Energy intensity and carbon market for climate justice

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***Abstract*— Climate change and global warming is a major concern. Future generation will suffer if the low carbon development strategy is not adopted by nations today. The Conference of Parties (COP21) recognizes the menace of global warming, emissions and also emphasizes the differentiation between the responsibilities of developed and developing nations. This legally binding agreement also gives a boost to carbon market in the interest of climate justice to transfer mitigation outcomes. This paper analyses the linkage of development of the states and the carbon market. The result show significant correlation between carbon market development and development of a state. It also tries to provide insights whether there is a possible pathway to achieve climate justice at the sub-national level (between developed and developing states in India) or in the sectoral scopes. The paper uses macro data and some case studies to emphasize the idea of climate justice at the sub-national level.**

***Index Terms*— Climate Justice, Climate Change, Energy, Emissions, Mitigation, Carbon Market.**

I. INTRODUCTION

The development and growth needs of nations based on the lifestyle fuel energy consumption. Therefore energy is a critical need for a nation's growth trajectory. As per the working group report of the 12th Plan India is likely to grow at a rate of about 8.5 percent per annum. It is interesting to note that the electricity consumption of the country has also been growing at the rate of 8.84% per annum between 2005-6 and 2013-14. India has taken up several measures to reduce the energy intensity even though it is a large emitter. The energy intensity (expressed as Total Primary Energy Consumption per Dollar of Gross Domestic Product or Btu per Year 2005 U.S. Dollars Market Exchange Rates) of India as per the International Energy Outlook has shown some declines due to several measures it has taken in the recent years. It has come down from 18,971.90 in 2007 to 17,485.68 in 2011.

Apart from that per capita consumption of energy in India is almost one third that of the global average. The argument advanced by India is that many developed countries ouucpied the carbon space using the fossil fuels and left very little for others to grow. The emissions from fossil fuels are likely to increase the temperature rise threshold of 2 deg C and would cause an irreversible damage. To reduce the emission and contain temperature to the above threshold every nation has come up with her Intended national Determined Contribution (INDC). India in her INDC, commits to reduce its emissions intensity per unit GDP by 33 to 35 percent by 2030 from 2005 baseline year. However, India has clearly made it conditional that it would do so with international assistance. Clean Development Mechanism (CDM) under the Kyoto Protocol provides opportunities to reduce and transfer mitigation outcomes amongst developed and developing countries. India has second largest number of clean development mechanism projects in in the world after China. Several states in India have undertaken CDM projects. It is examined in the context of India that whether there is any relationship between developed states using the carbon market options to reduce emission. It also explores based on case studies how a low carbon strategy may be possible using market based options at sub-national level.

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II. LITERATURE ON CLIMATE JUSTICE AND CARBON MARKET

In the context of carbon market, climate justice has evolved based on "polluter pay principle". Common But differential Responsibility (CBDR) has since been first mentioned in the principle 7 of Rio Declaration in 1997. Subsequently this has found mention in the United Nation Framework Convention on Climate Change (UNFCCC) (Rajamani, 2000). In the recent past there has been strident appeal by developing countries to repay the climate debt in the interest of climate justice. This has assumed a form of a movement and a sore point among developed and developing country blocks (Bond, 2012). This provision has seen hard bargain in several negotiations between developed and developing nations. The former is not ready to accept its historical responsibility and the later its rightful share of the global carbon budget in its quest to grow.

A. Kyoto protocol and Climate Justice Framework

Kyoto protocol provides the basis for emission reduction among developed and developing countries. The key elements of climate justice as embedded in Article 3 of the UNFCCC2 are as follows: (a) Equity & Common but Differentiated Responsibilities and Respective Capabilities (b) Full Consideration for Developing Country Needs & Circumstances (c) Precautionary principle i.e. the lack of scientific certainty should not prevent Parties from taking cautionary measures if the likelihood of serious damage to the environment exists. (d) Right to Sustainable Development (e) Cooperate to Promote Supportive and Open Economic System. The framework agreed then under Kyoto Protocol is considered zero sum and loose by some detractors and many have suggested an evolutionary principle (Deleuil, 2015) under the Paris agreement. However, since the developing countries had no obligation and right to the carbon space any

action that reduces emission above the business as usual (BAU) scenario helps in emission reduction. However emission reduction under Kyoto mechanism is only about 12%.

B. Climate Change and Carbon Market in India

India is the second largest market participant in carbon market after China. Several states have used the mechanism to structure projects and helped in reducing the emission. India has also formulated its national action plan on climate change in 2008. Several missions such as Green India Mission helps in creating larger carbon sink through planation; National Mission on Energy Efficiency helps in reducing carbon foot print through energy conservation and technological interventions; Solar Mission helps in having a prominent share of solar energy in the energy mix of the country. There are several standards in the carbon market, but it has not been able to address distributive as well as procedural justice concerns fully (Mathur, 2014). In addition the domestic mechanisms such as perform achieve and trade (PAT) under National Mission on Energy Efficiency has been at the nascent stage.

III. Materials and Methods

In this research the focus has been on the sub-national carbon-market. The United Nation Energy Programme (UNEP) database of registered CDM projects have been used for analysis. Similarly for the Gross State Domestic Product of the states the data from Planning Commission have been used. Multi-state projects have been excluded so that specificity to state boundary can be maintained.

Two case studies have been drawn from real measurement of energy efficiency. The case studies show the possibility of a domestic mechanism for low carbon development. The case studies are based on (a) the measurement of the actual emission reduction through introduction of technology package in steel re-rolling mills and (b) measurement of emission reduction in a street light programme through the replacement of traditional street lights with LED street lights.

IV. Results

The state wise no of CDM projects and the gross state domestic products were first plotted to check the suitability and then bi-variate statistics for Pearson correlation coefficient was determined.

The null hypothesis μ_0=no correlation between number of CDM projects and gross state domestic product (GSDP) alternate hypothesis μ_1 = there is correlation.

The following equation was used to compute the co-efficient.

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n(\sum x^2) - (\sum x)^2]\,[n(\sum y^2) - (\sum y)^2]}}$$

The results are given in the table below:

Table 1 Mean and standard deviation of CDM projects and GSDP for 30 states

	Registered CDM Projects (No)	Gross State Domestic Product in const. price (Rs Crore)
Mean	75.9	185390.50
Standard Deviation	105.19	192577.69

Pearson Correlation value has been presented in the figure below:

Table 2 Correlation between CDM Project and GSDP for 30 states in India

		CDM_project	GSDP
CDM_project	Pearson Correlation	1	.757**
	Sig. (2-tailed)		.000
	N	30	30
GSDP	Pearson Correlation	.757**	1
	Sig. (2-tailed)	.000	
	N	30	30

**. Correlation is significant at the 0.01 level (2-tailed).

The above table (table 2) shows that there exists significant correlation between developed states and the number projects. The strong positive correlation between the variables (.757) shows that there is a high possibility that the developed states (having high gross state domestic product) are more likely to develop more number of CDM projects.

Now coming to the case studies.

Case 1: Implementation of various energy saving technologies in the steel re-rolling mills.

It has been observed that new modern steel industries meet higher efficiency standards. However, the old steel re-rolling mills often use obsolete technologies. Observations were taken from a cluster of 20 industries of which in 18 mills baseline energy audit was conducted. 16 mills agreed to use various technological options.

The introduced technological options were as follows:

- Anti-friction roller bearing
- Direct rolling
- Introduction of recuperator
- Furnace automation and revamp measures

Post implementation audit in these mills showed the following results.

Table 3 Energy saving in steel re-rolling mill programme in a cluster

No.	Total GHG reduction				Productivity - BL	Annual GHG emission reduction
	BL	PI	Savings	Savings percent		
	tCO_2/t			%	tph	tCO_2/y
1	0.1258	0.115	0.0107	8.51%	19.44	749
2	0.2609	0.234	0.0273	10.45%	10.75	1055
3	0.2213	0.208	0.0137	6.21%	26.12	1293
4	0.2474	0.223	0.0242	9.79%	22.15	1932
5	0.2531	0.23	0.0233	9.22%	14.24	1196
6	0.2109	0.14	0.0704	33.39%	10.66	2702
7	0.375	0.261	0.1137	30.32%	10.67	4368
8	0.3881	0.11	0.2784	71.72%	10.49	10513
9	0.3264	0.199	0.1274	39.03%	5.27	2417
10	0.3128	0.28	0.0328	10.49%	3.32	392
11	0.2987	0.253	0.0457	15.31%	4.68	771
12	0.3211	0.292	0.0292	9.10%	0.51	54
13	0.3633	0.332	0.0316	8.70%	4.55	518
14	0.4546	0.343	0.112	24.62%	6.83	2753
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**30710**
Average	**0.297**	**0.23**	**0.067**	**0.205**	**10.691**	**2193.56**

Note: BL = baseline, PI=Post Implementation, NA=Not applicable

The total greenhouse gas (GHG) reduction in this cluster is about 2195 tonne CO_2 per annum. The activity is above business as usual and can be upscaled nationwide and can be funded through a CDM programme.

Case 2: Introduction of LED street lights replacing conventional lights

The street light replacement programme was initiated in a public private partnership (PPP) mode, where the entire capital expenditure was borne by the private party that he is expected to recover from the energy saving using an independent assessment of energy saving. The following results were obtained in a sample audit:

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Table 4 Energy saving in street light replacement with LED

Total No of fixtures (Q)	Connected Baseline load (KW) (R)	total no of operational lamp	Total Lamp hours (hrs) (J) kWh/fixture/hr	Adjusted baseline Energy Consumption_ ideal Scenario (kWh) S= (P*Q*J)	Baseline energy Consumption (kWh/Fixture/hour) T= S/Q/I	Adjusted Specific energy consumption (Wh/kW/Total lamp hours)*1000 U= S/R/J
58	14.5	14	0.408	248.53	0.4081	0.03

With 100 percent simulation: The smart street light solution with centralized telemetry the programme is expected to reduce greenhouse gas emissions by an estimated 10,500 tonnes of CO_2 annually.

This programme too can be up-scaled across urban local bodies in the country and significant reduction in GHG can be achieved.

V. Conclusion

The above results show that the GSDP and CDM project development has strong correlation and developed states (higher GSDP) have a strong ability to participate in the carbon market (higher the GSDP, likelihood of higher number of CDM projects). Since the developed states too have higher energy intensity through these projects they moderate the emission. This is a good indication of climate justice at subnational scale.

Some of the programmes highlighted in the case studies show that technological options can be used to achieve emission reduction in industrial clusters and urban sectors. These can be upscaled as a satte level programme or even national programme to fit into nationally appropriate mitigation action or CDM. The carbon credits thus obtained can offset the capital and operating cost.

The other option is to have a domestic trading of emissions amongst efficient clusters with laggard clusters or efficient urban local bodies undertaking street lighting replacement programme using LED lights with laggard ones with appropriate regulatory mechanism.

Many of these option will help in achieving our INDC and contain the global temperature rise in the interest of climate justice for future generations.

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