

Review of Clean Development Mechanism and use of Bundled Projects in Small and Medium Scale Enterprises

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Abstract

Carbon finance through the Clean Development Mechanism (CDM) offers significant opportunity to a developing country like India for an array of greenhouse gas (GHG) emission reduction projects. However, the transaction cost associated with the development of CDM project is a serious barrier to many small scale CDM (SSC) projects due to which these proponents face many difficulties in attracting international investors. To reduce this transaction cost, individual small projects with similar project context can be bundled together to form a single CDM project. These SSC bundled projects that reduce GHG emissions can claim Certified Emission Reductions (CERs) under the concept of bundling. This paper presents 98 bundled CDM projects registered and issued worldwide till October 2014, out of which India has 29 projects, along with a case study on small scale hydro-electric power generation project. The visited project is a good example of clean technology that helps to reduce stress on conventional energy sources and is an improvement of social and economic life of local people. Energy efficiency, grid connected electricity generation, fossil fuels switching, thermal energy production and methane recovery are some of the methodologies in these types of projects. These methodologies reduce GHG emissions without harming the environment.

Keywords: Clean development mechanism; Small scale projects; Bundled; Transaction cost

Introduction

CDM is an agreement under Kyoto protocol, which is a multilateral effort taken by United Nation Framework Convention on Climate Change (UNFCCC) to tackle climate change. It is meant to promote changes in the pattern of GHG emission intensive activities in developing countries as discussed in Kyoto, Japan on 11th December 1997 and entered into force on 16th February 2005. 192 countries have ratified the treaty to date. It aims to reduce the GHG emissions by 5.2 % against the 1990 levels over the first commitment period of five years 2008-2012 [1,2]. Now it has been extended for a second commitment period which is from January 2013 to December 2020. During the second commitment period, parties are committed to reducing their GHG emissions by at least 18 percent below 1990 levels in the coming eight year period from 2013 to 2020 [3]. As a part of CDM, the developed (Annex-I) countries have a target of GHG emission reduction [4]. In order to achieve this target developed countries invest in or finance projects that reduce emissions in developing countries (Non Annex-I) using clean technologies. After implementing these projects in developing countries, for every tone of CO₂ that does not enter into the atmosphere, a developing country earns one CER. These CERs can be further traded in international carbon market. Developed (Annex-I) countries exchange these CERs for money and technology transfer with Developing (Non-Annex-I) countries. Most of the demand for CERs from the CDM comes from the European Union Emissions Trading Scheme (EU-ETS) which is the largest carbon market. 93% of all the issued CERs come from five developing countries with maximum number of CDM projects. These are China, India, South Korea, Brazil and Mexico [5]. The Conference of Parties (COP), Executive Board (EB), Designated Operational Entity (DOE), Designated National Authority (DNA) are the important regulators in CDM. The COP is the supreme decision making body of the convention. EB supervises the CDM under the authority and guidance of the COP and reviews the regional/sub-regional distribution of the CDM project activities. It also maintains the registry of CDM projects and approves the methodologies for baseline and for monitoring project boundaries.

DOE is an independent auditor accredited by the EB to validate project proposals or verify whether implemented projects have achieved planned GHG emission reductions or CERs. DNA is the organization which has granted the responsibility to authorize and approve CDM projects in respected country. To attain CERs, project developer has to create first a Project Design Document (PDD) which requires the validation by the DOE, preferably by the DNA. Then it is sent to the EB for registration. After the registration, project can run in the developing (host) country. Monitoring is required for measuring CERs. The DNA then verifies and certifies the CERs which are finally issued by the EB. The project developer receives the certificate of CERs at this stage, which further can be sold out in the carbon market. CDM transaction costs are generally fixed. There are substantial diseconomies of scale that make it difficult for small projects to prove their financial viability [6-8]. The impact of such heavy cost warrants careful assessment of risks from potential buyers. Many investors, as well as administrators of carbon funds, would thus consider engaging into small scale CDM ventures only if the estimated potential credits exceed a minimum quota, depending upon their financial assessments. To conquer this, multiple small scale projects of the same type could be bundled together to form a single CDM project. Bundling of small scale projects is better option as it reduces overall costs for the administration of the CDM.

CDM Bundled Projects

Project activities with a maximum output capacity equivalent of up

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Received September 15, 2015; Accepted September 28, 2015; Published October 05, 2015

Citation: Naik M, Singh A, Unnikrishnan S, Naik N, Nimkar I (2015) Review of Clean Development Mechanism and use of Bundled Projects in Small and Medium Scale Enterprises. Int J Waste Resour 5: 184. doi: [10.4172/2252-5211.1000184](https://doi.org/10.4172/2252-5211.1000184)

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to 15 megawatts are termed as small scale CDM projects (SSC). SSC projects can be bundled at various stages as PDD preparation, validation, registration, monitoring, and verification [9,10]. The requirements for bundling of SSC projects include: projects should be of the same type, within the same geographical area, at the same stage of development and be bundled by one organization [11]. Further, project activities in a bundle can also be divided in to a series of sub-bundles, provided that each sub-bundle should belong to same type of project activity [12]. Having the same crediting period and composition of bundles shall not change over a period of time. At registration, all project participants have to submit an agreement about their individual project activities to be bundled and their proposed bundling agency should represent all project participants in order to communicate with EB [28]. After implementation of a project, an overall monitoring plan that monitors performance of the constituent project activities further verifies or certifies the emission reductions achieved [13]. A single DOE certifies achieved emission reductions in terms of CERs. So the advantage is that a single validation and certification report for the entire bundle can be obtained, which streamlines these processes for project participants [14]. Bundling of projects could help in achieving a critical mass that would attract financing from lenders. Another advantage in this approach is the sharing of CDM and financing transaction costs among individual projects which could be prohibitive or even create a negative leverage if the transaction is made for a single project [15]. Sometimes it is important to distinguish between a large-sized CDM project and a bundle of small CDM projects because few large sized CDM projects with intension to use the simplified modalities and procedures, and reduce transaction costs may split large projects into two or more small projects. Therefore, the de-bundling of a large project into smaller projects in order to be able to use the simplified procedures is not allowed [16]. As a result of this EB approved a set of criteria to screen out these types of projects to check that a small project truly is a small-scale CDM project by showing that it is not closely related to or integrated with another small-size project. In a bundle, single entity acts on everyone's behalf with lower transaction cost and single monitoring report and allows small scale projects access to carbon market and allows it to benefit from carbon finance. These smaller bundled activities are effectively promoting local sustainable development in impoverished areas of developing countries. This paper provides an insight into these bundled projects which are registered and issued by CDM EB in order to achieve emission reduction in small scale projects. The paper also represents a case study related to small scale CDM bundled project which involves hydroelectric power generation from the water reservoir made available for irrigation. The project was analyzed as it is efficient and environmentally safe technology for power generation.

Results and Discussion

World

Figure 1 and Table 1 describe the country wise distribution of the registered CDM bundled projects. A total of 98 CDM bundled projects are registered and issued till July 2014. These projects are categorized on the basis of renewable energy sources used. India is having maximum number of CDM bundled projects (29 numbers), out of which 24 projects deal with wind power, 2 projects are biomass based, 2 projects relate to hydro power and 1 project is on energy efficiency. Next to India, China has 26 projects, out of which 23 are power related and 3 are based on other renewable energy sources. 18 and 13 projects in Brazil and Mexico respectively are based on biomass energy. Republic of Korea has

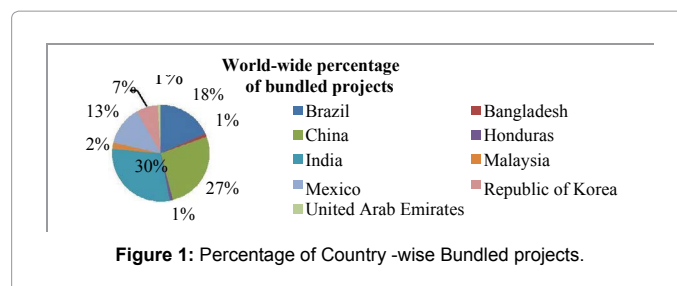


Figure 1: Percentage of Country -wise Bundled projects.

7 projects out of which 3 are based on hydro power, 1 on wind power, 1 is related to fuels switching and 2 projects are other renewable energy sources. Malaysia has 2 projects; out of which 1 is based on hydropower and other is biogas based project. Honduras has only 1 project based on biomass energy. Attracting investment to developing countries is a major goal of CDM. United Arab Emirates has 1 project on Energy efficiency. China, India, Brazil, Mexico and Malaysia are the top five countries with maximum number of registered CDM projects and number of issued CERs. These few developing countries are projected to emit more at a faster rate than the industrialized world and the rest of developing countries as these are at the stage of rapid industrialization [17,18]. Climate change mitigation projects can reinforce these countries pursuit to a low carbon path of development. Actual emission reduction is the achieved CERs which is the ratio of total CDM credits over a country's actual carbon emissions. It is the expected emission reduction achieved through CDM projects compared to a country's actual carbon emissions (Table 2). It gives a rough idea of the domestic emission reduction efforts via CDM and how much the CDM projects can contribute to national emission reduction efforts in a given country [19]. Up to July 2014, India has issued maximum number of CERs (1,296,695 metric tons) followed by China issuing 1,175,550 metric tons of CERs. Brazil and Mexico have issued 601,089 and 317,835 metric tons of CERs respectively. Republic of Korea and Malaysia have so far issued 137,485 and 109,485 metric tons of CERs respectively; United Arab Emirates has issued 2,004 metric tons of CERs. Honduras has so far issued 89,443 metric tons of CERs with maximum CER issuance rate (104.9%).

Renewable bundled projects

The CDM can also interface with renewable energy development to build up the capacity in the developing countries for renewable energy including wind, solar, biomass and hydro. The growth in CER issuance will be driven by capacity additions in the renewable energy sector and by the eligibility of more renewable energy projects to get CERs. Table 3 presents CERs issued under such renewable energy source used in CDM bundled projects across the world and in India respectively. Figure 2 presents renewable energy sources used in worldwide bundled projects. Out of total 98 bundled projects, 33 projects are based on biogas with 940,352 metric tons of CERs issued followed by 29 hydro power projects with maximum issued CERs of 1,393,979 metric tons. 25 projects are based on wind power with 928,386 metric tons. 5 projects are based on other renewable energy sources with 39,999 metric tons of issued CERs. Energy efficiency has 3 projects with 60,494 metric tons of issued CERs. 2 projects are based on biomass with 242,911 metric tons of CERs. Fuel switch have 1 project with issued CERs 6,290 metric tons.

Methodologies

Methodologies used in CDM projects help to reduce GHG emissions into the atmosphere without harming the environment. The function of

Sr. no.	Country	No. projects	Type of projects (No. of Projects)	Methodology used	CER Issued	CER Issuance Rate
1	Brazil	18	Biogas (18)	AMS III.D	601,089	53.4%
2	Bangladesh	1	Energy efficiency (1)	AMS-II.D	17,403	21%
3	China	26	Hydropower (23)	AMS. I.D	1,175,550	68%
			Other renewable energy (3)	AMS. I.D		
4	Honduras	1	Biogas (1)	AMS-I.D.	170,654	117.6%
5	India	29	Wind power (24)	AMS-I.D.	1,296,695	71.3%
			Biomass (2)	AMS-I.C. AMS-I.D.		
			Hydro (2)	AMS-I.D		
			Energy efficiency (1)	AMS-II.D		
6	Malaysia	2	Hydro (1)	AMS-I.D	109,485	85.60%
			Biogas (1)	AMS-III.H.		
7	Mexico	13	Biogas (13)	AMS-III.D.	317,835	34.70%
9	Republic of Korea	7	Hydro power(3)	AMS-I.D.	137,485	78.5%
			Wind power (1)	AMS-I.D.		
			Fuel switch (1)	AMS-III.B.		
			Other renewable energy (2)	ACM0002, AMS-I.D.		
10	United Arab Emirates	1	Energy efficiency (1)	AMS-II.D	2,004	20.9%
		98			3,828,200	

Table 1: Country-wise CDM Bundled Projects.

Sr. No.	Name of CDM Project Activity	State	Other Parties Involved	Project Participants (Authorized by Host Party)	Project Participants after registration (Authorized by other Parties involved)	Type of Project	Methodology	CER Issuance Audits	Total Issued CERs	Total Verified Days	CER Issuance Rate
1	8.75 MW Wind Power Project	Gujarat	Japan; Switzerland	Rolex Rings Private Ltd.	Emergent Ventures India Pvt. Ltd.; Mitsubishi Corporation	Wind power	AMS-I.D.	3	44,159	1,601	64%
2	12 MW Bundled Wind Power Project	Tamilnadu	Switzerland	NEG Micon (I) Private Ltd.	Vestas Wind Technology India Private Limited	Wind power	AMS-I.D.	2	54,732	1,027	82%
3	Bundled 15 MW Wind Power Project in India	Karnataka, Tamilnadu and Maharashtra	Spain; Sweden	GNA (HUF), Ferromar Shipping Private Ltd.	Kingdom of Spain (withdrawn); Swedish Energy Agency (withdrawn)	Wind power	AMS-I.D.	3	127,864	1,984	67%
4	3.7 MW Bundled Wind Power Project at Priyadarshini Polysacks Ltd.	Maharashtra	UK	Priyadarshini Polysacks Ltd.	The CarbonNeutral Company Limited	Wind power	AMS-I.D.	6	28,404	2,193	61%
5	13.4 MW bundled wind power project	Karnataka	Norway; Switzerland	NEG Micon (I) Private Ltd.	The Norwegian Ministry of Finance; Vestas Wind Technology India Private Limited	Wind power	AMS-I.D.	3	125,015	2,033	102%
6	11.2 MW Wind Power project	Tamilnadu	Switzerland	Amarjothi Spinning mills Ltd.	Vitol S.A.	Wind power	AMS-I.D.	2	158,386	2,555	92%
7	7.85 MW Bundled Wind Power Project in Southern India	karnataka and Tamilnadu	Switzerland	Vandana Ispat Ltd.	Bunge Emissions Fund Limited	Wind power	AMS-I.D.	1	16,494	385	66%
8	Bundled 3.0 MW Wind Energy Project	Tamilnadu	Switzerland	M/s Bhagyodaya Agencies	Emergent Ventures India (Pvt) Ltd.	Wind power	AMS-I.D.	1	10,373	750	68%
9	8.75MW Bundle Wind Power Project	Maharashtra	--	M/s Shahi Export Pvt. Ltd	--	Wind power	AMS-I.D.	1	32,977	976	59%
10	4 MW Bundled Grid Connected Wind Power Project	Tamilnadu	Spain	Pushpit Steels Private Ltd. ; V. S. Steel and Power Private Ltd. ; Garg Iron & Energy Private Ltd.	Zero Emissions Technologies S.A.	Wind power	AMS-I.D.	2	19,180	1,102	76%

11	7.2 MW Wind Project at Chitradurga	Karnataka	Japan	Mysore Mercantile Company Ltd.	Mitsubishi UFJ Morgan Stanley Securities Co., Ltd.	Wind power	AMS-I.D.	5	62,478	1,796	88%
12	8.5 MW Wind Energy Project by KS Oils Limited, India	Madhya Pradesh and Gujarat	Switzerland	K.S. Oils Ltd.	Emergent Ventures India Pvt. Ltd.	Wind power	AMS-I.D.	3	35,827	962	81%
13	2.5 MW Bundled Wind Power Project	Maharashtra	--	Raj Infrastructure Development, (India) Pvt. Ltd.	--	Wind power	AMS-I.D.	2	6,319	750	77%
14	Bundled Wind Power Project	Tamil Nadu	Switzerland	Jocil Ltd The Andhra Sugars Ltd	Bunge Emissions Fund Limited	Wind power	AMS-I.D.	2	57,479	765	80%
15	5.5 MW Bundled Wind Power Project by WMI Cranes Ltd.	Maharashtra, Gujarat and Tamil Nadu	Switzerland	WMI Cranes Ltd.	RWE Supply & Trading Switzerland S.A.	Wind power	AMS-I.D.	1	7,991	565	45%
16	7.5 MW bundled small-scale wind projec	Maharashtra	Spain; Sweden	Modelama Exports Ltd.	Kingdom of Spain (withdrawn); Swedish Energy Agency (withdrawn)	Wind power	AMS-I.D.	3	26,900	981	76%
17	9.75 MW Bundled wind power project	Kerala	--	Zenith Energy Services (P) Ltd.	--	Wind power	AMS-I.D.	1	19,160	370	89%
18	Bundled Wind Power Project by M/s. D. J. Malpani	Karnataka and Gujarat	--	M/s. D. J. Malpani	--	Wind power	AMS-I.D.	1	22,285	631	114%
19	Wind Power Generation Project activity by Interocean Shipping India Private Limited	Maharashtra, Tamilnadu and Rajsthan	Switzerland	Interocean Shipping India Private Ltd.	EGL AG	Wind power	AMS-I.D.	1	10,292	370	46%
20	Cleaner Technology in Electricity Production	Tamil Nadu	--	Sheela Clinic	--	Wind power	AMS-I.D.	1	6,403	322	86%
21	Bundled Wind Power Project	Gujarat	--	Vish Wind Infrastructure LLP ; J. N. Investment & Trading Co. Private Ltd.	--	Wind power	AMS-I.D.	1	17,732	396	54%
22	4.75 MW Bundled Wind Power Project by Associated Stone Industries (Kotah) Ltd	Tamil Nadu, Karnataka and Maharashtra	--	Associated Stone Industries (Kotah) Ltd.	--	Wind power	AMS-I.D.	1	4,010	366	34%
23	9.9 MW Bundled Wind Power Project	Maharashtra	--	REI Agro Ltd.	--	Wind power	AMS-I.D.	1	14,017	385	58%
24	Bundled 9.00 MW Wind Power Generation Project by Gangadhar Narsingdas Agrawal Group	Maharashtra and Karnataka	--	Gangadhar Narsingdas Agrawal (HUF) ; Ferromar Shipping Private Ltd. (FSPL)	--	Wind power	AMS-I.D.	1	17,615	355	99%
25	2 X 5 MW Upper khauli & Drinidhar small hydroelectric project for a grid system	Himachal Pradesh	--	Vamshi Industrial Power Ltd.	--	Hydro power	AMS-I.D.	1	31,643	731	43%
26	10 MW Renewable Energy Project for a Grid	Himachal Pradesh	--	AT Hydro (P) Ltd. ; Cimaron Power Ltd.	--	Hydro power	AMS-I.D.	1	54,962	730	70%

27	7.5 MW biomass plants using agricultural waste Limited	Tamilnadu	Germany	Shriram City Union Finance Ltd. • Shriram Transport Finance Company Ltd. (Shriram nvestments Ltd.	KfW ('withdrawn)	Biomass	AMS-I.D.	2	190,303	1,362	63%
28	Renewable biomass based thermal energy generation at Mahalaxmi Group of Companies	Gujarat	--	Mahalaxmi Fabric Mills Private Ltd. (MFM) ; Mahalaxmi Rubtech Ltd. (MRT)		Biomass	AMS-I.C.	2	52,608	1,430	39%
29	Fuel efficiency improvement in glass melting	West Bengal, Union Territory of Pondicherry and Haryana	Switzerland	Hindusthan National Glass & Industries Ltd.	Mercuria Energy Trading SA	Energy efficiency	AMS-II.D.	1	41,087	1,096	90%
		29			17	29		55	1,296,695	28,969	71.3%

Table 2: The List of Bundled CDM Projects in India.

Renewable Energy Source	No. of Projects		No. of CERs issued	
	World	India	World	India
Wind power	25	24	928386	9,26,092
Biomass	2	2	2,42,911	2,42,911
Biogas	33	0	11,56,141	0
Hydro power	29	2	13,93,979	86,605
Fuel Switch	1	0	6,290	0
Energy efficiency	3	1	60,494	41,087
Other Renewable	5	0	39,999	0

Table 3: CERs issued with respect to Renewable energy sources in World (including India).

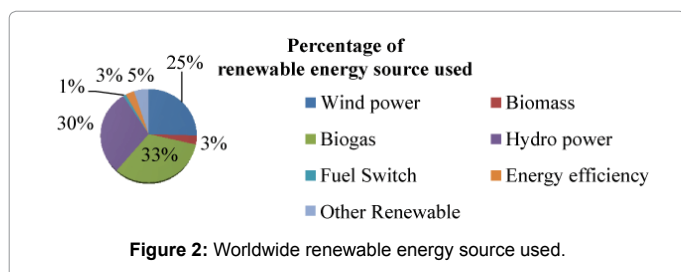


Figure 2: Worldwide renewable energy source used.

these methodologies is easy to grasp, but the methodologies themselves can be quite complex. These are necessarily diverse in their composition and application in order to accommodate the wide range of activities and areas covered by the CDM [20]. The CDM Executive Board approves all baseline-monitoring methodologies. It takes around 200 days between the submission of a new methodology and final decision on rejection; about 300 days are required to get the final approval decision [21]. Energy efficiency, renewable energy, landfill gas recovery, biomass and methane recovery [22] are the types of methodologies mostly used in simplified small scale projects which helps reduce the transaction cost of the project [23,24]. Table 4 and Figure 3 provides the list of all the methodologies that are used in all 98 bundled projects. Only 7 different methodologies were used in 98 bundled projects. All are approved small scale methodologies. Methodology “Grid connected renewable electricity generation” (AMS-I.D) contributes to 58 projects followed by “Methane recovery in animal manure management systems” (AMS-III.D) used in 31 projects. Methodologies “Energy efficiency and fuel switching measures for industrial facilities” (AMS-II.D.) contributes to 3 projects followed by “Thermal energy production with or without electricity” (AMS-I.C.) in 2 projects, “Grid-connected electricity generation from renewable sources” (ACM0002) were executed in 2

Sr. No.	Methodology	No. of Project	Name of the Methodology
1	AMS-I.D	58	Grid connected renewable electricity generation
2	AMS-II.D.	3	Energy efficiency and fuel switching measures for industrial facilities
3	AMS-III.D.	31	Methane recovery in animal manure management systems
4	AMS-I.C.	2	Thermal energy production with or without electricity
5	AMS-III.H.	1	Methane recovery in wastewater treatment
6	AMS-III.B.	1	Switching fossil fuels
7	ACM0002	2	Grid-connected electricity generation from renewable sources

Table 4: Methodologies used in worldwide Bundled CDM Projects.

projects. “Methane recovery in wastewater treatment” (AMS-III.H.) and “Switching fossil fuels” (AMS-III.B.) were implemented in 1 project each. Figure 4 shows methodology „Grid connected renewable electricity generation“ (AMS.I.D) was used in maximum number of projects. The methodology involves construction and the operation of a power plant that uses renewable energy sources and supplies electricity to the grid or retrofit, replacement or capacity addition of an existing power plant that uses renewable energy sources and supplies electricity to the grid (CDM Rule Book, 2013). It is an approved methodology for small-scale grid-connected renewable energy projects that have less than 15 MW threshold capacity [25]. This methodology is applicable to all type of projects that use renewable energy sources like wind, hydro, solar and biomass. Energy generated through CDM projects is supplied to the national grid which increases energy availability. This energy can be supplied to areas having shortage of electricity and help in reducing load on national and local grids as well as in community welfare.

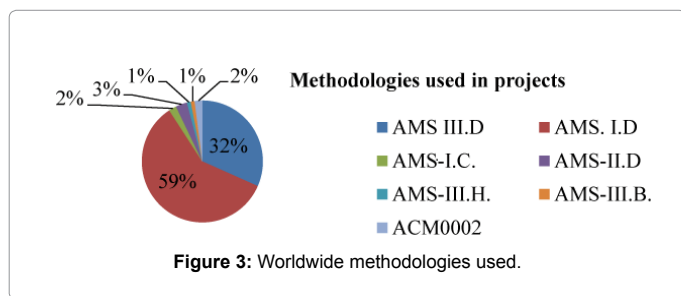


Figure 3: Worldwide methodologies used.

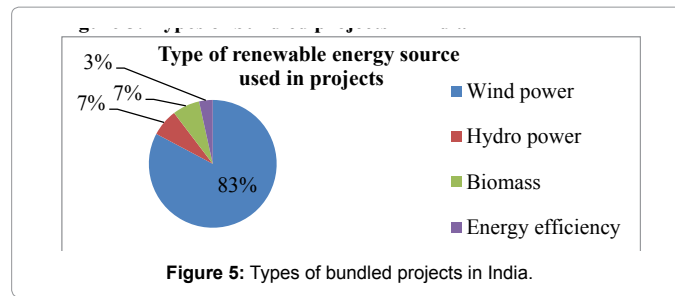


Figure 5: Types of bundled projects in India.

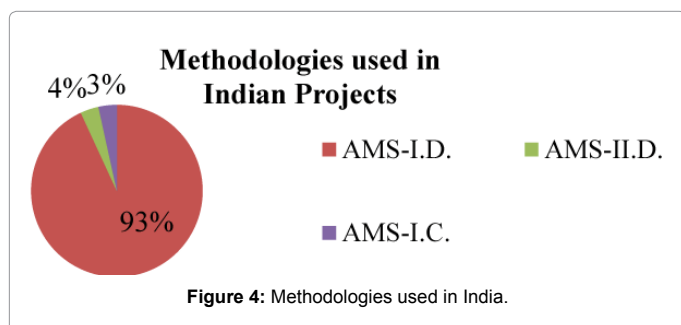


Figure 4: Methodologies used in India.

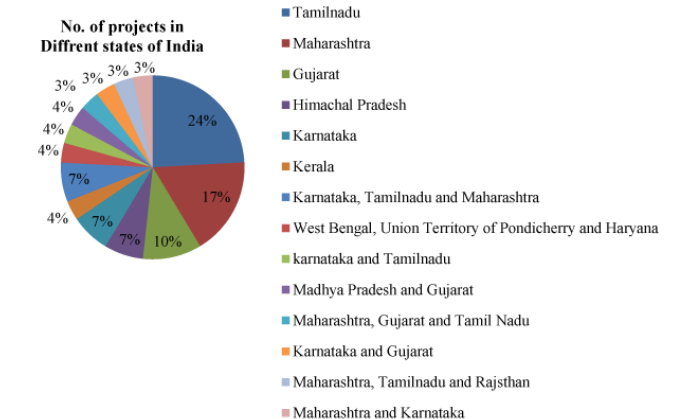


Figure 6: Bundled projects in different states of India.

India

India has a long dependency on traditional energy sources such as firewood, agricultural waste, animal dung etc., which are still continuing to meet the energy necessities especially in rural India. These traditional fuels are getting replaced by fossil fuels such as coal, petroleum and natural gas which are major cause of climatic change and air pollution. Thus, the focus of energy planners has shifted towards renewable resources like wind, solar, biogas for energy generation [26]. Table 2 presents the list of CDM bundled projects in India that use renewable resources and furnish the details of bundled project activities, such as project participants, use of renewable energy sources in the projects, methodologies used in these projects and estimated emission reduction per annum with respective number of issued CERs in the year 2014 for its total verified days and CERs issuance rate. India has 29 registered bundled projects till July 2014 having 1,296,695 metric tons of CERs issued with 71.3% issuance rate. In India bundled projects have been implemented in wind power, biomass based hydro power and energy efficiency sectors with the help of different methodologies. Figure 5 presents types of renewable energy source used in Indian bundled projects. Out of 29 bundled projects, 24 are based on wind power with 881,161 metric tons of issued CERs. 2 hydro power and biomass based project each with 54,962 and 242,911 metric tons of CERs respectively. 1 project is on energy efficiency with 41,057 metric tons of issued CERs. Wind power based projects have used AMS.I.D methodology with 926,092 CER issued with 73.5% CER issuance rate, biomass based projects implemented AMS.I.D and AMS.I.C methodologies with 242,911 CER issued with 50.8% CER issuance rate and energy efficiency used AMS.II.D methodology with 41,087 issued CER with 90% of CER issuance rate and hydropower based projects implemented AMS.I.D methodology with 86,605 CER issued with 56.5% of CERs issuance rate. Figure 6 represents number of bundled projects in different states of India. Karnataka, Tamil Nadu, Maharashtra, Gujarat, Madhya Pradesh, Kerala, Rajasthan, Himachal Pradesh, West Bengal, Haryana, Pondicherry are the states where bundled projects are being implemented. Out of 24 wind power

projects in India, maximum projects are carried out in Tamil Nadu (6) and Maharashtra (5) followed by Karnataka and Gujarat with 2 projects each and Kerala with only 1 project. Tamil Nadu and Gujarat each have 1 biomass based CDM bundled project. Himachal Pradesh has 1 hydropower based project. Within 29 projects in India, 5 projects have achieved below 50% CERs. 10 projects have achieved CERs between 50% - 70%. Other 10 projects have achieved CERs within 70-90%. Only 4 projects have achieved CERs more than 90%. In India maximum projects have used wind energy for power generation. These projects use wind energy for power generation thereby reducing usage of fossil fuel which leads to reduction of GHGs emission into the atmosphere. Wind turbine generators deployed in these projects ensure efficient and safe operation of the project activity. Thus the mechanism establishes technical expertise in countries with little prior experience, helping to incentivize increasing amounts of foreign investment (Hedger and Stokes, Undated). Grid-interactive power generated from renewable sources in the year 2013 was 4125 MW, out of which wind power generation was maximum 2500 MW, 350 MW power is obtained from Small Hydro Power and Bagasse Cogeneration each, 105 MW power is from Biomass & Gasification, Waste to power generation was 20 MW and power generated from solar energy was 800 MW [27].

Case Study

The visited project is the Dhom (Balkawadi) water reservoir which has capacity of 115.53 million cubic meters. It is built across flow of Krishna River in Balakwadi village, Wai Taluka, Satara district, Maharashtra state, India. The project is a 'bundled project activity' with a total installed capacity of 6.5 MW electricity generations. Projects are typical 'dam-toe' irrigation based river hydro projects with the installation of power house at the foot of an existing dam. The projects utilize irrigation discharges from the storage across river and surplus discharges through the spillway to generate electricity. The electricity



Figure 7: Total Catchment Area



Figure 8: Powerhouse



Figure 9: Penstock

is mainly supplied to co-operatives, industries, educational institutions and other sectors. The total catchment area (Figure 7) is around 42.77km². The length of the dam is 1.173 km. Dam serves the purpose of storing water for irrigation. Released water is stored downstream. The irrigation is from the submergence of Dhom backwaters. The water stored in the dam is released into the reservoir through tunnel. Project envisages the construction of a small powerhouse of (Figure 8) capacity 4 MW to be operated by the water released from the reservoir made available for irrigation. The annual net generation of the project is estimated at 9.37 MW [28]. A pipe between the surge tank and

prime mover and a butterfly wall, which is used to regulate the flow in a pipe, is called a penstock (Figure 9). Penstock is made of steel through reinforced concrete and usually equipped with the head gates at the inlet which can be closed during the repair of the penstocks. A sufficient water head should be provided above the penstock entrance in the fore bay or surge tank to avoid the formation of vortices. The butterfly valve consists of a disk built onto a rod, which when turned to the closed position completely stops the flow. When the butterfly valve is in the open position, the flow is nearly unrestricted. A turbine device with blades at one end and electromagnets at the other end, generates electricity as the blades moves. It consists of different parts viz. generator, shaft, and guard wheel. The online monitoring of electricity is done on continuously. The meters are capable of measuring the electricity parameters on real time basis. Data is archived in electronic form for two years after the end of the crediting period or of the last issuance of CERs. The generated electricity is connected to grid which supplies electricity to an identified consumer facility. On-site small scale renewable energy generation projects can produce significant clean energy, environmental, and economic benefits for a local government and the community. Hydropower is one of the highest renewable energy resources used after wind. Also, it contributes to grid stability by providing flexibility, as spinning turbines can be ramped up more rapidly than any other generation source [29]. Cited small scale hydro-power project is good example clean power generation. The project leads to conservation of resources as the power facility that would have come up in the absence of the conventional energy sources. It has the potential to shape the social and economic life of the local people by creating jobs on a regular and permanent basis and additional investment consistent with the needs of the local community. It is expected to accelerate the commercialization of grid connected renewable energy technologies such as small hydro in the market and thus, provide an alternative to the high-growth, coal-dominated business as-usual scenario.

Recommendation Suggested as per the Study

India is still depending on traditional energy sources to fulfill their energy needs. Whereas traditional energy sources are non-renewable and limited in supply also causes climatic change and air pollution. Thus, to minimize these effects energy-use pattern have changed towards renewable energy resources like wind, solar, hydro, biogas. Rapid deployment of renewable energy resources are resulting in significant energy security, climate change mitigation, and economic benefits. CDM can interface with renewable energy development projects to build up the capacity for renewable energy in developing countries. But small scale energy generation projects, which are typically found in less developed countries, face proportionally higher transaction costs. Therefore, approach in the concept of bundling of small scale CDM projects is to share CDM financing transaction cost between individual projects. Bundling of projects will facilitate the scaling-up of carbon finance business, while minimizing the transaction costs per unit emission reductions. Many small bundled and large scale renewable energy projects are serving as climate change mitigation projects. Also, these projects keep money circulating within the local economy and would reduce the need to spend money on importing coal and natural gas from other places. Thus, they projects have high potential to contribute local sustainable development, as these projects provide new opportunities for industries and economic activities to setup in the area thereby resulting in greater local employment, ultimately leading to overall development. With respect to renewable energy there are great opportunities for India as in emerging markets renewable energy potential is attracting foreign investment, generating new jobs and

creating local supply chains. Government of India is also promoting use of renewable energy through its National Action Plan on Climate Change. The renewable energy goals require continuous effort, strong implementation and improve utilization of capacity. Improvement in energy efficiency makes renewable energy source more affordable and attractive to finance source.

Conclusion

In recent years there has been increasing attention to the crucial issue of whether CDM has fulfilled its sustainable development objective. But the actual effects of CDM project activities on the host countries sustainable development at the national level are difficult to evaluate [30-33]. The global GHG emission reduction potential of such activities and empirical research is needed to identify and quantify actions that will yield the most emissions savings. Thus, the paper provides a probing insight into these small scale CDM project activities and their methodologies in order to achieve emission reduction. Small and medium scale industries occupy an important and strategic place in economic growth and equitable development in all the developing countries. Although CDM is devised to foster sustainable development, small scale CDM project activities which are known to be beneficial to the sustainable development of local communities, are often burdened with high costs and low returns. In order to leverage the development of small scale CDM projects, the UNFCCC introduced bundle concept. The concept is for the utilization of the CDM in simplified modalities and procedures for small-scale projects in order to secure carbon revenue for a community-scale. Small-scale project activities may be bundled up to the defined threshold level and eligible SSC project activities can be bundled to overcome transactions costs. By using bundle scheme, small projects can become cost effective and thus become sufficiently attractive with CER revenue.

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