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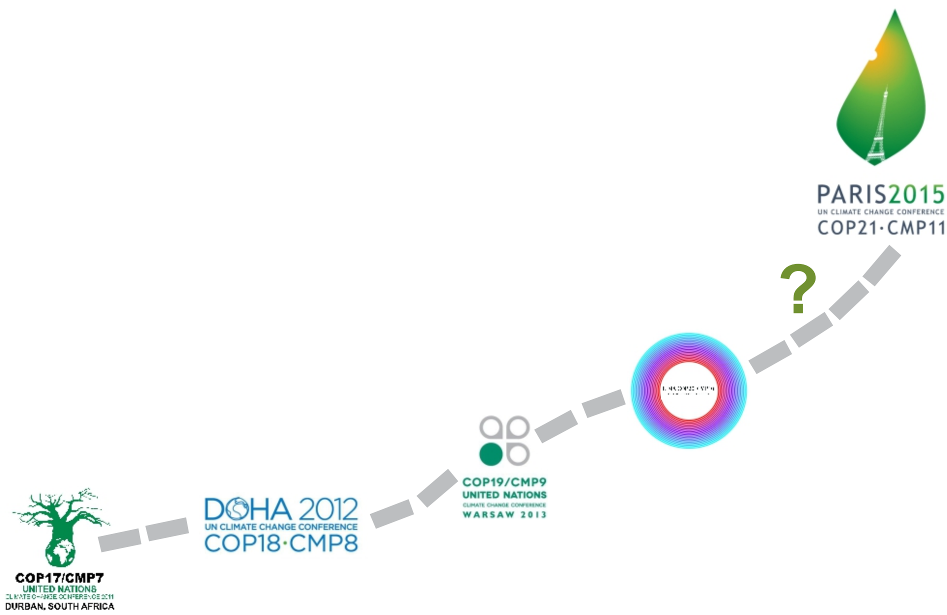
India's Intended Nationally Determined Contributions

Renewable Energy and the Pathway to Paris

SUDATTA RAY, VAIBHAV CHATURVEDI, KARTHIK GANESAN, AND ARUNABHA GHOSH



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The Council on Energy, Environment and Water (http://ceew.in/) is an independent, not-for-profit policy research institution. CEEW addresses pressing global challenges through an integrated and internationally focused approach. It does so through high quality research, partnerships with public and private institutions, and engagement with and outreach to the wider public. CEEW has been ranked as India's top climate change think-tank two years in a row (ICCG Climate Think Tank Ranking). CEEW has been ranked best in India (and South Asia) in several categories two years running in the Global Go To Think Tank Index.

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ABOUT CEEW

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- 1st in India among 'Top Think Tanks with Annual Operating Budgets of Less Than $ 5 Million USD' (2013, 2014 also first in South Asia; 14th globally)
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- 1st in India for 'Best Policy Study/Report' for its study on India's National Water Resources Framework (2013)

In four years of operations, CEEW has engaged in more than 70 research projects, published more than 40 peer-reviewed policy reports and papers, advised governments around the world over 80 times, engaged with industry to encourage investments in clean technologies and improve efficiency in resource use, promoted bilateral and multilateral initiatives between governments on more than 30 occasions, helped state governments with water and irrigation reforms, and organised more than 80 seminars and conferences.

CEEW's major completed projects: 584-page National Water Resources Framework Study for India's 12th Five Year Plan; India's first report on global governance, submitted to the National Security Adviser; foreign policy implications for resource security; India's power sector reforms; first independent assessment of India's solar mission; India's green industrial policy; resource nexus, and strategic industries and technologies for India's National Security Advisory Board; $125 million India-U.S. Joint Clean Energy R&D Centers; business case for phasing down HFCs; geoengineering governance (with UK's Royal Society and the IPCC); decentralised energy in India; energy storage technologies; Maharashtra-Guangdong partnership on sustainability; clean energy subsidies (for the Rio+20 Summit); reports on climate finance; financial instruments for energy access for the World Bank; irrigation reform for Bihar; multi-stakeholder initiative for urban water management; Swachh Bharat; environmental clearances; nuclear power and low-carbon pathways; and electric rail transport.

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low-carbon rural development; modelling long-term energy scenarios; modelling energy-water nexus; coal power technology upgradation; India’s 2030 renewable energy roadmap; energy access surveys; energy subsidies reform; supporting India’s National Water Mission; collective action for water security; business case for energy efficiency and emissions reductions; assessing climate risk; modelling HFC emissions; advising in the run up to climate negotiations (COP-21) in Paris.

ABOUT THE AUTHORS

Sudatta Ray

Sudatta Ray is a Junior Research Associate at the Council on Energy, Environment and Water (CEEW), India. She is a recent graduate of Carnegie Mellon University's (CMU) Heinz School of Public Policy and Management. On a Fulbright scholarship at CMU, Sudatta completed her Masters in Public Policy and Management, with an additional certification in Policy Analytics. She specializes in large data analyses with skills ranging from data visualization, econometric analyses to geographic information systems.

Sudatta has previously worked with the World Wide Fund for Nature (WWF-India) and the Ministry of Environment & Forests, Government of India. As a Senior Programme Officer with WWF-India, Sudatta was responsible for climate policy research and represented the Indian country office at WWF's Global Climate and Energy Initiative. With the Climate Change division of the Ministry of Environment & Forests, she participated in five Conference of the Parties meetings of the United Nations Framework Convention on Climate Change (UNFCCC) and has also contributed towards the synthesis of publications in the capacity of a Technical Officer.

Sudatta has Bachelors and Masters degrees in Chemistry from Delhi University. During her time at CMU, Sudatta interned with the Energy and Environment division of the United Nations Development Programme as well as the Environmental Defense Fund.

Dr Vaibhav Chaturvedi

Dr Vaibhav Chaturvedi is a Research Fellow at CEEW. Prior to CEEW, Vaibhav worked as a Post Doctoral Research Associate at the Joint Global Change Research Institute (JGCRI), collaboration between the Pacific Northwest National Laboratory, USA and the University of Maryland, College Park, USA. He holds a PhD in Economics from the Indian Institute of Management Ahmedabad, India and Masters in Forest Management from the Indian Institute of Forest Management Bhopal, India.

His research is focused on Indian and global energy and climate change mitigation policy issues- carbon dioxide emission stabilization pathways, low carbon and sustainable energy policies, modelling energy demand, and water-energy nexus within the integrated assessment modelling framework of the Global Change Assessment Model (GCAM). Vaibhav's recent work includes analyzing nuclear energy scenarios for India, Indian HFC emission scenarios, climate policy-agriculture water interactions, transportation energy scenarios, model evaluation, investment implications for the global electricity sector, and modelling the building sector energy demand scenarios for India. Vaibhav has been actively involved in global model comparison exercises like Asian Modelling Exercise (AME) and Energy Modelling Forum (EMF).

At CEEW, Vaibhav's research focuses on India within the domain of energy and climate policy, mid-range and long-range energy scenarios, HFC emission scenarios, urban energy demand pathways, and energy-water inter relationship. He has been actively publishing in leading international energy and climate policy journals.

Karthik Ganesan

Karthik Ganesan is a Senior Research Associate at CEEW, India. He leads the research efforts in the area of energy access and the future energy consumption pathways of rural India, and the opportunities for industrial energy efficiency gains. Most recently, he carried out an extensive analysis of the Indian government's policy support for RE industry and the cost implications of the exchequer. His focus has been to bring quantitative techniques from other domains, such as consumer choice models and system dynamics modelling to provide a holistic understanding of the various factors that influence energy policy and their impact in turn, on development and sustainability.

Prior to his association with CEEW he has worked on an array of projects in collaboration with various international institutions, with a focus on technology and environmental valuation. His published (and under review) works include the *Power Sector Expansion Plans in the Greater Mekong Sub-region: Regional governance challenges* (ADB), *Carbon Capture and Storage Potential for SE Asia* (ADB), *Valuation of Health Impact of Air pollution from Thermal Power Plants* (ADB), and *India's Energy Conundrum – What the future holds* (World Scientific).

Karthik graduated with a Masters in Public Policy from the Lee Kuan Yew School of Public Policy at the National University of Singapore. He has an M.Tech in Infrastructure Engineering and a B.Tech in Civil Engineering from the Indian Institute of Technology, Madras in Chennai.

Dr Arunabha Ghosh

ARUNABHA GHOSH is CEO of the Council on Energy, Environment and Water (CEEW), an independent, policy research institution in India. Arunabha conceptualised and has led CEEW, since its founding in August 2010, to the top-ranked climate think-tank in India for the last two years in a row. CEEW has been ranked best in India (and South Asia) in several categories two years running in the Global Go To Think Tank Index. With experience in 35 countries and having worked at Princeton, Oxford, UNDP and WTO, Arunabha advises governments, industry and civil society around the world on: energy and resources security; renewable energy; water governance; climate governance; energy-trade-climate linkages; and international regime design. He is a World Economic Forum Young Global Leader, Asia Society Asia 21 Young Leader, and fellow of the Aspen Global Leadership Network. He is also a founding board member of the the Clean Energy Access Network (CLEAN). He writes a monthly column, Inflexion Points, in the Business Standard.

Dr Ghosh is member of Track II dialogues with the United States (co-chair of the taskforce on economic relations for the Aspen Strategy Dialogue), Bhutan, Israel, Pakistan and Singapore. He formulated the Maharashtra-Guangdong Partnership on Sustainability. Dr Ghosh is associated with Oxford's Global Economic Governance Programme and Oxford's Smith School of Enterprise & the Environment. He was Global Leaders Fellow at Princeton's Woodrow Wilson School and at Oxford's Department of Politics and International Relations. He was Policy Specialist at the United Nations Development Programme (New York) and worked at the World Trade Organization (Geneva). He is on the Board of the International Centre for Trade & Sustainable Development.

Arunabha's publications include: Materials, Markets, Multilateralism; Three Mantras for India's Resource Security; Understanding Complexity, Anticipating Change (India's first report on global governance, submitted to the National Security Adviser); National Water Resources Framework Study (for India's 12th Five Year Plan); Strategic Industries and Emerging Technologies (for the National Security Advisory Board); Laying the Foundation of a Bright Future (first evaluation of India's solar mission); Making the UN Secretary General's Climate Summit Count; India's Resource Nexus (also for NSAB); Governing Clean Energy Subsidies; RE+: Renewables Beyond Electricity; Urban Water and Sanitation in India; Institutional Reforms for Improved Service Delivery in Bihar (on irrigation); Harnessing the Power Shift (on climate finance); International Cooperation and the Governance of Geoengineering (for the IPCC); Collective Action for Water Security and Sustainability; and three UNDP Human Development Reports. He has also led research on trade, intellectual property, financial crises, development assistance, indigenous people, extremism and conflict.

Dr Ghosh has presented to heads of state, India's Parliament, the European Parliament, Brazil's Senate, and other legislatures; trained ministers in Central Asia; and hosted a documentary on water set out of Africa. His op-eds have appeared in the Times of India, The Hindu, India Today, Indian Express, Financial Express, Mint, Seminar, and Tehelka. He has delivered public lectures in several countries, and commented on All India Radio, ABC (Australia), BBC, CNN-IBN, NDTV (India) and Voice of America, among other broadcasters.

Arunabha has been consulted by the Asian Development Bank, Commonwealth Secretariat (London), DFID (UK), IDRC (Canada), International Energy Agency, International Finance Corporation, IPCC, Oxfam International, Transparency International, UK Ministry of Justice, USAID, and the World Bank. He co-chaired the international governance working group for the UK Royal Society's Solar Radiation Management Governance Initiative. He has been an Editor of the Journal of Human Development and Capabilities.

Arunabha holds a doctorate and M.Phil. in international relations from Oxford (Clarendon Scholar and Marvin Bower Scholar); an M.A. (First Class) in Philosophy, Politics and Economics (Balliol College, Oxford; Radhakrishnan Scholar); and topped Economics from St. Stephen's College, Delhi University.

CONTENTS

1. INTRODUCTION

The 20th Conference of Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) concluded in the early hours of 14 December 2014. While some basic directions on areas of inclusion for the Intended Nationally Determined Contributions (INDCs) have been provided in the COP decision at Lima, for the most part it still remains an open ended decision left to individual countries. Specifically, it was decided that the INDCs would be submitted by the first quarter of 2015 (for those who are in a position to do so) or by 1 October, 2015 should include the following:[1]

1. Quantifiable information on the reference point (including a base year)
2. Time frames and/or periods for implementation
3. Scope and coverage (implying gases and sectors)
4. Planning processes (to oversee the fulfilment of INDCs)
5. Assumptions and methodological approaches, including those for estimating and accounting of GHGs
6. How the Party considers that its INDC is fair and ambitious, in light of its national circumstances, and how it contributes towards achieving the objective set out in Article 2 of the convention

With the above as guiding points, it is now up to India to decide what the country feels is a fair and ambitious target to achieve the stabilisation of GHG concentrations in the atmosphere at a safe level. For the purposes of this document, the safe level has been assumed as one that provides greater than 66% likelihood of staying within a 2^{o}C degree rise in temperature above pre-industrial levels.[2] Our analysis suggests that India could push its ambition towards a target of 1,041 Billion Units (BU) of electricity from renewable energy sources by 2030. This would translate to cumulative emissions of 3.4 Gt of CO_2 equivalents (CO_2 eq.) and per capita emissions of 2.25 tonnes of CO_2 eq. in 2030. However, this target would require an incremental cost of approximately INR 39,320 billion (2010, INR) (2010, US$ 715 billion) over the next 15 years and could make the consumption of a threshold level of electricity unaffordable for the bottom two deciles of Indian households.[3]

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[1] *Lima Call for Climate Action*. Rep. no. Decision -/CP.20. Lima: UNFCCC, 2014. Web. 26 Dec. 2014.

[2] This corresponds to the scenario RPM 2.6 in the AR5 Synthesis Report, which includes median CO_2 concentration of 450 ppm in 2100.

[3] The threshold level of annual electricity consumption for an average household in 2030 is defined as 2,000 kWh. The incremental cost indicated in each case highlights not only the capital cost required to set up the infrastructure, but also the accompanying need for grid integration to ensure the stability of the grid. Grid integration costs include a range of investments spanning from backup capacity of gas to storage. With increasing contribution from renewable energy, grid integration costs increase in a non-linear manner and account for nearly a third of the total incremental cost with 150 GW of solar energy in the electricity grid.

This document outlines one component of India's INDC submission to the UNFCCC focussing on the renewable energy contribution to its future electricity mix. So far, the Government of India has articulated solar targets for renewable energy, which therefore deserves careful analysis. The document has been divided into the following sections:

Contributions and Actions of Major Emitters: Implications for the Rest of the World – In order to assess the fairness of a potential Indian INDC, it is important to understand the actions and intended contributions of other major emitters (the United States, the European Union, China, Japan, Australia and Canada). Following an analysis of the contributions, this section also analyses the carbon space that remains for the rest of the world including India.

India and China: Differences in Scale and Nature of Emissions in the Past, Present and Future – This section compares India's and China's climate actions at various levels of development (2000, 2010 and 2020).

India's Contributions: Balancing Ambition and Fairness – Given India's national circumstances and development needs, this section provides details of the most ambitious targets that India could offer to ensure the global achievement of a 2^{o}C scenario. This section also illustrates the issue of electricity affordability and provides options on how India could ensure that its climate actions are in line with its development needs.

2. CONTRIBUTIONS AND ACTIONS OF MAJOR EMITTERS: IMPLICATIONS FOR THE REST OF THE WORLD

In order to limit to a 2^{o}C global rise in temperature, various reports including Intergovernmental Panel on Climate Change’s Fifth Assessment Report (AR5) and the United Nations Environment Programme’s 2013 version of the Emissions Gap Report estimate that the total budget for CO_2 emissions is approximately 1,000 Gt of CO_2 eq. While the scientific community has broadly reached consensus on the global emissions pathway, allocation of the annual budgets to each individual country remains a hotly debated topic.

This brief does not attempt to create an equity allocation framework, but merely lists out the actions undertaken, the pledges that the major emitting countries have made and how these translate to the carbon space available for remaining countries.

Table 1 provides a snapshot view of where China, the US, the EU, India, Japan, Canada and Australia stand in terms of emissions, ambition and intended contributions.

Table 1: Country Status on Climate Targets and Contributions

S. No.	Indicator	China	US	EU	Japan	Australia	Canada	India
1.	GDP Per Capita, PPP (2013)	11,907	53,042	35,502	36,449	43,544	43,247	5,412
2.	Aggregate Emissions (2010,Gt of CO_2 eq.)	8.287	5.433	3.701	1.171	0.373	0.499	2.009
3.	Per Capita Emissions (2010, mt)	6.2	17.6	7.4	9.2	16.9	14.7	1.7
4.	Peaking year/ Base year and Reduction	2030	26%-28% reduction Over 2005 levels by 2025; Previous Announcement included 17% Reduction by 2020 and 83% reduction by 2050 over 2005 levels	40% reduction over 1990 levels by 2030; 27% of RE as well as EE by 2030 ; 80%-95% Reduction over 1990 by 2050	Changed their earlier commitment of 25% reduction over 1990 by 2020 to 3.8% reduction over 2005 by 2020 (translates to 3% increase over 1990 by 2020)	5% reduction over 2000 by 2020 (unconditional); 15% reduction over 2000 by 2020 (global agreement including major economies); 25% reduction over 2000 by 2020 (450 ppm)	17% reduction over 2005 levels by 2020	Not Announced
5.	Emissions Intensity(2010, CO_2 kg/ $ PPP GDP)	0.7	0.4	0.2	0.3	0.4	0.4	0.4
6.	Renewable Energy as % of Total Energy (TARGET)			20% of total energy mix from RE by 2020, of this 10% (min.) to come from bio-fuels				
7.	Renewable Energy as % of Electricity Generation (2011)	17.0%	11.3%	20.7%	11.8%	9.1%	62.2%	17.4%

Table 1: Country Status on Climate Targets and Contributions

S. No.	Indicator	China	US	EU	Japan	Australia	Canada	India
8.	Renewable Energy as % of Electricity Generation (TARGET)	Targets not declared as a proportion of electricity mix. 12 FYP targets include 104 GW of wind, 260 GW of hydro and 35 GW of solar by 2015	10% of electricity from RE by 2015, 15% by 2016-17, 17.5% by 2018-19 and 20% by 2020		Revised previous target of 13.5% of RE in electricity by 2020 and 20% by 2030	20% of electricity from RE by 2020	No target at present	100 GW of Solar Energy by 2022
9.	Non-Fossil Fuel Energy as % of Total Energy (2011)	11.7%	16.3%	25.5%	10.4%	5.2%	26.5%	27.7%
10.	Non-Fossil Fuel Energy as % of Total Energy (TARGET)	20% from non-fossil fuel sources in primary energy generation by 2030						
11.	Non-Fossil Fuel Energy as % of Electricity Generation (2011)	19.1%	31.6%	49.5%	19.6%	9.5%	77.5%	20.6%
12.	LULUCF (2012, Gt of CO_2 eq.)		-0.941	-0.303	-0.075	0.015	0.41	
13.	Agriculture (2010, Million mt of CO_2 eq, CH_4 +N_2O)	140.2	503.7	273.7	55.3	116.4	60.0	611.7
14.	Transportation (2011, Million mt CO_2 eq.)	623.3	1638.1	897.3	219.7	86	166	169.9

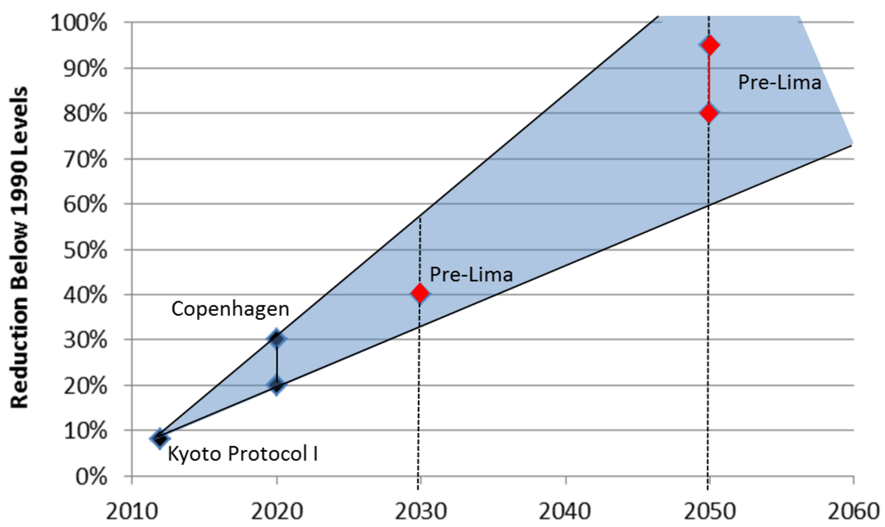
Source: World Bank, CEEW Analysis

Given below are straight line projections of previously announced climate actions for the EU, the US and China. The respective graphs also plot the most recent announcements made in October and November of 2014 and illustrate the change (if any) in ambitions for the three regions.

European Union (28)

During the 15th COP in Copenhagen, the EU had declared a 20% reduction target by 2020 below 1990 levels. Additionally, it also had a target of 30% reduction by 2020, conditional on commitments made by other countries in proportion to the one made by EU. These two numbers were used to create straight line projections of reduction pathways for the region (Figure 1). Consequently, the grey band indicates the maximum and minimum extent of the region's ambition (the former subject to global commitments). In late October 2014, the EU announced its intention of reducing the region's GHG emissions by 40% over 1990 levels by 2030 and 80%-95% by 2050 (indicated as Pre-Lima).[4]

Figure 1: European Union's Climate Declarations



Source: CEEW Analysis

Figure 1 indicates that the EU has increased its ambition with respect to the 20% reduction commitment for 2020, but remains below the trajectory, which would materialize if the 30% reduction target were followed. A recent report released by the UNFCCC indicates that the European Union had decreased its GHG emissions in 2012 (not including LULUCF) by 19.2% from 1990 levels.[5] This accounts for a net emissions reduction of 1.08

[4] The European Union. European Commission. *EU Action on Climate*. N.p., 12 Dec. 2014. Web. 3 Jan. 2015.

[5] *National Greenhouse Gas Inventory Data for the Period 1990–2012*. Rep. no. FCCC/SBI/2014/20. Lima: UNFCCC, 2014. Print. Subsidiary Body for Implementation.

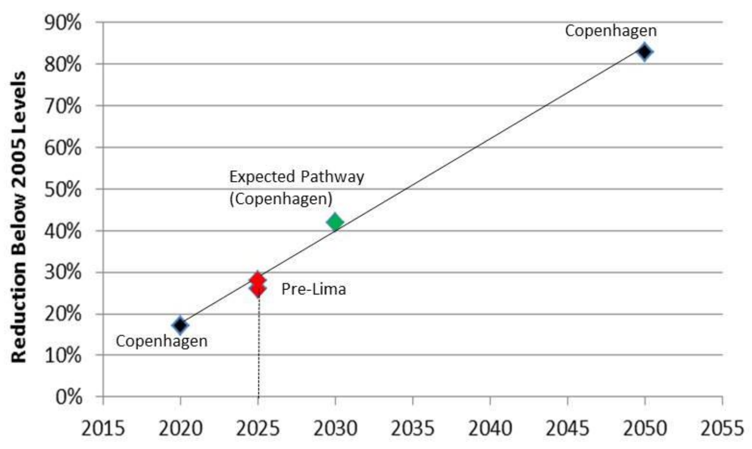
Gt of CO_2 eq. from 1990 to 2012 and well beyond the KP-I targets (8% reduction over 1990 levels) ascribed to the region.

United States

In 2009 at Copenhagen, the US announced its reduction targets of 17% and 83% for 2020 and 2050, over 2005 levels, respectively.6 Additionally, the announcement also included a tentative reduction target of 42% for 2030 to indicate the expected pathway leading up to 2050. The three numbers were interpolated and resulted in a straight-line reduction pathway. In November 2014, the US and China made a joint announcement which would be the bases of their respective INDCs. For the US this entails a 26%-28% emissions reduction by 2025 over 2005 levels.[7] This Pre-Lima announcement for the US lies on the lower side of the straight line interpolation, hence indicating nothing new or ambitious as compared to its Copenhagen announcement.

The Kyoto Protocol target for the first commitment period is not indicated in the graph below for reasons that the United States did not ratify to the protocol. However, as per the GHG inventory submissions made to the UNFCCC, the United States had actually increased its GHG emissions by 4.3% in 2012 as compared to 1990 levels (excluding LULUCF).[8] Further, this accounted for a net increase of 0.28 Gt of CO_2 eq. in 2012 from 1990 as opposed to what should have been a net decrease of 0.70 Gt of CO_2 eq. as per the KP-I targets.

Figure 2: United States' Climate Declarations



Source: CEEW Analysis

[6] The White House. Office of the Press Secretary. *Administration Announces U.S. Emission Target for Copenhagen.* Whitehouse.gov. N.p., 25 Nov. 2009. Web. 21 Nov. 2014.

[7] The White House. Office of the Press Secretary. *FACT SHEET: U.S.-China Joint Announcement on Climate Change and Clean Energy Cooperation*.Whitehouse.gov. N.p., 11 Nov. 2014. Web. 21 Nov. 2014.

[8] *National Greenhouse Gas Inventory Data for the Period 1990–2012*. Rep. no. FCCC/SBI/2014/20. Lima: UNFCCC, 2014. Print. Subsidiary Body for Implementation.

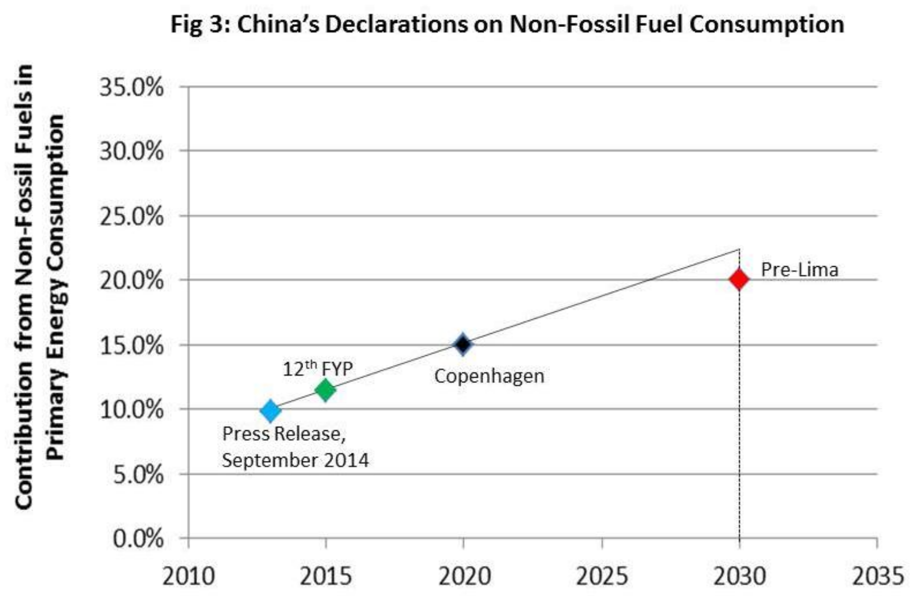
It is important to refrain from comparing one-to-one between the EU and the US on account of different base years and initial levels of emissions.

China

China, still a developing country, has not declared any absolute emissions reduction target so far. Prior to Copenhagen, China announced a carbon intensity reduction target of 40%-45% by 2020 over 2005 level. Most recently, alongside the US, China announced its peaking target around 2030 and 20% contribution of non-fossil fuel in its total primary energy consumption mix by 2030.

While the increase in the share of primary energy consumption sounds ambitious, a straight-line projection including previous domestic targets indicates that the declared target of 20% may be lower than what the country could achieve with a constant rate of growth of non-fossil fuel consumption beginning in 2013.[9,10]

Figure 3: China's Announcements on Non Fossil Fuel Consumption



Source: CEEW Analysis

<u>It is unclear at what level China plans to peak and its actions thereafter</u>. Given its 12th Five Year Plan target of 7.5% of consumption from natural gas by 2015, China intends to replace

[9] "*SCIO Briefing on Climate Change*." Mr. Xie Zhenhua, vice minister of the National Development and Reform Commission (NDRC). China.org.cn. N.p., 19 Sept. 2014. Web. 21 Nov. 2014.

[10] Aden, Nate. "*China's "New Long March" through the UN Climate Summit: Context and Opportunities*." World Resources Institute. N.p., 22 Sept. 2014. Web. 21 Nov. 2014.

its coal consumption with natural gas in the years to come.[11] The region owns the largest geologically estimated shale reserves of 35 trillion cubic metres and natural gas emits roughly half the emissions emitted by coal. This suggests that China may not need to curb its fossil fuel energy consumption in spite of its peaking target in the decades to come.[12,13]

Carbon Space: How much space is left for the rest of the world?

Increasing ambition aside, the key question still remains unanswered. Given the changing (but often lowering) appetite of the major emitters to reduce their emissions, what does it translate to in terms of the available carbon space for the rest of the world? Our analysis indicates that with the current pledges of the three regions, less than half the total carbon emissions permissible in 2030 and 2050 would be available for the rest of the world.

Methodology

The United Nations Environment Prgramme (UNEP) in its 2013 Gap Report estimates a global emissions range of 32-42 Gt CO_2 eq. in 2030 and 18-25 Gt CO_2 eq. in 2050 to remain within a likely chance of 2^oC rise.[14] The Global Change Assessment Model (GCAM) estimates global annual emission of 36 Gt CO_2 eq. in 2030 and 25 Gt CO_2 eq. in 2050 as the least cost pathway to limit to a 2^oC rise in temperature.[15] Thus, using 36 Gt CO_2 eq. and 25 Gt CO_2 eq. as the annual budgets in 2030 and 2050 respectively, the carbon space was calculated for the rest of the world. For expected emissions of the EU, the US and China, two scenarios were chosen: one included individual country pledges, and the other used results from GCAM.

While countries decide based on their individual needs of growth and GDP output, GCAM results indicate the least cost strategy, which assumes free market flows of goods, services and emissions trading across the globe. Since China has not made any definitive pledges in terms of emissions in 2030 and 2050, data from the MIT-Tsinghua report, which models China's emissions pathway, are used instead.[16] Specifically, the Concentrated Effort pathway numbers have been used (this is the medium effort scenario in the report).

[11] Juan, Du. "New 5-year Plan to Raise Goals for Renewables." *China Daily*. N.p., 14 Oct. 2014. Web. 21 Nov. 2014.

[12] Higashi, Nobuyuki. *Natural Gas in China Market Evolution and Strategy*. Energy Markets and Security/2009. N.p.: International Energy Agency, 2009. Print.

[13] "*How Much Carbon Dioxide Is Produced When Different Fuels Are Burned*?" Frequently Asked Questions. United States Energy Information Administration, 4 June 2014. Web. 15 Dec. 2014

[14] Likely chance is defined as a probability ≥ 66%

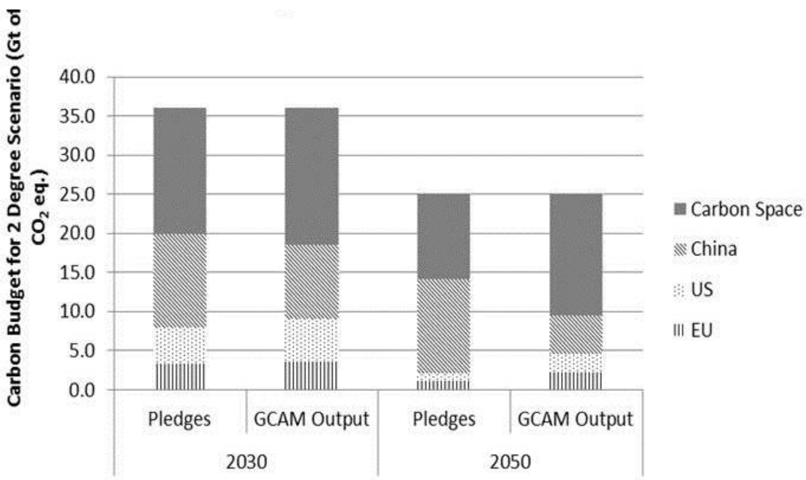
[15] The Global Change Assessment Model (GCAM) is an integrated global assessment tool for exploring climate and energy scenarios. GCAM is a Representative Concentration Pathway (RCP)-class model and is a type of dynamic-recursive model. It includes technology-rich representations of the economy, energy land use and water linked to a climate model of intermediate complexity that can be used to explore climate change mitigation policies including carbon taxes, carbon trading, regulations and accelerated deployment of energy technology. The model runs in five year time steps and includes India as a separate region.

[16] Zhang, Xiliang, Valerie J. Karplus, Tianyu Qi, Da Zhang, and Jiankun He. "Carbon Emissions in China: How Far Can New Efforts Bend the Curve*?" MIT Joint Program on the Science and Policy of Global Change* No. 267 (2014): n. pag. Web. 26 Nov. 2014.

Results

Using the country pledges and modelling results from GCAM, the available carbon space for the remaining countries was calculated in both cases. Figure 4 illustrates that GCAM models a more equitable distribution of the available carbon space, with a greater proportion available to the remaining nations. Further, China dominates the carbon space, and this situation is exacerbated if China decides to level off its emissions at 12 Gt of CO_2 eq. (as modelled by the MIT study). A summary of the results is provided in table 2.

Figure 4: 2030 and 2050 Carbon Space Allocation under GCAM Outputs and with Current Commitments



Source: CEEW Analysis

Table 2: Carbon Space Occupied by the EU, US and China in 2030 and 2050

Region	2030				2050			
	Pledges		GCAM		Pledges		GCAM	
	Gt of CO_2 eq.	% of Total	Gt of CO_2 eq.	% of Total	Gt of CO_2 eq.	% of Total	Gt of CO_2 eq.	% of Total
EU	3.3	9.3%	3.6	10.0%	1.1	4.3%	2.2	8.8%
US	4.6	12.7%	5.5	15.3%	1.1	4.2%	2.3	9.2%
China	12.0	33.3%	9.4	26.1%	12.0	48.0%	5.0	20.0%
Remaining Nations	**16.1**	**44.7%**	**17.5**	**48.6%**	**10.9**	**43.5%**	**15.5**	**62.0%**
Total	36.0	100.0%	36	100.0%	25	100.0%	25	100.0%

Source: CEEW Analysis

3. INDIA AND CHINA: DIFFERENCES IN SCALE AND NATURE OF EMISSIONS IN THE PAST, PRESENT AND FUTURE

Any submission made by India as its INDC is bound to get compared with that of China. This is largely due to that the fact the two countries rank as the fourth largest and largest emitters respectively, and have been members of the same negotiating groups within the UNFCCC.[17] Consequently, it is important to understand the differences in scale and context that exist between the two countries before analysing components of India's INDC that would qualify as fair and ambitious. Table 2 provides economy and energy related information for India and China at different levels of development (2000, 2010 and 2020).

India's and China's emissions have differed both in quantum and nature in the past
While the story of incredible growth in both countries is well known, what is discussed less are the differing pathways of the respective development in the two countries. Specifically, India witnessed a growth in per capita GDP (PPP) of 121% between 2000 and 2010, but this occurred with a concomitant growth in absolute emissions of 69%. China on the other hand, grew at almost twice India's growth rate at 216 % but registered more than double the growth rate in emissions (143%). This difference in the nature of growth is reflected in both their emissions intensities. While both India and China aim to reduce their emissions intensities, and have done so, China's emission intensity has been higher in the past and is projected to be higher than that of India even in 2020.

India's and China's actions to curb growth in emissions have been different at comparable levels of income
Emissions intensity, are a function of macroeconomic policies, advancing technologies and industrial policies (which in turn are driven by a multitude of factors). On the other hand, the thrust on increasing renewable energy generation is a clearer indicator of the two countries' climate ambitions. Further, since both India and China house mammoth populations, energy needs feature high in their list of priorities.

Renewable energy contribution to electricity was negligible in 2000 in both India and China.[18] However, in 2010, its share in India increased to 4.4%, leaving China far behind at 1.7%. If large hydropower were included, China's share of renewable energy was only marginally more than India's in 2010 and would be slightly higher in 2020. For India, with a much smaller overall electricity generation capacity and a vast electricity deficit, share of more expensive renewable energy is a more commendable achievement. Consequently,

[17] In 2009, China and India came together with South Africa and Brazil to form the BASIC. More recently in 2012, the two countries joined ranks with ten other countries to form the group of Like Minded Developing Countries on Climate Change (LMDC) (http://www.twn.my/title2/climate/info.service/2012/climate20121005.htm).

[18] Renewable energy here does not include hydro projects, as most of the hydro projects in both countries are classified as large.

India will need to rapidly increase its installed capacity to provide electricity access to a quarter of its population.[19] However, even in 2020, as per GCAM projections (as well as respective government publications), India will continue to march ahead of China in terms of renewable energy contribution to electricity (GCAM projects 13.8% share of renewable energy in India's and 3.0% in China's electricity mix).

The nature of emissions will remain different for both India and China in the decades to come

Growth in China has chiefly been driven by manufacturing and industry, evidenced by the sector's contribution of 44% to the total GDP in 2013.[20] This sector has been the major contributor to the country's emissions and is responsible for the increased demand for energy.[21] Considering that China was already at a GDP per capita (PPP) of $11,907 in 2013, the country may not witness large growth in its already massive industrial sector in the years to come.[22]

In contrast, the industrial sector in India contributed a mere 25% to the national economy in 2013, with a much larger services sector accounting for 57% of GDP.[23] At GDP per capita (PPP) of $5,412, India still requires many years of rapid growth to combat its development challenges. With an already dominating service sector, it is likely that the country will turn to industry to sustain its growth. The country's new government has similar plans of transforming India into a global manufacturing hub.[24] As a result, although currently at a much lower level, the future rate of growth in emissions may be significantly more for India than China. This underscores the need for an adequate carbon space to accommodate India's industrial growth and energy needs.

[19] In 2011, China housed 3 Million people without electricity as compared to India's over 300 Million.

[20] "*Industry, Value Added (% of GDP).*" The World Bank. N.p., n.d. Web. 5 Jan. 2015.

[21] Afsah, Shakeb, and Kendyl Salcito. "*Global Carbon Intensity: How China Wrecked This Metric*." CO_2 Scorecard. N.p., 18 Sept. 2014. Web. 4 Jan. 2015.

[22] "*GDP, Per Capita (Current US$).*" The World Bank. N.p., n.d. Web. 5 Jan. 2015.

[23] "*Service, Value Added (% of GDP).*" The World Bank. N.p., n.d. Web. 5 Jan. 2015.

[24] Coined as Make in India, the government initiative is designed to facilitate investment, innovation and skill development to accelerate the manufacturing sector in the country.

Table 3: Comparison between India and China on Key Development Indicators and Climate Actions in 2000, 2010 and 2020

S. No.	Indicator	2000		2010		2020*	
		India	China	India	China	India	China
1	GDP Per Capita, PPP	2,063	2,864	4,549	9,053	6,824	13,217
2	Population (Billion)	1.04	1.26	1.21	1.34	1.35	1.55
3	Aggregate Emissions (Gt of CO_2 eq.)	1.187	3.405	2.009	8.287	2.227	8.666
4	Per Capita Emissions (2010, Mt)	1.1	2.7	1.7	6.2	1.7	5.6
5	Peaking year/ Base year and Reduction						Around 2030
6	Emissions Intensity (TARGET)					20% - 25% Reduction in Emissions Intensity by 2020 over 2005 levels (Calculated as 0.3)	40%-45% Emissions Intensity reduction by 2020 over 2005 levels (Calculated as 0.5)
7	Emissions Intensity(CO_2 kg/ PPP of $ GDP) (ACTUAL)	0.6	0.9	0.4	0.7	0.24	0.42
8	Renewable Energy as % of Electricity Generation (including Hydro) (ACTUAL)	13.80%	16.60%	16.30%	18.90%	20.8% (12th FYP targets indicate 18% at the end of 2017)	24.0% (CEC projections estimate 20%)
9	Renewable Energy as % of Electricity Generation (excluding Hydro) (TARGET)					20 GW of Solar Energy by 2022 100 GW of Solar Energy by 2022**	Solar and Wind Generation to have an annual growth rate of 89.5% and 26.4% respectively until 2015
10	Renewable Energy as % of Electricity Generation (excluding Hydro)	0.50%	0.2%	4.4%	1.7%	13.8% (12th FYP targets indicate 9% at the end of 2017)	3.0% (CEC projections estimate 5%)
11	Non-Fossil Fuel Energy as % of Total Energy (TARGET)						20% of total primary energy mix by 2030
12	Non-Fossil Fuel Energy as % of Total Energy (ACTUAL)	35%	19.70%	27.50%	12.30%	28.30%	12.70% (13th FYP targets 15% by 2020)
13	Non-Fossil Fuel Energy as % of Electricity Generation	16.80%	17.90%	19.10%	20.80%	25.30%	25.50%
14	Agriculture (2010, Gt CO_2 eq., $CH_4 + N_2O$)	0.575	0.878	0.612	1.14		
15	Transportation (Gt CO_2 eq.)	0.094	0.253	0.162	0.575	0.249	0.693

Source: World Bank, CEEW Analysis
** The 2020 numbers included are those modelled by GCAM. All emission numbers for 2020 are from fossil fuels only and hence may be lower as compared to other assessments.*
*** This updated target is not reflected in the Solar Mission yet.*

4. INDIA'S CONTRIBUTIONS: BALANCING AMBITION AND FAIRNESS

The information provided by the Lima Call for Climate Action on form and content of the INDCs can be described as vague guidance at best. It is now up to individual countries to decide upon the appropriate balance between ambition and fairness, which in turn, will drive their climate targets. The following section therefore analyses the renewable contribution of India's climate targets as part of its INDC submission. Despite the fact that it is unlikely for most developing countries to commit to an absolute emissions reduction in 2030, it is critical that the various forms of ambitions be translatable to an absolute emissions number. This will help in assessing the adequacy of the communicated targets in limiting the rise to 2^{o}C. Consequently, the final part of this section translates the suggested target to an overall emission number for India in 2030. This section forms the basis of point 14 of Decision -/CP.20, the Lima Call for Climate Action document, which calls for parties to justify the ambition and fairness of their INDCs.[25] It specifically outlines three aspects of the targets –

- **Ambition** – the extent to which India can push its ambition for increasing domestic funding, creating facilitating environment and ultimately make binding commitments for increasing the use of clean energy and decline that of fossil fuels

- **Fairness** – how these targets will be attained alongside India's primary goal of achieving inclusive growth and eliminating the extant development challenges. An assessment of affordability of electricity in 2030 is presented in this sub-section.

- **Reconciling Ambition, Fairness and Overall Emissions –** includes the target, the appropriate context that deems the target ambitious and the implications for India's emissions in 2030.

[25] *Lima Call for Climate Action*. Rep. no. Decision -/CP.20. Lima: UNFCCC, 2014. Web. 26 Dec. 2014.

Ambition

In April 2014, an Expert Group on Low Carbon Strategies for Inclusive Growth submitted its report to the Planning Commission. The Expert Group estimated the potential share of non-fossil sources in India's electricity mix, drawing on solar, hydropower, wind, biomass and nuclear energy. For the purposes of this analysis, we include renewable energy sources as solar, hydropower, wind, biomass and others (including geothermal, tidal etc.).

Including large hydropower, renewable energy contribution to electricity in India was already at 16.3% in 2020. The current pace of growth in renewables and recently announced increase in targets indicate the presence of both ambition and enabling environment required to aid the acceleration of this contribution.[26] However, aggressive targets for renewable electricity generation sources imply that tremendous growth rates in installation would be required in the years ahead. It would be useful to ground the expectations of such rapid growth in the realities associated with environmental clearances, acquiring of land for the projects and project financing cycles.

For this reason, we conducted a bottom-up analysis as opposed to the extant modelling results that project growth of renewables endogenously based on macro-level growth patterns and projected demand in energy. Our analysis studies industry-specific growth patterns, government policies announced and are based on discussions held with industry experts and practitioners. Tables 4 and 5 summarise the results of our analysis and include a comparison with the Low Carbon Inclusive Growth (LCIG) scenario numbers from the Planning Commission Report.[27]

Table 4: Summary of Results for Renewable Electricity Generation in India in 2030 in BU

S No.	RE Source	Low Carbon Growth Report	Bottom-Up Analysis
1	Solar	275	356
2	Hydro	230	239
3	Wind	279	371
4	Biomass	70	59
5	Others	-	16
	TOTAL	854	1,041

Source: CEEW Analysis

[26] Although the announcement is yet to be converted to official targets and deadlines, the Minister of Power, Renewable Energy and Coal went on record stating the government's plan of increasing the solar targets to 100 GW by 2022; almost quadruple its earlier target of 22 GW by 2022.

[27] India. Planning Commission. *The Final Report of the Expert Group on Low Carbon Strategies for Inclusive Growth*. New Delhi: GoI, 2014. Print.

Table 5: Summary of Results for Electricity Generation from Non-Fossil Fuel in India in 2030

S No.	RE Source	Low Carbon Growth Report	Bottom-Up Analysis
1	Solar	275	134
2	Hydro	230	239
3	Wind	279	371
4	Biomass	70	59
5	Others	-	16
6	Nuclear	280	141
	TOTAL	1,134	1,182

Source: CEEW Analysis

India generated almost 140 billion units of renewable energy in 2010. Consequently, renewable-based power generation needs to increase by more than seven times by 2030 to reach the above stated target of 1,041 billion units. By way of comparison, Germany achieved similar growth from 1990 to 2012.[28] India has to meet its targets in a much shorter timeframe. This indicates the scale of India's ambitions but also recognises that renewable energy prices have fallen rapidly, technologies have moved along learning curves and new business models have developed. The aggressive renewable energy targets would not be easy to achieve but are not outside the realm of possibility either.

The assumptions used to estimate growth rates for each renewable energy technology, and the supporting justifications for these assumptions –are outlined below.

1. **Solar** – All the discussions surrounding an aggressive target for solar are based on the recent announcements by the Government of India.[29] While the programmatic details of these targets are yet to be announced, given the performance of the industry in the last four years, reaching 100 GW of solar by 2022 will be more than a challenging feat to accomplish.[30] Although India is endowed with a large potential, the issues of grid connectivity for large solar parks and for roof-top systems is far from certain. Additionally, with a minute domestic manufacturing capacity, ramping up installations will require coordinated effort across policymakers, manufacturers, engineering contractors and other stakeholders[31]. However, given the ambitious appetite of the

[28] CEEW Analysis, data sourced from http://www.volker-quaschning.de/datserv/ren-Strom-D/index_e.php

[29] "*A $400-bn Plan with Fair Returns Will Ensure 24X7 Power: Piyush Goyal*."Business Standard. N.p., 6 Dec. 2014. Web. 15 Dec. 2014.

[30] The Gujarat government reneging on agreed tariff rates in 2013 certainly hurt the prospects of India's most prolific state.

[31] Choudhury, Poulami, Shalini Agrawal, Kanika Chawla, Karthik Ganesan, Rajeev Palakshappa, and Arunabha Ghosh. *Tapping Every Ray of the Sun*. CEEW Policy Brief. New Delhi, 2014.

current government, in line with the 100 GW target, the bottom-up calculations reflect an annual addition of approximately 12 GW until 2020 and 6 GW thereafter until 2030.

2. **Hydropower** – India's installed base of 40 GW is well short of the established potential of ~150 GW. The 12th five year plan had aggressive targets of more than 10 during 2012-17. However, less than 2 GW has actually been commissioned in the first two years and given the number of projects under construction and awaiting approval, it is likely that the targets will slip yet again.[32] Given the pace of development observed in the last decade, the projects that are under development and the lead time in commissioning, a reasonable expectation for the industry to achieve in the next 15 years would be to add 1 GW on an annual basis.

3. **Wind** – Although wind based generation has made significant inroads into the overall mix, it is far from realising the true potential on offer. As per estimates, the industry has a capacity to produce up to 10 GW of wind turbines on an annual basis. However, with no clarity in policies and financial incentives, the time taken to achieve this full potential of the industry is significant. In the last two years, there has been a considerable dip in investor confidence. As a result, bringing it back to the 3 GW per year levels (that were witnessed until 2011) would require immediate response from policymakers. Based on conversations with project developers, it is expected that by 2018, the industry would be able to reach its full potential and exceed it, if policy clarity exists. A National Wind Mission to have 100 GW by 2022 was one trigger for the industry to express that confidence in installations is rebounding. Discussions with industry stakeholders are being conducted to explore the possibility of increasing the target to 200 GW by 2030[33]. Our assumptions of annual installations of between 10 and 12 GW per year for a good part of the next decade are in line with these aggressive targets. Wind (unlike solar) is already cheaper than thermal generation in many states, if the Feed-in-Tariffs provided are any indication.

4. **Nuclear** – The 2006 Integrated Energy Policy envisaged that India would have up to 63 GW of installed capacity by 2032.[34] In December 2011 this was revised down to 27 GW. In addition to the 4.3 GW that is under construction, 22 units have been proposed (with identified sites and technology) amounting to 21 GW of capacity[35]. Assuming suitable lead times for projects and accounting for the fact that more than half this proposed capacity is using 'imported' technology, an added lag is expected to account for negotiation and cost finalisation. Spreading the proposed projects and under construction projects over the next fifteen years results in an annual addition of about 1.1 GW per year.

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[32] India. Central Electricity Authority. *Hydro Capacity Added during 12th Plan (2012-17).* New Delhi: GoI, 2014. Print.

[33] "*Wind Discussion Forum – Towards 200 GW by 2030*." Shakti Sustainable Energy Foundation. N.p., 2014. Web. 22 Jan. 2015.

[34] India. Planning Commission. *Integrated Energy Policy - Report of the Expert Committee*. New Delhi: GoI, 2006. Print.

[35] "*Nuclear Power in India*." World Nuclear Association. N.p., 31 Dec. 2014. Web. 22 Jan. 2015.

Fairness

With nearly 60% of its population surviving on less than USD 2 a day, India faces mammoth development challenges in the decades to come.[36] Despite the fact that the country is one of the biggest economies, the fact remains that India has more in common with some of the least developed nations in terms of growth needs. India's climate targets need to be consonant with its development needs. While this need not cap India's ambition in increasing renewable energy generation, it could have ramifications on the extent of renewable energy contribution in the total electricity mix.

Our estimated target of 1,041 billion units from renewable energy translates to more than 30% of the total electricity generation in 2030 from renewable energy.[37] Further, the cumulative electricity generation number indicates 2,246 kWh of per capita electricity consumption. In contrast, consumption in China was already at 3,298 kWh per capita.[38]

These numbers represent economy-wide consumption. However, for reasons of political and development concerns, actual residential consumption and affordability of the electricity would form the cornerstone of the country's policy decisions on increasing renewable energy generation. Therefore, we assessed the affordability of electricity in 2030 among household income deciles of the country. We studied the twin challenges of affordability and aggressive renewable targets through multiple scenarios.

Methodology

The 68th round of the National Sample Survey was used to calculate household income deciles. Average annual household expenses, electricity expenses and electricity consumption values were calculated for each of the ten deciles. The calculations show that households on an average spent 3%-4% of their monthly expenses on electricity and the top decile consumed an annual average of 2,300 kWh per household of electricity in 2011-12.

We modelled the electricity prices for India and incremental costs required for achievement of the stated solar and wind targets using the GCAM model. We also assumed a decadal growth rate of 30% for household incomes.[39] Using 2,000 kWh as a benchmark for minimum residential electricity consumption in 2030, proportions of total household expenses spent on electricity were calculated for each decile. We also assumed that 10% should be a cap on the proportion that a household can spend on electricity.

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[36] "*Poverty Headcount ratio at $2 a day (PPP) (% of population).*" The World Bank. N.p., n.d. Web. 5 Jan. 2015.

[37] The cumulative demand has been taken from Planning Commission's Low Carbon Strategies for Inclusive Growth report; population in 2030 has been sourced from GCAM projections (1.502 Billion).

[38] "*Electric Power Consumption (kWh per capita).*" The World Bank. N.p., n.d. Web. 5 Jan. 2015.

[39] Using CAGR values for MPCE from the 55th and 68th rounds of NSS.

Results

1. Under both a Business As Usual (BAU) scenario as well as a global 2^oC scenario, cost optimised results suggest that the renewable energy contribution to electricity will be extremely low in 2030 in India. This will occur concomitantly with an increase in the average electricity price, making an annual threshold household consumption of 2,000 kWh unaffordable for the bottom 30% of households under the BAU scenario and bottom 50% in the global 2^oC scenario.

2. With the recently announced target of 100 GW of solar (assuming this is met by 2030), together with our bottom-up analysis of 170 GW of wind, an incremental burden of approximately INR 24,842 billion (2010, INR) (2010, US$ 452 billion) would be imposed during 2015-30 to make electricity prices close to those in BAU.

3. Were India to reach the announced solar target of 100 GW by 2022 and continue to build upon it (albeit at a slackened pace) to reach 150 GW of solar, together with 170 GW of wind by 2030, an incremental amount of INR 39,320 billion (2010, INR) (2010, US$ 715 billion) could be needed.

4. The incremental cost indicated in each case highlights not only the capital cost required to set up the infrastructure, but also the accompanying need for grid integration to ensure the stability of the grid. Grid integration costs include a range of investments spanning from backup capacity of gas to storage. With increasing contribution from renewable energy, grid integration costs increase in a non-linear manner and account for nearly a third of the total incremental cost with 150 GW of solar energy in the electricity grid.

5. In both cases, including ambitious renewable energy targets (100 GW or 150 GW of solar capacity by 2030), threshold level of annual household electricity consumption would remain unaffordable for the bottom 20% of households in 2030.

Table 6 provides a summary of results for the proportions of household expenses used for electricity in 2030 across household income deciles.

Table 6: Affordability of Electricity Consumption in 2030 under BAU, Global 2°C and Aggressive Renewable Targets

Household Income Deciles	Household Expenses	Proportion Expenses Utilized for Electricity			
		BAU (INR 5.07/kWh)	**Global 2°C** (INR 6.73/kWh)	**100 GW Solar + 170 GW Wind** (INR 4.19/kWh)	**150 GW Solar + 170 GW Wind** (INR 4.02/kWh)
1	45,669	22%	29%	18%	18%
2	72,555	14%	19%	12%	11%
3	90,722	11%	15%	9%	9%
4	107,735	9%	12%	8%	7%
5	125,655	8%	11%	7%	6%
6	146,164	7%	9%	6%	5%
7	170,993	6%	8%	5%	5%
8	204,966	5%	7%	4%	4%
9	261,444	4%	5%	3%	3%
10	482,724	2%	3%	2%	2%
Total Incremental Cost Required (INR Billion)		-	-	**24,842** (2010, US$ 452 billion)	**39,320** (2010, US$ 715 billion)

Source: CEEW Analysis

Reconciling Ambition, Fairness and Overall Emissions

Evidently, even achieving the targets stated in the previous section, while ensuring that significant progress is made on the extant development needs, would be a challenging task. India would not be in a position to declare peaking targets for a considerable time to come. Consequently, alternative formulations have been included in the list below to ensure that while India tackles its development challenges, ambition in climate change remains rooted in its actions:

1. **Convergence in Income and Electricity Consumption** – Along with periodic commitments on renewable energy targets, India could commit to declaring a peaking year when threshold levels for per capita GDP (PPP) and electricity consumption reach $10,000 and 4,000 kWh respectively.

   Strength

   This formulation would allow India to ensure sustained ambition in renewable energy growth, while allowing flexibility on the actual structure of the economy (for instance, relative growths in manufacturing versus services sector). It also avoids locking India into a peaking year, which would have no relation to how the overall economic development of the country is progressing.

Weakness

The problem with this formulation is that it assumes an inherent trickle-down of wealth across the population. Studies show that with rise in GDP, income inequality is exacerbated in many parts of the world. Therefore, it may be so that the income inequality actually rises at the threshold level. The average income inequality of countries with GNI per capita (PPP) between $10,000 and $30,000 was 0.60 in 2011.[40]

2. **Convergence in Human Development index (HDI) –** In addition to periodic commitments on renewable energy targets, peaking year commitments could be made contingent to India reaching a 0.70 value (against the 2013 value of 0.56) on its HDI.[41]

Strength

There are many advantages to using HDI instead of GDP. First, HDI along with incorporating income, also looks at other aspects of social welfare of the population. Further, actions on adaptation and increasing resilience to climate change are better captured by the HDI. Finally, UNDP has plans in the pipeline to link climate change impacts with the human development index, which would further strengthen the applicability of this indicator.[42]

Weakness

Linking a peaking year with the achievement of HDI may delay reduction in absolute emissions. Since the HDI is a relative value, dependent upon observed maximum values, in the remote event that rate of growth of the most developed country outpaces that of India's, achievement of 0.70 value may take longer than expected. Assuming an annual increase of 1%, India's HDI is expected to reach 0.75 in 2038 as compared to 0.586 in 2013.

Finally, we translated the renewable energy target of 1,041 billion units in 2030 into absolute emissions, using GCAM numbers. A cumulative amount of 3.38 Gt of CO_2 eq. is projected to be emitted by India; 2.25 metric tonnes of CO_2 eq. in terms of per capita emissions. We assumed an overall generation of 3,373 TWh, with renewable energy accounting for over 30% of the total electricity generation. Coal still dominates amongst the fossil fuels accounting for nearly 50% of total electricity generation, followed by gas at 15%. When compared with the EU, the US and China, even in 2030 India's per capita emissions are a fraction of these countries' per capita emissions. This is despite housing nearly a fifth of the world's population. Table 7 provides a summary of the results. Emissions for the EU and US have been calculated from their commitments and

[40] "*Human Development Report 2014*." United Nations Development Programme. N.p., 2014. Web. 28 Jan. 2015.

[41] The base HDI value for countries classified under 'High Human Development' category was 0.70 in 2013. Inequality in Income is expressed in the form of Atkinson Inequality Index.

[42] *Linking Climate Change Policies To Human Development Analysis and Advocacy*. Rep. New York: United Nations Development Programme, 2009. Print.

information provided in their respective National Communications. For China, the number used is from the MIT-Tsinghua study.

Table 7: Cumulative and Per Capita Emissions of the EU, the US, China and India in 2030

Region	Cumulative Emissions in 2030 (Gt of CO_2 eq.)	Projected Population in 2030 (Billion)	Per Capita Emissions in 2030 (m.t. CO_2 per capita)	% of Allowed Emission
EU	3.4	0.596	5.66	9.40%
US	4.6	0.379	12.06	12.70%
China	12	1.574	7.62	33.30%
India	3.4	1.502	2.25	9.40%
Remaining countries	12.68	4.198	3.02	35.20%

36 Gt of CO_2 emissions has been assumed to be the annual emissions budget for 2030
Source: CEEW Analysis

5. CONCLUSION

The INDCs present an important opportunity for India to showcase its climate leadership through the communication of its past, present and future ambitions in the climate arena. It is clear that leadership in climate change has not been forthcoming from some of the largest emitters. Therefore, countries such as India, likely to be acutely impacted by climate change would need to develop a strategy on two formats: pressing major emitters to increase their mitigation targets; and ramping up its own ambition to reduce the vulnerability of its own population to climate risks. Our analysis suggests that India could push its ambition towards a target of 1,041 billion units of electricity from renewable energy sources by 2030. This would be greater than the cumulative generation from all sources in 2013-14.[43]

However, this ambitious target would add a significant burden to the economy and may even make electricity unaffordable to a large section of its population. Therefore, it is imperative that discussions around technology partnerships and financial mechanisms be an important pillar of any new climate agreement. Additionally, it may be useful to formulate a comprehensive framework to assess the capacity of developing countries to commit to peaking targets and similar climate commitments.

[43] India. Ministry of Power. Central Electricity Authority. *Load Generation Balance Report 2014-15*. New Delhi: GoI, 2014. Print.

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