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Paris Agreement: Differentiation without Historical Responsibility?

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The Paris Agreement on Climate Change has reiterated the principle of Common but Differentiated Responsibility and Respective Capabilities (CBDR-RC) but has not referred to historical responsibility. How important is historical responsibility and what does it imply? How is one going to differentiate without historical responsibility? What would be India's responsibility? How do India's INDC targets compare with its responsibility?

These are the questions we address.

India's INDC Targets

India submitted its intended nationally determined contributions (INDC) on October 2 to UNFCCC(UNFCCC, 2015). Countries were asked to submit their own INDC before the Paris Conference of Parties (COP).

The process of INDC preparation involved modeling studies by two different groups, IRADe and TERI with frequent consultations with MOEF officials. Various ministries were also consulted to get their view points on possibilities in their sectors. It also considered the earlier report of the expert group on low carbon strategy for inclusive growth (Parikh et al, 2014).

India's INDC aims to reduce India's emission intensity (i.e. amount of CO2 emitted per unit of GDP) by 30 to 35 % by 2030 compared to that in 2005. It also aspires to increase non-fossil based power generation capacity to 40 % by 2030. Additional carbon sink of 2.5 – 3 billion tones of CO2 equivalent through additional forest and tree cover will be created.

India's INDC also states that it can achieve these targets if low cost finance and technology are provided. It assesses that 2.5 trillion US$ (at 2014-15 prices) required for meeting India's climate change actions between now and 2030.

We argue here that India's INDCs are ambitious and much above what India's responsibility for climate change requires. We believe that the goals are attainable but at some cost. We also argue that the some of the comments on India's INDC made by some people are misplaced. For example Dubash and Khosla (2015) have argued that the estimate of cost of low carbon measure in INDC is an over estimate as co-benefits of these measures are not accounted for. India's INDCs are also criticized by Adve and Kothari (2015) as being not ambitious enough, not such that would lead to a global agreement and would not take care of the poor in India as it does not emphasize distributed renewable energy (DRE).

Are These Targets Achievable?

Reducing emissions intensity by 35 % in 25 years requires an annual reduction of 1.7 %. With a number of measures India has already taken for energy efficiency and for renewable energy, our emissions intensity has been coming down at a much faster rate. Our emissions grew over 205 to 2012 by around 1.9 % per year (WRI CAIT database) while our GDP grew at over 8 % per year implying emission intensity reduction of over 6 % per year. Thus the target is realizable.

Could we have made a more ambitious commitment? We could have but at considerable costs. Even the target of 35 % reduction is estimated to cost a lot. Are the costs over estimated as it does not account for co-benefits?

The Co-benefits Approach: How Relevant for India?

The notion of co-benefits is not strictly applicable to conditions in India. The co-benefits of reducing CO_2 emissions by greater use of renewables replacing coal based power plants to generate power are less local pollution and creation of employment.

Local air pollution from a coal based plant can be controlled by end-of-pipe measures, which are far less expensive than replacing a coal based plant by a solar or a wind plant. The USA uses more coal than India. It generated around 1610 bkWh of electricity using coal in 2014 (US-EIA, 2015) compared to around 855 bkWh generated by India using coal in 2013-14 (MOSPI, 2015). US plants keep local air pollution from coal plants under control. India can also do so.

Replacing coal based generation by solar and wind may actually increase emissions from coal based generation. Since solar and wind power are available only for a part of the day, balancing by coal based plant will require that coal plants are run at varying capacity levels. This increases coal consumption and also related emissions. This has actually happened in Germany (Carlyle, 2013).

The other co-benefits of renewables is claimed to be generation of employment. This may be true in the USA or Europe where coal mines are highly mechanized and the installed generating capacity hardly needs any expansion. Building a renewable plant would be additional investment. However, in India, we need to add generating capacity and a renewable plant would be built in place of a coal-based plant. Also our coal mining employs many more persons per ton of coal than in USA or Europe, renewable may not generate more employment. The productivity in Coal India Limited is 0.75 tonne per employee hour (CIL, 2015) compared to % tonnes per employee hour in the USA (EIA, 2015). Of course one could argue that we should make coal mining more efficient. Even then we would employ more people per tonne of coal mined than USA or EU. Also solar and wind plant operations require hardly any manpower. It is therefore quite unlikely that building a renewable plant instead of a new coal plant would create more employment in India. As told to us buy a builder of solar PV plant in Delhi the construction of a one MW PV solar plant requires 20 persons for 4 months. Surely the construction of a coal-based power plant generates much more employment. Patwardhan and Jain (2013) asses the employment in manufacture, fabrication, installation and maintenance of a solar PV plant to range from 7.7 to 13 per MW of a centralized plant and from 19.8 to 25.3 for decentralized installations. Their estimate of jobs created in a biomass based plant (which may be less than a coal based plant) range from 19.6 to 1592 per MW for a large plant (average size 6MW) and from 414 to 737 Persons per MW for smaller plants (average size 20 KW). The co-benefits of employment for solar power does not seem to be borne out for India.

We have to recognize that a renewable plant costs more. For example a solar plant requires twice as much investment per KW as a coal plant. Also a one KW solar plant will generate 1600 units of energy whereas a coal based plant could generate 6000 to7000 units per year. Thus to replace a one KW coal plant we need to invest in around 4 KW of solar plant requiring 8 times as much investment. Thus the co-benefits should be compared with the co-costs. For India it is not obvious that co-benefits significantly reduce co-costs.

Differentiating Responsibility

Before we compare India's INDC targets to India's responsibility we need to know what India's responsibility is. Responsibility of countries could be based on per capita emissions, per capita GDP or on how much they have contributed to the stock of greenhouse gases in the atmosphere. If we consider per capita emissions or per capita GDP we need to relate them to responsibility whereas responsibility can be directly proportional to stock of GHGs as it is the stock of GHGs that causes warming. Even when we look at the current stock of GHGs in the atmosphere, a reference to past emissions is unavoidable to assess how much has been contributed by whom. Thus differentiation without historical responsibility will be a non-starter. The Paris Agreement is a pyrrhic victory for developing countries. We look at what responsibilities are implied by contributions to global stock of GHGs.

Accounting for Global Absorptive Capacity: A New Perspective

Every year what cumulates in the atmospheric stock is less than global emissions as the oceans and land sinks absorb a part of it. To work out the contribution of each country we need to assess what gets absorbed by the natural environment and what is each country's share in the absorption.

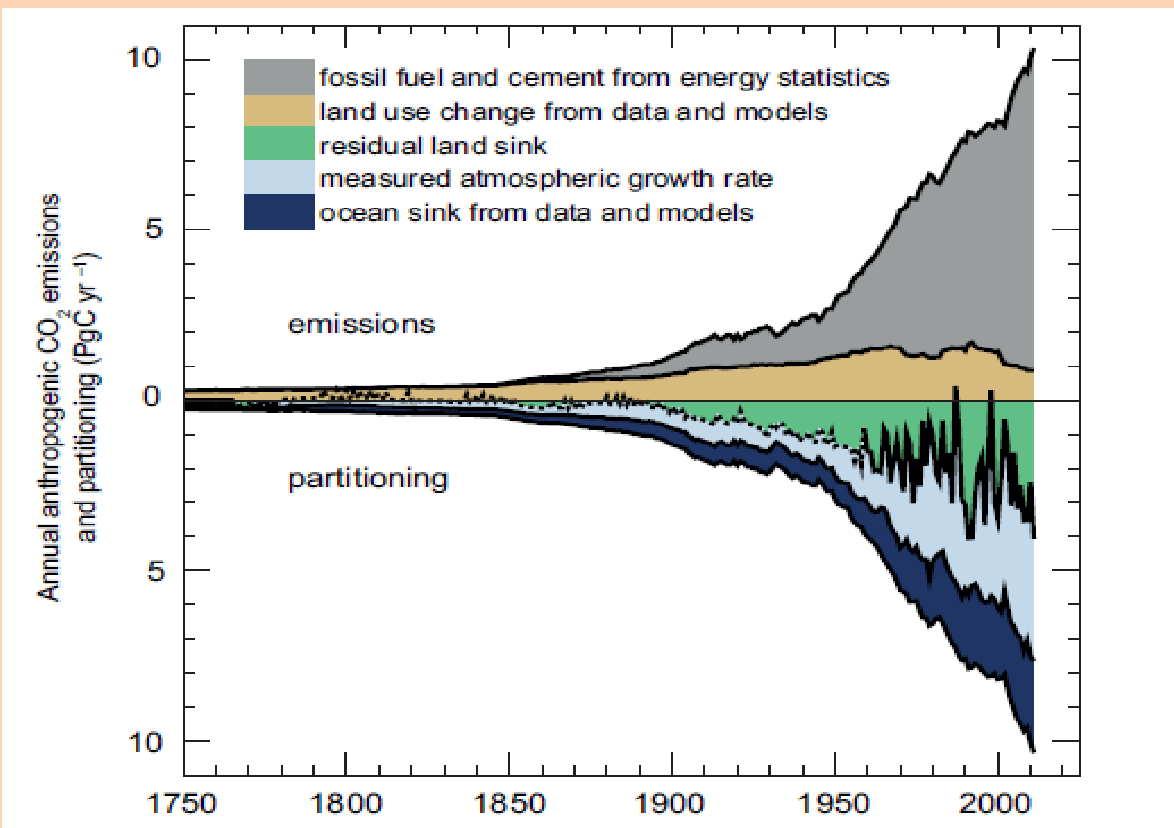
The box shows that some 60 % or more of global emissions get absorbed and only about 40 % get accumulated in the atmosphere. To get a lower bound on the responsibility of countries who have emitted more in the past, we take that only 33 % gets added to the global stock.

How Much Of Emission Got Into The Atmosphere?

In order to assess the responsibility of different countries we need to estimate their share in the stock of GHGs in the atmosphere. While the science is complex and precise assessment is difficult, we take a broad macro approach. The figure 1 from IPCC's AR5 shows where the total global emissions go. The top part shows the sources of emissions, fossil fuel and cement from energy statistics and Land use change from data and models. The bottom part shows where these emissions go. They go in three directions, residual land sink, measured atmospheric growth rate and ocean sink from data and models. It is seen that only around 30% to 40% of global emissions get in to the atmosphere and that the amount absorbed by oceans and land is increasing along with the emissions. While this may not continue forever for assessing past contributions this can be taken as given.

Another way to look at it is to relate the changes in the amount of CO2 in the atmosphere to emissions made. An increase of 1 ppmv of carbon concentration in the atmosphere corresponds to an increase of 2.13 GT of carbon or 7.817 GT of CO2.

Total global emissions over 1850 to 2000 is 441.5 GT of carbon whereas ppmv changed from 288 in 1850 to 369.5 in 2000 which amounts to addition of (369.5-288)*2.13 = 174 GT of carbon. Thus only 40% of the emissions are in the atmosphere and rest were absorbed by the oceans and terrestrial biosphere. (http:cdiac.ornl.gov/pns/faq.html).



Source: IPCC AR-5 WG I TS Figure TS.4 https://www.ipcc.ch/report/ar5/wg1/

From 1990 to 2012 the atmospheric C changed from 353 ppmv to 393.82 ppmv i.e. by 40.82 ppmv whereas the total emissions over this period was 864 GT of CO2. Thus the ratio of accumulation/emissions is 7.817 x 40.82/ 864, which is around 37 percent.

Thus we take a lower bound figure of that only 33 % of emissions get accumulated in the atmosphere to assess the responsibilities of those who have occupied the carbon space. This provides a lower bound on their responsibilities.

We argue that every citizen of earth has equal right to that absorptive sink capacity.

Thus for year t every person's right of absorptive capacity is given by

$$a_t = 0.67 EG_t / PG_t$$

Where EG_t is global emissions and PG_t is global population in year t.

The net contribution to atmospheric stock, by country c in year t, $N_{c,t}$ is given by

$$N_{c,t} = E_{c,t} - a\, P_{c,t}$$

Where $E_{c,t}$ and $P_{c,t}$ are emissions and population of country c in year t

Many developing countries emit less than their absorption entitlement. The surplus may be distributed to those who emit more. We have distributed this surplus to those who have emitted more in proportion to their net emissions. This also reduces the responsibility of those who have emitted more in the past.

Based on this the shares of different groups of countries over 1990 to 2012 are worked out shown in Table 1.

Table 1: Contribution to Atmospheric stock of GHG's over 1991 to 2012

Groups	Accumulated CO2 in the Atmosphere (1991 to 2012)	Share in the Total
Annex 1	**251324**	**0.74**
USA	109604	0.322
EU(28)	56588	0.166
Other Annex 1	85132	0.250
Non Annex 1	**88606**	**0.26**
India	0	0.000
China	26024	0.077
East Asia	18093	0.053
Other Non-Annex 1	44488	0.131
World Total of 184 Countries	**339930**	**1.000**

Source: Author's calculations based on WRI's CAIT data base

We have taken emissions only from 1991, since no country can claim being unaware of the impact of their emissions on others and climate change after 1990 when the preparations for the Rio de Janeiro Earth Summit of 1992 started.

The table shows that India has not contributed even 1 tonne to the atmospheric stock of CO2 and has no responsibility as of now.

The annex 1 countries have contributed 74% of the stock of CO2 in the global atmosphere counting emissions over 1991 to 2012 and after giving them the benefit of the absorptive capacity not used by non-annex 1 countries over this period. Compared to this whatever India does for mitigation should be considered ambitious. India has to grow economically to take care of its human development deficit. India cannot by its own action reduce the threats of climate change to its citizens when the sum total of emissions by the major emitters, Annex-1 countries and China in 2030 will be more than what they emitted in 2012 today even if they fulfill their INDC goals. They must create space for India's emissions to grow. Experience has shown that economic growth does reduce poverty. While one can argue that anti-poverty measures could help reduce poverty faster, the impact of economic growth cannot be denied and that such measures are facilitated by economic growth.

Cost of India's INDC

We now look at the cost of India's INDC. Since the claims of co-benefits are grossly exaggerated, looking at the costs of INDCs becomes important.

As argued above replacing a coal based plant by a solar plant requires 8 times as much investment. It is often argued that a solar plant can be built near the consumers and would not require so much investment in transmission and distribution lines. However since a solar plant generates electricity only for limited hours, it will require either storage or a sophisticated smart grid that can deal with intermittent power. The cost of either of the solutions is likely to offset the savings in transmission costs, particularly when the capacities of renewables like solar and wind become a substantial part of total capacity. Also one needs to recognize that solar and wind resources are concentrated in few states and so is hydro potential which can provide balancing load. This will require substantial amount of transmission over long distances

As the investment required to create capacity to replace a coal plant by a solar plant is not likely to be less than 8 times as large, it displaces other investments and the country would be able to invest less in say education, health or infrastructure. The growth rate of the economy would be smaller. The burden of this would disproportionately fall on the poor.

Modeling studies done at IRADe (Parikh et al, 2014) for the expert group on low carbon strategy for inclusive growth has shown that this cost can be substantial. With such costs should India give up financial and technology help?

How Important are Finance and Technology for India?

The Paris Agreement provides for finance but has weakened past commitment by not laying down any minimum level for it. Also a lot of attention was given to 'mission innovation' at Paris COP outside the formal meeting, but the agreement does not say anything specific about low-cost access to technology. Former minister of environment Jairam Ramesh's comments on India's INDC in Business Standard dated October 18, 2015, unless he is misquoted, suggest as also the Chief Economic Adviser Arvind Subramaniam did some time ago, that we should not ask for either finance or technology. He considers demand for finance and technology as obstructionist, presumably because the U.S will be reluctant to provide them and obstruct any agreement if we ask for them. How important are finance and technology access for India?

In table 2 we have calculated impact of finance and technology on the cost of solar power. A conventional coal based plant with a capital cost of Rs 3 crores/MW, a debt equity ratio of 4:1, interest on debt of 12%, coal price of Rs 1000/tonne and a desired return on equity of 15% will provide electricity at around Rs.1.48 per kWhr. A supercritical coal plant with capital cost of Rs.5 crore/MW and 10% lower specific coal consumption would provide electricity at Rs.1.97 per kWhr. Compared to this a solar plant costing Rs.6 crores/MW will provide electricity at Rs.5.68/KWhr.

Now assume that 20 year international finance is available at 4%, the electricity from solar plant will cost only Rs.3.23/KWhr. This can be at least competitive at some distance from coal mines. With availability of such finance, India's INDC would not result in lower GDP. This is the importance of finance.

How important, is technological help? Today a solar photo voltaic cell works with an efficiency of around 15 percent. If cells are developed and they are likely to be developed, with an efficiency of 45 percent, even if the initial cost goes up to Rs.10 crore/MW from Rs.6 crore/MW with 20 year low interest finance the cost of electricity would be only Rs.1.79 per KWhr, cheaper than a coal plant at pithead.

Table 2: Importance of Finance and Technology for Solar PV Plants

	Capital cost Rs/KW	Bus bar kwh/year	Interest Rate on Debt	Rs/kwh				
				Interest on Debt (80% of capital)	15% Return on Equity (20% of Capital)	Operating Cost	Fuel Cost	Total Cost
Coal*	30000	6000	0.12	0.60	0.13	0.10	0.65	1.48
Coal SC**	50000	6000	0.12	1.00	0.22	0.17	0.58	1.97
Solar PV	60000	1600	0.12	4.51	0.98	0.19	0.00	5.68

Solar PV	60000	1600	0.04	2.06	0.98	0.19	0.00	3.23
Solar PV	80000	3200	0.04	1.37	0.66	0.13	0.00	2.15
Solar PV	100000	4800	0.04	1.14	0.55	0.10	0.00	1.79
Coal cost Rs 1000/tonne, Operating cost 2 % of Capital cost for coal plant, 0.5 % for solar plant								
* heat rate 2400 kcal/kwh								
** heat rate 2150 kcal/kwh								

Thus finance and technology can change the whole picture. Coal can almost become economically obsolete and we can move rapidly to a renewable energy system. It is hard to understand why those who want India to move ambitiously are willing to give up finance and technology.

One may add that India should recognize the importance of technology and mount its own ambitious R & D effort to develop solar cells with 45 percent efficiency.

Role of Distributed Renewable Energy (DRE) in INDC?

One of the criticisms of India's INDC is that it does not emphasize distributed renewable energy such as wind, solar, micro hydro and biomass based rural generation of electricity. However, one needs to appreciate the difficulties involved in DRE. A village level electricity network will need a business plan, someone to maintain and manage it, collect bills and make sure that it keeps working. This calls for a person with such managerial capacity. Such a person is not likely to be satisfied by what she can earn by running one village level network.

One has to recognize that solar and wind power are erratic and not available on demand and they vary from month to month and day to day.. Figures 2 and 3 show the power generation from wind and solar in Gujarat. Thus even a village level network will require electricity storage or a backup capacity to provide power when the main system does not generate enough power. This would be very expensive if every village has to provide it. The best solution is to provide 24x7 grid connected power so that the rural consumers are not treated as second class citizens. Of course large-scale renewable plants should generate substantial amount of electricity and feed the grid.

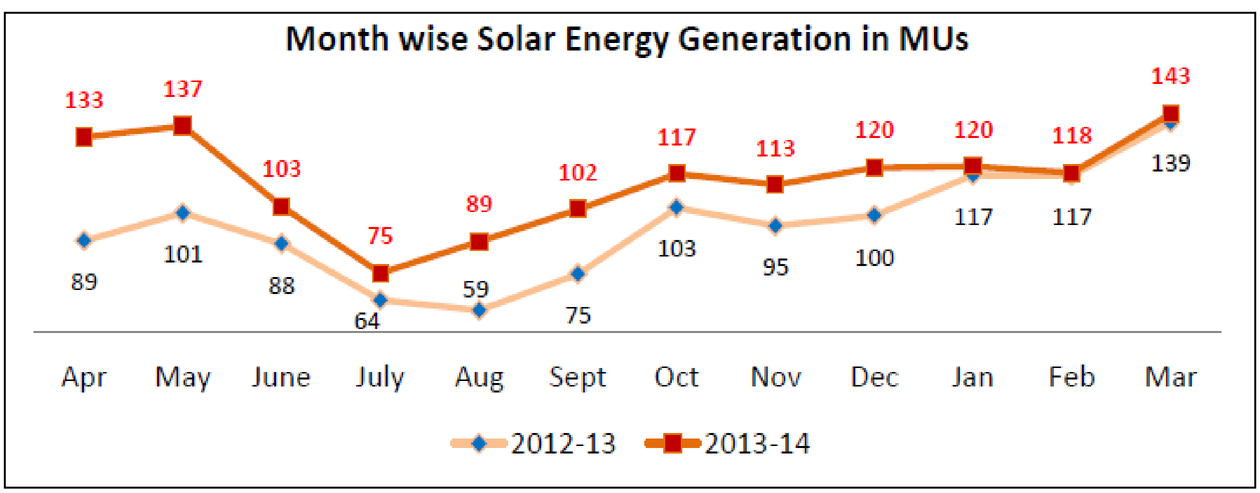


Figure 2: Month wise Solar Energy Generation in Million Units in Gujarat

Source: Annual Report, 2013-14, SLDC (2014), Gujarat

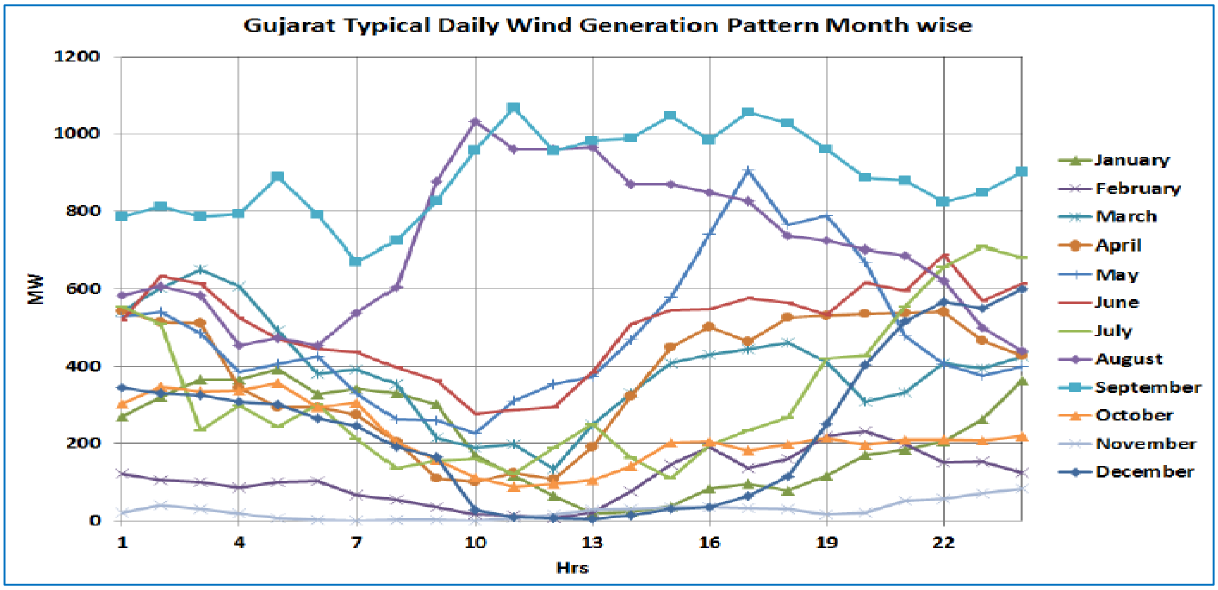


Figure 3: Typical Daily Wind Generation Pattern Month wise in Gujarat

Source: Annual Report, 2013-14, SLDC (2014), Gujarat

In Conclusion

Differentiating responsibility without reference to historical emissions is a lot weaker statement. While one may not consider historic responsibility for emissions from 1850 onwards, at least responsibility for the emissions from 1990 onwards should have been kept, which are emissions within the negotiation time frame. Since the atmospheric stock of GHGs causes global warming, it is natural to consider responsibility in proportion to a country's contribution to it. India's responsibility on that basis is nil as India has not contributed to even one tonne of GHGs to the current stock. Thus INDCs promise more than its responsibility for the threat of climate change. While India could have promised greater reduction in its emission intensity, it should do so only if other major emitters promise deeper cuts in their emissions and provide finance and technology.

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