Paris Agreement
Differentiation without Historical Responsibility?

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The Paris Agreement on Climate Change has reiterated the principle of Common but Differentiated Responsibilities and Respective Capabilities, 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 Intended Nationally Determined Contribution targets compare with its responsibility?

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India submitted its Intended Nationally Determined Contributions (INDCs) on 1 October 2015 to the United Nations Framework Convention on Climate Change (UNFCCC) (Government of India 2015). Countries were asked to submit their own INDCs before the Paris Conference of Parties (COP).

The process of INDC preparation involved modelling studies by two different groups—Integrated Research and Action for Development (IRADe) and The Energy and Resources Institute (TERI)—with frequent consultations with the Ministry of Environment, Forest, and Climate Change (MoEFCC) officials. Various ministries were also consulted to get their viewpoints on the possibilities in their sectors. The earlier report of the expert group on low carbon strategy for inclusive growth was also considered (Parikh et al 2014).

India's INDC aims to reduce its emission intensity (that is, the amount of carbon dioxide [CO_2] emitted per unit of gross domestic product [GDP]) by 30%–35% by 2030, compared to that in 2005. It also aspires to increase non-fossil-based power generation capacity by 40% by 2030. An additional carbon sink equivalent of 2.5–3 billion tonnes of CO_2 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 (at 2014–15 prices) is 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 some of the comments on India's INDC made by some people are misplaced. For example, Navroz K Dubash and Radhika Khosla (2015) have argued that the estimate of cost of the low carbon measure in the INDC is an overestimate as co-benefits of these measures are not accounted for. India's INDCs are also criticised by Nagraj Adve and Ashish Kothari (2015) as not being ambitious enough to lead to a global agreement, and that this would not take care of the poor in India as it does not emphasise distributed renewable energy (DRE).

Are These Targets Achievable?

Reducing emissions intensity by 35% in 25 years requires an annual reduction of 1.7%. With the 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 during 2005–12 by around 1.9% per year (WRI–CAIT 2014), while our GDP grew at over 8% per year, implying emission intensity reduction of over 6% per year. Thus, the target is realisable.

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 overestimated as it does not account for co-benefits?

The Co-benefits Approach

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 United States (US) uses more coal than India. It generated around 1,610 bkWh (billion kilowatt-hours) of electricity using coal in 2014 (US Energy Information Administration 2015), compared to around 855 bkWh generated by India using coal in 2013–14 (Central Statistics Office 2015). The US plants keep local air pollution from coal plants under control. India can also do so.

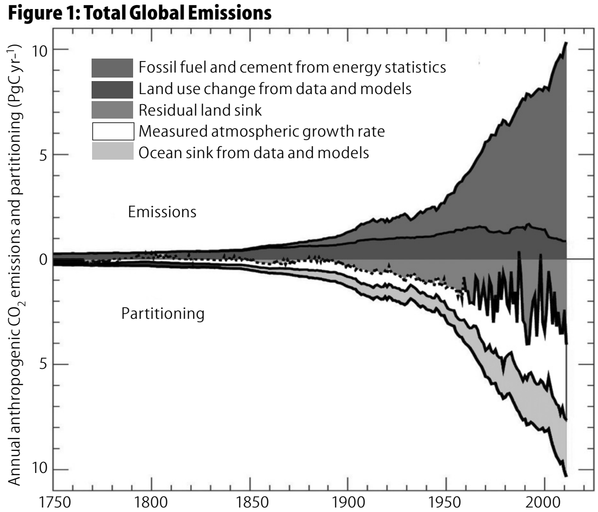
Replacing coal-based generation by solar and wind may actually increase emissions from coal-based generation. Since solar and wind power are available only for a part of the day, balancing with a coal-based plant will require that coal plants are run at varying capacity levels. This increases coal consumption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

The other co-benefit of renewables is claimed to be generation of employment. This may be true in the US or Europe where coal mines are highly mechanised 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. Also, our coal mining employs many more persons per tonne of coal than in the US or Europe, and a renewable plant may not generate more employment. The productivity at Coal India, based on production of 2014–15 and employee strength as of January 2016, is 0.75 tonnes per employee hour,[1] compared to 5.22 short tonnes per employee hour in the US in 2011.[2] 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 in the US or European Union (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 by a builder of a solar photovoltaic (PV) plant in Delhi, the construction of a 1 MW PV solar plant requires 20 persons for four months. Surely, the construction of a coal-based power plant generates much more employment. Manisha Jain and Anand Patwardhan (2013) assess the employment in manufacture, fabrication, installation and maintenance of a solar PV plant to range from 7.7 to 13 persons per MW of a centralised plant, and from 19.8 to 25.3 persons for decentralised installations. Their estimate of jobs created in a biomass-based plant (which may be less than a coal-based plant) ranges from 19.6 to 191.6 persons per MW for a large plant (average size 6 MW), and from 414 to 737 persons per MW for smaller plants (average size 20 KW). The co-benefits of employment for solar power do not seem to be borne out for India.

We have to recognise that a renewable plant costs more. For example, a solar plant requires twice as much investment per KW as a coal plant. Also, a 1 KW solar plant will generate 1,600 units of energy, whereas a coal-based plant could generate 6,000 to 7,000 units per year. Thus, to replace a 1 KW coal plant we need to invest in a solar plant of around 4 KW, requiring eight 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.

Figure 1: Total Global Emissions



Source: IPCC (2014).

Differentiating Responsibility

Before we compare India's INDC targets to its responsibility, we need to know what the latter 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 (GHGs) 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 as 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. In the next section, we look at what responsibilities are implied by contributions to the global stock of GHGs.

Global Absorptive Capacity

Every year what cumulates in the atmospheric stock is less than the total 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.

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 that have emitted more in the past, we assume that only 33% gets added to the global stock.

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 macro approach. Figure 1 shows where the total global emissions go. It is seen that only around 30% to 40% of global emissions get into the atmosphere and that the amount absorbed by oceans and land sinks 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 CO_2 in the atmosphere to emissions made. An increase of 1 ppmv (parts per million by volume) of carbon concentration in the atmosphere corresponds to an increase of 2.13 GT (gigatonnes) of carbon or 7.817 GT of CO_2.

Total global emissions during 1850–2000 was 441.5 GT of carbon, whereas the ppmv changed from 288 in 1850 to 369.5 in 2000, which amounts to addition of 174 GT of carbon ([369.5-288]*2.13 =174). Thus, only 40% of the emissions are in the atmosphere and the rest were absorbed by the oceans and terrestrial biosphere (CDIAC nd).

From 1990 to 2012, the atmospheric carbon changed from 353 ppmv to 393.82 ppmv, that is, by 40.82 ppmv, whereas the total emissions over this period was 864 GT of CO_2. Thus, the ratio of accumulation/emissions is 7.817 × 40.82/864, which is around 37%.

Thus, we take a lower bound figure, 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 the earth has an equal right to that absorptive sink capacity.

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

$$\alpha_t = 0.67 EG_t / PG_t$$

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

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

where $E_{c,t}$ and $P_{c,t}$ are the 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 absorption entitlement. This also reduces the responsibility of those who have emitted more in the past.

Based on this, the shares of different groups of countries during 1990–2012 are worked out as shown in Table 1.

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.

Table 1 shows that India has not contributed even 1 tonne to the atmospheric stock of CO_2 and has no responsibility as of now.

Table 1: Contribution to Atmospheric Stock of GHGs during 1991–2012

Groups	Accumulated CO_2 in the Atmosphere, 1991–2012 (Mt CO_2 e)	Share in the Total
Annex 1	251,324	0.74
US	109,604	0.322
EU (28)	56,588	0.166
Other annex 1	85,132	0.250
Non-annex 1	88,606	0.26
India	0	0.000
China	26,024	0.077
East Asia	18,093	0.053
Other non-annex 1	44,488	0.131
World total of 184 countries	339,930	1.000

Mt CO_2 e = Million tonnes of CO_2 equivalent.
Source: Authors' calculations based on WRI–CAIT (2014).

The Annex 1 countries have contributed 74% of the stock of CO_2 in the global atmosphere, counting emissions during 1991–2012 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, even if they fulfil 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 eight 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, such as solar and wind, become a substantial part of the total capacity. Also, one needs to recognise that solar and wind resources are concentrated in few states and so is the hydro potential, which can provide the 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 eight 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.

Modelling studies done at IRADE (Parikh et al 2014) for the expert group on low-carbon strategy for inclusive growth have shown that this cost can be substantial. With such costs should India give up on financial and technological aid?

Finance and Technology

The Paris Agreement provides for finance but has weakened past commitments by not laying down any minimum level for it. Also, a lot of attention was given to "mission innovation" at the 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 (Sethi 2015), unless he is misquoted, suggest, as also the Chief Economic Adviser Arvind Subramanian suggested some time ago, that we should not ask for either finance or technology. He considers the demand for finance and technology as obstructionist, presumably because the US will be reluctant to provide them and obstruct any agreement if we ask for them. How important is finance and technology access for India?

In Table 2 we have calculated the impact of finance and technology on the cost of solar power. A conventional coal-based plant with a capital cost of ₹3 crore/MW, a debt–equity ratio of 4:1, interest on debt of 12%, coal price of ₹1,000/tonne and a desired return on equity of 15% will provide electricity at around ₹1.48 per kWh. A supercritical coal plant with a capital cost of ₹5 crore/MW and 10% lower specific coal consumption would provide electricity at ₹1.97 per kWh. Compared to this, a solar plant costing ₹6 crore/MW will provide electricity at ₹5.68/kWh.

Now assuming that 20-year international finance is available at 4%, the electricity from the solar plant will cost only ₹3.23/kWh. This can be at least competitive with coal-based power. 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 PV cell works with an efficiency of around 15%. If cells are developed, and they are likely to be developed, with an efficiency of 45%, even if the initial cost goes up to ₹10 crore/MW from ₹6 crore/MW, with 20-year low-interest finance the cost of electricity would be only ₹1.79 per kWh, cheaper than a coal plant at pithead.

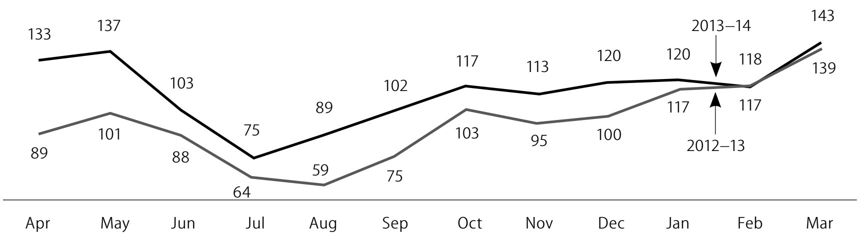
Thus, finance and technology can change the whole picture. Coal can almost become economically obsolete and we can move rapidly to a renewable energy system. It is hard to understand

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*	30,000	6,000	0.12	0.60	0.13	0.10	0.65	1.48
Coal SC**	50,000	6,000	0.12	1.00	0.22	0.17	0.58	1.97
Solar PV	60,000	1,600	0.12	4.51	0.98	0.19	0.00	5.68
Solar PV	60,000	1,600	0.04	2.06	0.98	0.19	0.00	3.23
Solar PV	80,000	3,200	0.04	1.37	0.66	0.13	0.00	2.15
Solar PV	1,00,000	4,800	0.04	1.14	0.55	0.10	0.00	1.79

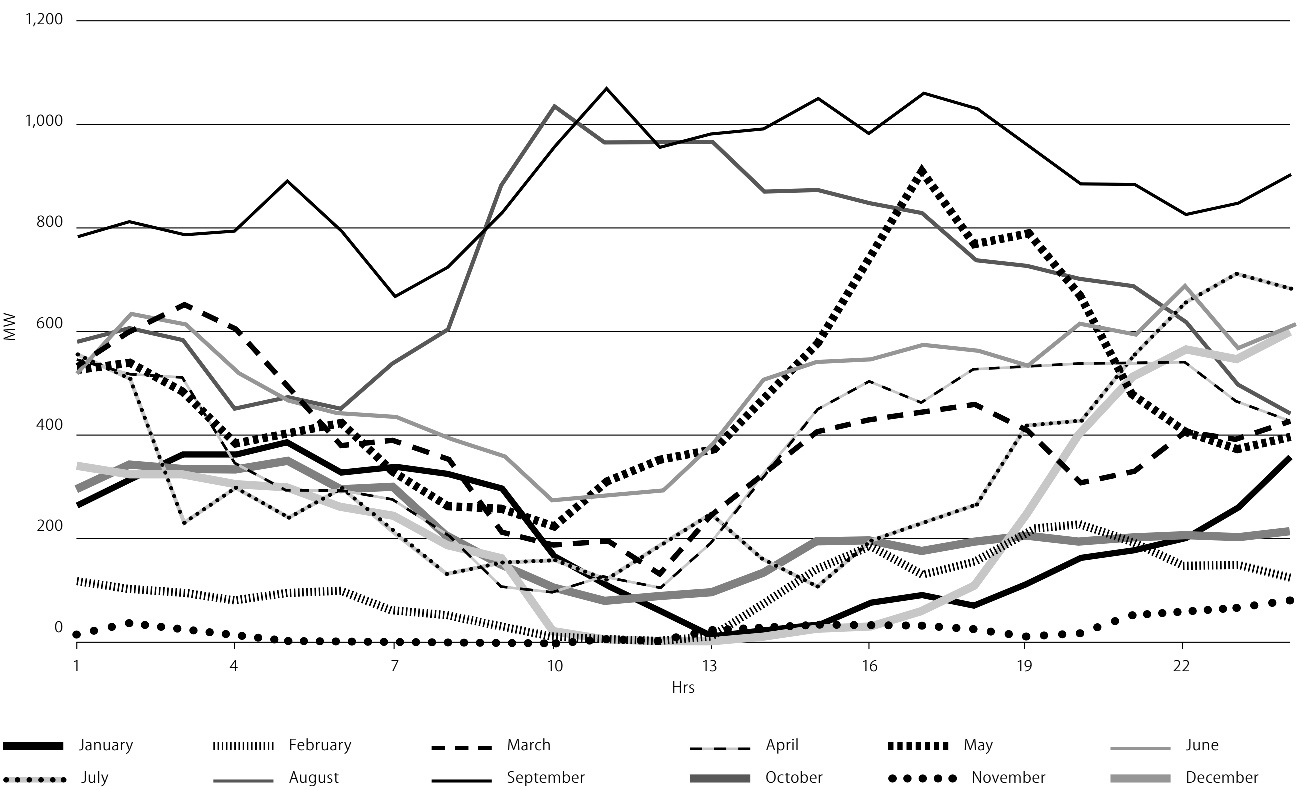
Coal cost = ₹1,000/tonne, Operating cost = 2% of Capital cost for coal plant, 0.5% for solar plant.
* Heat rate = 2,400 kcal/kWh.
** Heat rate = 2,150 kcal/kWh.

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



Source: Figure 5.2.1, Annual Report, 2013-14, SLDC (2014), Gujarat.

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



Source: Baba (2014).

why those who want India to move ambitiously are willing to give up finance and technology.

One may add that India should recognise the importance of technology and mount its own ambitious research and development efforts to develop solar cells with 45% efficiency.

Distributed Renewable Energy

One of the criticisms of India's INDC is that it does not emphasise DRE, 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 they can earn by running one village-level network.

One has to recognise 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 (p 24) show the power generation from wind and solar energy in Gujarat. Thus, even a village-level network will require electricity storage or a back-up 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 24×7 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.

In Conclusion

Differentiating responsibility without reference to historical emissions is a weak 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 1 tonne of GHGs to the current stock. Thus, the INDC promises 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 aid.

Notes

1 This figure is based on the data presented on the Coal India (nd) website. It shows production of 494.24 mt of coal in 2014–15 (fiscal 2015) and the number of workers at 2,74,372 in January 2016. This gives us, assuming 300 working days at eight hours a day, 0.75 tonnes per worker hour. If one includes all employees then even with 2,000 working hours per year, it comes to 0.75 tonnes per employee hour.

2 In 2011, coal mining productivity was at 8.86 short tonnes per employee hour in surface mining and at 2.76 short tonnes per employee hour in underground mining, averaging out to 5.22 short tonnes per employee hour. See, US Energy Information Administration (2012), Table 7.7.

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