sector's development, this study conducts a comparison between several ongoing projects and widely recognized sustainable development criteria. The study's findings are then considered in light of future modifications on their policy. Leading governments throughout the world are currently placing a high priority on addressing the issues of how to combat climate change. After going through various reports published by the government and research papers, it has been ventured to highlight the CDM projects, processes and case analysis.

## 1 INTRODUCTION

### 1.1 Purpose and Scope of Study


Studies on CDM have made a point that is the Earth's ability to absorb carbon is limited and will eventually run out. GHG emissions are rising, even if they are dangerous to humanity at this point. Economic success and per capita GHG emission have been found to be highly connected. It is acknowledged that developing countries wouldn't be able to achieve their socio-economic objectives without any expand in GHG emissions. The Kyoto Protocol encompasses three primary mechanisms: the Clean Development Mechanism (CDM), Emission Trading, and Joint Implementation. This investigation places particular emphasis on the CDM. Within the realm of CDM, there is a notable emphasis on enhancing the profitability of wind energy production.


It's worth noting that a significant portion of CDM wind energy projects rely on power-generating equipment. However, the extent of the advantage

varies depending on the technology and the specific country. The central economic challenge lies in the considerably higher costs associated with energy generation in this context. When compared to other project categories, wind energy projects do not experience as substantial benefits from the CDM.

There are 1700 projects that are currently at an advanced stage of CDM project cycle accounting for 21% of all projects, hydropower projects at 19%, and wind energy at 12%. 59% of the portfolio of projects are related to renewable energy [kingdom of Saudi Arabia ,2006)]. Clean development activity involves for example: A rural project using wind powerplant. This project attracted the international investors from developed countries and received CER's for the emission reduction which is achieved. CDM make it simpler to reduce emissions globally. Institutions from the public and business sectors can join the CDM Compared to JI, rules for the CDM are a little stricter project must meet the host nation sustainability standards and cannot use ODA Funds.

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### 1.2 Basic Principles of CDM

An investor undertakes a project in a foreign country to reduce emissions and, in return, receives emission credits [Elsevier B.V.(2019)]. This project could involve establishing a new facility using renewable energy sources or upgrading an existing coal-fired power plant with advanced technology to improve efficiency.

These emission reductions are only granted if they go beyond reductions that would have occurred naturally without the project. This ecological "additionally" is evaluated against a baseline, which represents the emissions that would have occurred if the project had not taken place [UNFCC's,2003)].

Carbon emission reduction or carbon credits are the currencies used in this trade. one metric ton of carbon dioxide is equal to 1 unit of CER informally 1 CER is equal to 1 tons of CO2. Since they are now recognized as the intangible good, carbon credits can be exchanged on the commodities market. Certified Emissions Reductions or CERs are the currency used in the trading of carbon credits similar to stock certificates CER's come in the form of documents. The CDM Executive Board validates that initiatives in developing nations have diminished yearly emissions of one metric ton of carbon dioxide through the issuance of Certified Emission Reductions (CERs).

Table 1: Objectives and Limitations of CDM.

S.no.	Objectives	Limitations
1	Contribute to halting and prevention of climatic change	Weak environmental integrity
2	Assist developing countries in strategy development that is long lasting	High transaction cost and complex governance
3	Assist industrialised countries in reducing emissions	Risk of non-additionality

## 2 LITERATURE REVIEW

The Clean Development Mechanism (CDM) is a process established under the United Nations Framework Convention on Climate Change (UNFCCC) to promote clean and sustainable

development in developing countries. Its primary objective is to assist these countries in achieving sustainable development while also reducing greenhouse gas emissions. The CDM allows developed countries that have emission reduction commitments (known as Annex I countries under the UNFCCC) to invest in emission reduction projects in developing countries [UNFCC's,2003)].

Table 2: Literature Review.

Author(s)	Details	Year
Surendran Subrayan Pillay	Clean Development Mechanism (CDM) is a market-based climate change instrument used to reduce emissions of greenhouse gases and have become popular in many developing countries [Surendran Subrayan Pillay(2015)].	2015
Semida silveria	The CDM project can be developed by public or private entities. The objective is to create a clear line of procedures so that participation is facilitated, and CERs can become internationally accepted and tradeable [Semida silveria(2005)].	2005
Johannes urpelainen	The Clean Development Mechanism (CDM), a partnership tool founded under the Kyoto Protocol, grants potential opportunities to help developing countries achieve sustainable development [Johannes urpelainen(2013)].	2013

## 3 PROCESS OF CDM

CDM is provided under article 12 of protocol which states that "The clean development mechanism's primary goal is to aid non-Annex I Parties in attaining sustainable development and supporting Annex I Parties in fulfilling their specified emission reduction commitments, thereby contributing to the Convention's overarching objectives [ UNEP DTU CDM/JI database, 2021)]."

An industrialized nation needs to convince the developing country hosting the Clean Development Mechanism (CDM) project that it will contribute to the host country's sustainable development goals before it becomes eligible to receive credits from the project. Additionally, the applicant must demonstrate, using methods approved by the CDM executive board, that the carbon project would not have been

implemented otherwise. This also involves creating a baseline that predicts future emissions in the absence of the registered project, as depicted in Figure 1 of the CDM project cycle [kingdom of Saudi Arabia, 2006].

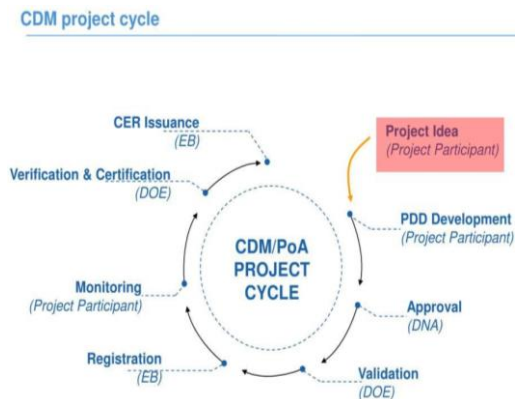


Figure 1: CDM project cycle.

### 3.1 Several Steps of CDM Process Involved in Indian Power Sector

#### Step 1: Project Identification

This means to identify a project that can potentially generate emission reductions, and this includes renewable energy projects, energy efficiency improvements etc. This entails investigating the energy industry figuring out where the greenhouse gas emissions come from and realizing the potential for sustainable growth. Projects that meet certain requirements are eligible for CDM funding. These requirements include additionality, which confirms the CDM support. The projects contribution to sustainable development scalability and alignment with the national interest may also be considered as in additional criteria [UNFCC, 2023]. Transparency, impartiality and conformity to the predetermined criteria are all the granted by this selection procedure.

This implementation phase which entails project design, funding arrangement, monitoring and reporting can begin after projects have been identified [Cassimon, D., M. Prowse and D. Essers, 2014]. The CDM offers a framework for project developers to gain the access to financial and technical assistance promote sustainable development and help effort to reduce global climate change.

In general, project identification in the CDM entails a thorough review stakeholder involvement setting eligibility criteria developing the reliable methodologies and help to reduce emissions.

#### Step 2: Project Design Document and Monitoring Plan Preparation

To seize the recognized opportunity, the project sponsor is required to compose a CDM project design document (PDD) using the PDD format officially approved by the CDM executive board. In general, sector specific strategies to earn carbon credit is further describe the broad categories of domains in which projects might be implemented [European Bank for Reconstruction and Development (2004)]. Initiative participants that inform readers about the project developer backgrounds and their duties. Indicate the project's host nation and any other participating nation. Describe how the initiative will help.

Demonstrating additionality in a project involves proving that the emissions reductions or removals achieved exceed what would have occurred without support from the Clean Development Mechanism (CDM). This involves identifying the financial, technological, and regulatory barriers that necessitate CDM assistance. Furthermore, outlining the monitoring techniques is crucial, detailing the procedures for assessing actual emission reductions and specifying the methods for data collection, measurement, and quality assurance. This ensures the accurate measurement of a project's environmental impact while avoiding any form of plagiarism. Describe monitoring intervals and reporting specifications.

#### Step 3: Additional Assessment

In order ascertain whether the proposed project leads to emissions reductions that wouldn't have occurred without it, additionality assessments are carried out. In simpler terms, these assessments determine if the project activities exceed what would have naturally occurred under normal circumstances. Part of this assessment involves examining the Baseline scenario, which represents emissions in the absence of the project. The emissions expected from the project's implementation are compared to this baseline to evaluate its additional impact. Various methods and tools, such as financial analysis, technological benchmarking, and industry-specific standards, are employed in this [Nobuhiro Sawamura, 2022].

Overall, the CDM's additionality assessment is an important step in making sure that emission reduction programs are actually aiding in sustainable development and reducing climate change. The CDM can give investors, host nations, and the international community assurance that the emission reductions achieved are reliable and deserving of being recognized with CERs by proving

additionality. specialists to supply a nitty gritty assess for your specific extend.

#### **Step 4: Validation**

Plans extend plan counting work portrayal, outflow base, add and other points of interest. Venture plan ought to take after rules endorsed by the CDM Official Board. DOE produces a confirmation report that incorporates discoveries and proposals with respect to qualification for CDM enrollment. The report was submitted to Official Board for review. On off chance that venture completes the approval prepare and meets all required criteria, it is enrolled by the CDM Official Board. Once enrolled, extend can produce Certified Emission Diminishments (CERs) for each ton of confirmed emanation decreases achieved.

It is worth noticing that the work of the CDM cycle isn't restricted to distinguishing proof, but to incorporates checking, recognizable proof and distribution of CERs. Another stage guarantees coherence of operations and guarantees straightforwardness and accountability. Validation of the CDM venture cycle is required to guarantee the keenness and unwavering quality of the CDM prepare. By taking after the confirmation handle, CDM points to guarantee that outflow lessening ventures are genuine, quantifiable and contribute to feasible improvement of the nation [Howard, Andrew, 2001)].

#### **Step 5: Project Registration**

The venture designer distinguishes a potential extend that can contribute to the decrease of nursery gas (GHG) outflows and economical improvement in creating nations individuals. The extend must take after CDM rules and procedures. Customary checking and investigation are carried out after the ponders are enlisted to guarantee outflow decreases. After confirmation, ventures will get Certified Emission Diminishments (CERs) that can be exchanged or utilized by creating nations to meet decrease commitments. It is worth noticing that CDM trade cycle proceeds after enrollment, counting normal checking, confirmation and reestablishment periods. Another step is to guarantee the unwavering quality and astuteness of the proposed emanation diminishment plan.

The CDM enlistment handle is complex and requires broad assessment by free organizations to guarantee that the extend contributes to economic improvement and meets the specified guidelines yes. Project sponsors are prompted allude to allude to the

CDM Rules, look for DOE back, and take after built up methods for fruitful enrollment.

#### **Step 6: Monitoring and Verification**

Monitoring and verification is basic portion of the Improvement Component (CDM) to guarantee the precision, straightforwardness and unwavering quality of outflow decreases detailed by enlisted CDM ventures. In case the certificate is affirmed by the CDM Controlling Committee, the extend is qualified for a Certificate of Emissions Lessening (CER) to approve the emanation diminishments accomplished amid support. CERs are relegated to producers and can be exchanged or utilized to meet discount commitments [Jiwan Acharya,2012)]. Regular observing and confirmation: CDM ventures will be checked and confirmed amid the crediting period.

Project engineers ought to proceed to gather and report data as laid out within the observing arrange. Customary surveys guarantee that outflows diminishments proceed to be exact and reliable. The CDM checking and confirmation prepare is planned to supply straightforwardness and responsibility and to guarantee that outflow decreases claimed by CDM ventures are solid and consistent with CDM standards. DOE's free certification makes a difference construct believe and certainty within the judgment of CDM ventures and their commitments to feasible advancement and climate alter.

#### **Step 7: Certified Emission and CER Calculation**

Within the Clean Advancement Program (CDM), the term "certificate" alludes to the arrangement of Certified Emission Diminishments (CERs) for CDM ventures. CERs speak to confirmation and approval of outflow diminishments accomplished by projects. Once a CDM extend has completed the checking and confirmation prepare and is found to meet moderation prerequisites, it'll be qualified for the issuance of CERs. The grant of CERs shows that the venture has decreased nursery gas (GHG) emanations and meets CDM requirements. CERs are issued by the CDM Official Board or a Assigned Working Organization (DOE) recognized by the Official Board. The number of CERs issued by the extend is decided based on real and confirmed outflow diminishments over the observing period .

After the CER calculation is total, the CDM Controlling Committee issues the CERs for the project. Project designers get CERs that can be utilized for a assortment of purposes, such as offsetting emanations, following a trade or exchange. The distribution of CERs gives unmistakable prove of

outflow diminishments accomplished through CDM ventures and serves to bolster and remunerate climate alter relief endeavors. CERs issued beneath the CDM have an compelling verification process to guarantee they are solid and straightforward within the carbon showcase.

#### 4 RESULTS AND ANALYSIS

Data and parameters fixed in Table 3 & 4 (TWEPL, 2013) which include operating margin, build margin etc.

Table 3: Data of operating margins and build margin.

Data/Parameter	$EF_{grid,OMsimple,y}$
Unit	tCO <sub>2</sub> /MWh
Description	Operating margin CO <sub>2</sub> emission factor for the project electricity system in the year y
Source of data	“CO <sub>2</sub> Baseline database for Indian power sector” version 8 (January 2013) published by the Central Electricity Authority, ministry of power, government of India
Value applied	NEWNE grid- 0.9723
Choice of data or Measurement methods and procedures	Operating Margin Emission Factor has been calculated using the simple OM approach in accordance with ACM0002 and “Tool to calculate the emission factor for an electricity system” Version 04.0.0. The generation weighted average of simple operating margins of the year 2009-10, 2010-11, 2011-12 have been used to calculate ex-ante OM.
Purpose of data	Calculation of baseline emissions
Additional comment	-
Data/Parameter	$EF_{grid,BM,y}$
Unit	tCO <sub>2</sub> /MWh
Description	Build Margin CO <sub>2</sub> emission factor for the project electricity system in the year y
Source of data	“CO <sub>2</sub> Baseline database for Indian power sector” version 8

	(January 2013) published by the Central Electricity Authority, ministry of power, government of India
Value applied	NEWNE grid- 0.9164
Choice of data or Measurement methods and procedures	Build Margin Emission Factor has been calculated using the simple OM approach in accordance with ACM0002 and “Tool to calculate the emission factor for an electricity system” Version 04.0.0. The ex-ante for the year 2011-12 has been used.
Purpose of data	Calculation of baseline emissions
Additional comment	-

Table 4: Data and Parameters of Combined Margin.

Data/Parameter	$EF_{grid,CM,y}$
Unit	tCO <sub>2</sub> /MWh
Description	Combined Margin CO <sub>2</sub> emission factor for grid connected power generation in the year y
Source of data	“CO <sub>2</sub> Baseline database for Indian power sector” version 8 (January 2013) published by the Central Electricity Authority, ministry of power, government of India
Value applied	NEWNE grid- 0.9583
Choice of data or Measurement methods and procedures	Combined Margin Emission Factor has been calculated ex ante as the weighted average CO <sub>2</sub> of the operating margin emission factor and build margin emission factor.

	In case of wind power projects default weights of 0.75 for operating margin and 0.25 are applicable as per ACM0002 version 14.0.0.
Purpose of data	Calculation of baseline emissions
Additional comment	-

**STEP 1: Method to Determine Operating Margin (OM) Emission**

The method relies on calculating the operational emission factor by considering the generation-weighted average of CO2 emissions per unit of net electricity production (measured in tCO2/MWh) from all power plants within the system, excluding those classified as low-cost or must-run units.

$$EF_{grid,OMsimple,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

Table 5: Simple OM used as low cost.

Net generation in OM(GWH)			
Region	2009-10	2010-11	2011-12
NEWNE	1590.00%	1760.00%	19.20%

**STEP 2: Calculate Operating Margin Emission**

Table 6: Simple operating margin emission factor.

Parameters	Units	2009-10	2010-11	2011-12
Simple OM emission factor	tCO <sub>2</sub> /MWh	0.978	0.971	0.969

Table 7: The OM emission factor for the NEWNE grid.

Financial Year	2009-10	2010-11	2011-12
NEWNE Grid Net Generation in OM	4,58,042	4,76,986	5,02,301
Net electricity import from southern (GWH)	0	0	0
Electricity import from other countries (GWH)	5,342.10	5,611.00	5,285.50

Net generation including import (GWH)	4,63,385	4,82,596	5,07,584
Simple operating margin (tco2/MWH)	0.9776	0.9706	0.9688
Weighted generation operating margin (EFgrid OMY)			0.9712

So, the final weighted generation operating margin is estimated that is 0.9712.

**STEP 3: The Build Margin (BM) Emission Factor**

The latest available data for establishing the emission factor margin during the PD submission relied on a small sample group. This group was composed of M energy systems, representing 20% of the total power plant capacity additions. These systems were chosen because they have been constructed most recently, and their annual generation, measured in MWh, surpasses that of the five most recently built power plants in the sample group.

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times FE_{EL,m,y}}{\sum_m EG_{m,y}}$$

Central Electricity Authority (CEA) of government of India has calculated the CO2 OM emission for in table 8.

Table 8: NEWNE grid and build margin calculated.

Parameters	Units	2008-09
Simple Build Emission Factor	tCO <sub>2</sub> /MWh	0.916

**STEP 4: The Combined Margin Emission Factor**

The baseline emission factor refers to the EF grid, which is determined by combining the operating argin emission factor (EF grid, OMy) and the build emission factor (EF grid, BMy) through a weighted average calculation.

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM}$$

This calculation involves using equal weights of 0.75 for operating margin emissions (WOM) and 0.25 for

build emissions (WBM), both expressed in tCO<sub>2</sub>/MWh, as described in steps 3 and 4.

Table 9: Calculation of Combined Margin.

	Simple Operating			Average OM	Build Margin	Emission factor (EF <sub>grid,CM,y</sub> )
	Margin (tCO <sub>2</sub> /MWh)					
	2009-10	2010-11	2011-12		2011-12	
Region						
South	0.978	0.971	0.969	0.972	0.916	0.958

So, combined margin is 0.958 in table 9.

**STEP 5: Calculate Baseline Emission Factor and Total Emission Reduction also Called CER Calculation in Table 10 & Table 11**

The provided electricity is used to calculate the baseline emissions. Grid connected electricity generated from renewable resources multiplied by an emission factor determined in a transparent and cautious manner, and then added to the grid. Version 14.0 of ACM002

$$BE_y = EG_{Facility,y} \times EF_{grid,CM,y}$$

The contrast between baseline emissions (BE<sub>y</sub>) and project emissions (PE<sub>y</sub>) during a given year y represents the emission reduction.

$$ER_y = BE_y - PE_y$$

Table 10: Calculate baseline emission factor.

RCR Eco Power Wind Power in Project in Tamilnadu	Project in maharashtra		
Parameters	Units	Value	Reference

Capacity of Windmill			
No of WTGs	No.	3	
Plant capacity	MW	52.8 MW	Purchase order
Generation and sale of energy			
Net generation	GWH	1453566	Calculated

Table 11: Calculation of total emission reduction.

Total Saleable units (EG <sub>y</sub> )	MWh	1453566	Calculated
Baseline Emission Factor (EF <sub>grid,CM,y</sub> )	tCO <sub>2</sub> /MWh	0.958	Refer 'EF <sub>grid,CM,y</sub> ' sheet
Baseline Emission (BE <sub>y</sub> )	tCO <sub>2</sub>	89085	Calculated
As L <sub>y</sub> = 0, E <sub>Ry</sub> = BE <sub>y</sub>			
Total Emission Reduction (ER <sub>y</sub> )	tCO <sub>2</sub>	89085	Calculated

So, total emission reduction is **89085**.

## 5 CONCLUSION

Forecasting the potential opportunities available to economically disadvantaged nations through the Clean Development Mechanism (CDM) is a complex task. Nevertheless, there are substantial reasons for optimism due to the CDM's substantial capacity to promote sustainable development and attract foreign investment. Its capacity to address local and regional environmental concerns and advance social objectives becomes evident with meticulous planning and the establishment of a national CDM strategy.

In situations where funding for greenhouse gas emission reduction measures might be constrained by

other developmental priorities, the CDM offers developing countries a pathway to engage in the global fight against climate change. The CDM acknowledges that only through enduring sustainable development.

A summary of present state of Clean Development Mechanism projects reveals that India has the second-largest number of projects record under the mechanism and biggest anticipated certified emission reductions, after China. As a result, India and Indian businesses have a fantastic opportunity to earn from carbon credits.

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