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ORIGINAL ARTICLE

ASSESSMENT OF THE IMPACT OF CLEAN DEVELOPMENT MECHANISM (CDM) IMPLEMENTATION TOWARDS CO_2 EMISSION REDUCTION OPPORTUNITIES AT RURAL DOMESTIC ENERGY SECTOR IN TAMIL NADU

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ABSTRACT

This paper attempts to assess the impact of Clean Development Mechanism (CDM) implementation towards sustainable development and the CO_2 emission particularly in rural energy sector based on Inter Governmental Panel on Climatic Change (IPCC) guidelines. A detailed investigation was undertaken in the state of Tamil Nadu, in southern part of India to map the rural do mestic energy consumption pattern. The data collected was analysed that throws insight into the inter-relationships of the various parameters that influence domestic energy consumption. The results were used to estimate the feasible extent of CO_2 emission reduction through use of various energy resources. The analysis also provides a plot form for implementing Clean Development Mechanism (CDM) projects in the sector and related prospects with respect to the Indian scenario.

Keywords: Clean Development Mechanism (CDM), CO_2 emission, Energy Consumption pattern

1.INTRODUCTION

One of the important responses of Kyoto Protocol towards mitigation of global warming is Clean Development Mechanism (CDM) that has garnered large emphasis amidst t he global carbon market in terms of Certified Emission Reductions (CER). While Clean Development Mechanism (CDM) aimsto achieve sustainable development in energy production and consumption in developing cou ntries, the results achieved through its implementation are still uncertain. More than four hundred studies have been und ertaken since 1997 with respect to Clean Development Mechanism (CDM). However, the contribution of these studies towards effective implementation of Clean Development Mechanism (CDM) at regional level and thereby reap the benefits of sustainable development has been ill addressed (Nath,2008).

India as a rapidly developing nation has an enormous potential to benefit from Clean Development Mechanism (CDM). The projects pertainings to Clean Development Mechanism (CDM) imp, is expected to encourage private investments owing to the high rate of financial returns. Indian economic growth at the present rate points to a huge increase in energy usage in both industrial and domestic sectors. However, studies and modeling in designing policies to address the related issues needs to be undertaken rigorously. In this study, it is attempted to assess the potential to improvise rural domestic energy efficiency, especially in the domestic secotr and investigate measures that can be framed as projects under the Clean Development Mechanism (CDM).

India, a developing nation has long depended on traditional energy resources such as firewood, agricultural wast e, animal dung and human power which are still continuing to meet the bulk of energy requirements, particularly in rural India. Presently, these traditional fuels are gradually getting replaced by commercial fuels such as coal, petroleum, natural gas and electricity. With the recognition of fossil fueldsbeing the major cause of climatic change and air pollution, the focus of energy planners has shifted towards renewable resources and energy conservation (Pachauri and Spreng, 2002).

2. ENERGY SCENARIO IN INDIA

"India experiencing a GDP growth rate of 8% per annum, putting tremendous pressure on the power sector of the country". The deficiency in the supply of energy is generally met through imports from other countries. The Indian energy scenario shows a float in the energy balance mainly due to the differed energy sources in India. The country confronts fulgurous challenges in meeting its energy

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needs and providing adequate energy both in terms of sufficient quality and quantity to users in a sustainable fashion and at tenable costs. If the energy production pattern is analysed, coal and oil account for about 65% (Table 1). The rest is met by hydro power, nuclear power and natural gas. In the generation sector about 60% is from coal fired thermal power plants and 70%ofcoal produced every year in India is being used for thermal generation (Pachauri and Spreng, 2002).

Table 1: Total installed capacity in India (Source: Ministry of Power, Government of India, 2007)

Fuel	MW	Percentage
Thermal	99861.5	64.6
Hydro	36885.4	24.7
Nuclear	4120.00	2.9
Renewable Sources	15225.35	7.8
Total	156092	100

On the consumption side, about 55% of commercial energy consumption is by the industrial sector. Even though the per capita energy consumption in India is one of the lowers in the world, the energy intensity, which is energy consumption per unit of GDP, is one of the highest in comparison to other developed and developing countries. The energy intensity is about 4 times that of Japan, 1.6 times that of USA, 1.5 times that of Asia and about 1.55 times that of Asia and about 1.55 times that of the world average, rendering a large scope for energy conservation (Devadas, 1997)

3. ENERGY SCENARIO IN TAMIL NADU

In Tamil Nadu, the total installed generation capacity (as of March 2013) of 10515.34 MW to satisfy the state's energy needs. The installed capacity of non-conventional energy sources as of March 2013 is 7999.025MW. The break-up of the total installed capacity as Conventional and Non-Conventional sources is as given below:

Table 2: Break-up of Total Installed Capacity of Power in Tamil Nadu

S. No.	Source	Capacity in MW
I.	**Hydel, coal, oil based conventional soruces**	
1.	TANGEDCOs own generationg stations (Hydel, Thermal, Gas)	5677
2.	Private sector (IPP)	1180
3.	Share from Central Generating Stations	2861
4.	External assistance	305
5.	Others (Captive Power Plants)	214
	Added during the year (Thermal & Hydro) (2012-13)	127.5
	Total	10364.5
II	**Renewable Energy Sources**	
1.	Wind	6696.61
2.	Solar	10.0
3.	Biomass Co-generation	610.0
4.	Biomas power	161.15
5.	Small hydro	90.05
6.	Waste to energy	4.25
	Added during the year (2012-13)	696
	Total installed capacity	**17936.56**

Reproduced from TN Policy Note 2012-13

4. CLEAN DEVELOPMENT MECHANISM (CDM) IMPLEMENTATION ANALYSIS

The National Sample Survey Organization (NSSO), in its sixth survey that is carried out once in five years included coverage of on-agricultural Enterprises in the Informal Sector additionally. The highlights of the survey particularly applied to cooking and lighting sector reveals that at national level, electricity and kerosene accounted for 99% of the households as primary source for lighting in both rural and urban areas whereas around 78% of rural people used firewood and chips as major source of energy for cooking. There has been an increase in the proportion of households using electricity as major source of lighting by 11% (from 37% to 48%) in rural areas and by 6% (from 83% to 89%) in urban India since 1993-94. There was decrease in the percentage of households using kerosene as primary source of energy for lighting, from 62% to 51% in rural India, and from 17% to 10% in urban India, since 1993-94 (Ralph and Barnes,1980; Choi Thomas,2009; NSSO, 1997).

One of the previous studies on determinants of energy consumption concludes that income is a weak predictor of residential energy consumption, explaining only 38% of energy consumption. The consumption of energy by a household essentially depends on the location and the socio-economic factors of the household. Using the EXCEL trend analysis, the differences in the average consumption of energy across all the districts were used. The results of both these tests indicate that there are significant differences in the average energy consumed by the households in the different districts and across different slabs of usage. This justifies the sample selection and its purpose. The quant it y of electricity and different fossil fuels used in the rural sector for lighting and cooking application in domestic sector in Tamil Nadu is given in Table 3.

Table 3: Electricity and Fossil Fuels used in Tamil Nadu Domestic Sector for Cooking and Lighting (Source: NSS Report) per 1000 households

Year	Electricity (GWh)	Kerosene (T)	LPG (Tons)	Firewood (Tons)
1994	0.4	13.75	5.28	816
1999	0.55	8.28	11.42	768
2004	0.63	5.14	22.83	723
2009	0.72	1.77	43.28	626

The variation in electricity and kerosene usage for lighting pertaining to rural sector from the year 1994 to 2009 and trend in energy usage established through data analysis is depicted in Figure 1. The trend analysis shows that, in the lighting sector, the usage of electricity is increasing whereas the usage of kerosene is decreasing in the rural sector. This increased reliance on electricity for lighting can be attributed to considerable difference in cost of appliances and operating cost. Most households in the state presently has

been electrified, albeit availability is constrained by frequent lo addition of shedding, black outs, and voltage fluctuations.

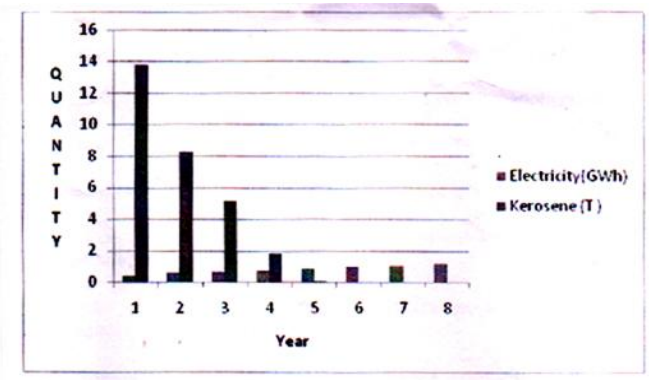

Fig. 1: Trend showing the usage of electricity and kerosene from 1994 to 2029

The variation of firewood and LPG usage for cooking in rural sector from the year 1994 to 2029 and trend in firewood and LPG usage established through data analysis is depicted in Figure 2. LPG demand has increased rapidly in Tamil Nadu in recent years whereas the use of firewood as a fuel is decreasing. One of the major concerns from the Tamil Nadu states perspective on energy consumption pattern is the increased availability of LPG to the poor sections of t he society. Hence any attempt to implement Clean Development Mechanism (CDM) in this sector would essentially the addressedthrough replacementof LPG with alternative energy resources such as Biogas or Biomass.

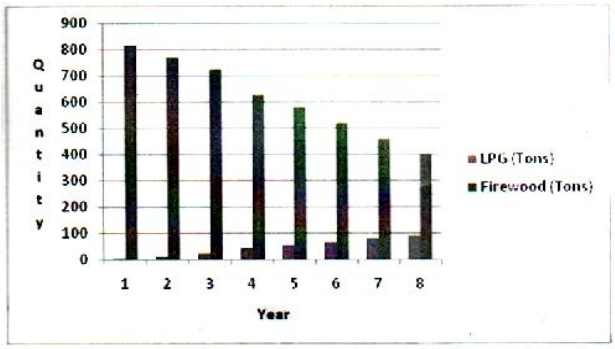

Fig. 2: Trend showing the usage of firewood and LPG from 1994 to 2029

The various trend equations for the lighting and cooking applications are given in the Table 4. The CO_2 emission from electricity and fossil fuels can be found out by the IPCC guide line 2006 which is as follows:

CO_2 emission from fossil fuel use = fuel consumed x Net calorific value (NCV) x CO_2 emission factor

CO_2 emission from electricity use = [(kWh consumed x Electricity emission factor) / (Transmission and Distribution Efficiency)]

The electricity emission factor for India is 0.0008 per ton of CO_2 /kWh with Transmission and Distribution Efficiency of 75%.

Energy sources	Application	Trend equation	R^2 value
Electricity	Lighting	Y =0.02x -41.05	0.997
Kerosene	Lighting & Cooling	$Y = 0.021x^2 - 84.95x - 85811$	0.997
LPG	Cooking	Y = 2.508x – 4999	0.992
Firewood	Cooking	Y = -12.3x – 25352	0.995

By using the above formula, the CO_2 emission for Tamil Nadu from electricity and fossil fuels used for cooking and lighting in rural sector was computed and the results are presented in Figure 4.

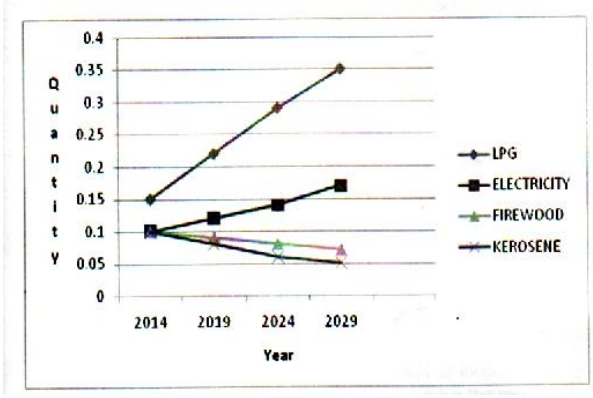

Fig.3. CO_2 emission (in million tons for Tamilnadu from electricity and fossils fuels)

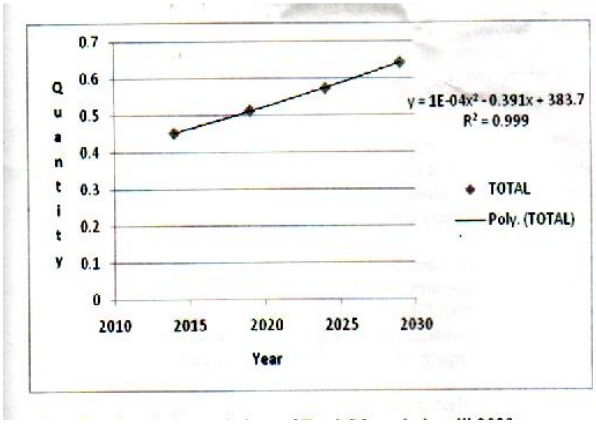

Figure 4 depicts the trend analysis on the variation of total CO_2

The projected Kyoto target analysis for the required total CO_2 emission due to energy utilization for lighting and cooking applications is presented in Table 5. From the table, it can be observed that about 40% of the Kyoto target can be achieved by the year 2029. The estimated variation showing the percentage of Kyoto target till 2029 is depicted in Figure 4, which indicates achievement of 100% target would be possible.

Table 5: The Kyoto target analysis for CO_2 emission

Sl. No.	Year	Emission from 2014 onwards	CO_2 reduction requirement	Percentage of Kyoto target
1.	2014	0.45	0.07	16%
2.	2019	0.51	0.12	24%
3.	2014	0.55	0.18	32%
4.	2019	0.65	0.26	40%

5. CONCLUSION

The study results presented herein is a pilot attempt in modeling energy consumption patterns and trends in the state of Tamil Nadu in India, identifying the various factors influencing energy usage, especially in the domestic energy sector, that could form a basis for energy planning in not only in the state but also for India as a whole. The models envisaged to be developed is expected to aid in planning adapatation of Clean Development Mechanism (CDM) in the energy sector, which could go a long way in contributing

to reduction in Carbon Emission Reduction through implementation of alternative energy potentials particularly in rural India. The study presents only minor area concerning the energy requirement patterns in rural domestic sector. However, the study methodology can be extended to other areas of energy applications encompassing equally both rural and urban areas.

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