issue of wastewater management and water quality have cross-linkages with a range of other water- and non-water issues. It has also been acknowledged that wastewater management clearly plays a role in achieving future water security in a world, where water stress is expected to increase manifold. Alongside this, there is an emergent need for understanding and having a clear recognition of the importance of good wastewater management and its contribution to protecting water quality. Indian corporates are playing an important role in addressing some of those issues and looking at the problems caused by the neglect of wastewater management and its reuse, and also at the benefits and opportunities that can be realized through giving proper attention to this area.

In order to attain SDGs in a given time-frame it is essential to have a reliable, clear and viable process for planning and selection, supplemented by the constructing contracts that are suitably priced and have least risk transmission to the corporates.

The feedback by the Indian industry members present touched upon issues like having a monitoring and review process of the 2030 Agenda, developing relevant indicators for capturing corporate sector contribution towards sustainable development, aspects of financing, leveraging capacity building/skill development across sectors, enable industry to move forward in a practical way to address the issues of environment, and provide the expertise and knowledge where the corporate sector is known for its competence.

Existence and implementation of business models integrating sustainable actions into core organizational systems: to manage risks, capitalize on opportunities and meet CSRs, etc. can play a crucial role in any long-term sustainable development strategy. Moreover, there are efforts underway by the private sector and civil society, in providing a platform for the corporates to pronounce long-term goals and partnerships to make an important contribution towards attaining sustainable development for all, as highlighted Erik Solheim (Executive Director, UN Environment) during the meet.

Now the important action remains to get all the relevant players, including the policy-maker, corporate and private sector, and Government to fund the application, follow-up, observe and evaluate the 2030 Goals with a robust approach. This includes mobilizing corporate investors by setting up attractive business models based on fundamental cost-competitiveness. Essentially affordability and accessibility to finance will determine the pace with which various goals can be mainstreamed in Indian economy. Therefore, the need to unlock private sources of finance is imperative.

While the Goals in the 21st century provide gripping opportunities for the private and corporate sector, multilateral and bilateral development banks, and other development agencies and stakeholders to leverage cooperative resources, they also create an enabling environment for businesses, government, and civil society to work together towards meeting the desired economic, environment and social needs.

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An alternate energy future for India – its implication for India's climate pledge and the global goal of limiting warming to safe levels

Rajiv Kumar Chaturvedi and Mitavachan Hiremath

The International Energy Agency (IEA) recently projected that India is heading for the centre of the global energy stage as she is projected to contribute more than any other country to the rise in global energy demand over the next quarter century (up to 2040)[1]. Apart from the trade and market implications, India's increasing energy demand could have serious implications for local air pollution, freshwater availability, and greenhouse gas (GHG) emissions to global sustainability, among others. Increasing energy consumption and GHG emissions have implications for India's climate pledge to the international community[2], and to the global goal of stabilizing warming to safe limits. A new report published by the Grantham Research Institute on Climate Change and the Environment, London explores two divergent energy scenarios for India up to 2047, and their implications for meeting the country's climate pledges and the global goal of limiting warming to below 2°C.

India Energy Security Scenarios – 2047 tool

The report titled 'A more sustainable energy strategy for India' has explored a possible low carbon (LC) growth path for India's energy sector compared to the business-usual scenario (BAU), using India Energy Security Scenarios – 2047 (IESS-2047) tool[3]. Ahluwalia *et al.*[4] elaborate on the multiple policy interventions that are needed to achieve the objectives of LC scenario and how this scenario helps in meeting India's nationally determined contributions (NDCs) to the United Nations Framework Convention on Climate Change (UNFCCC) and the global goal of stabilizing warming below 2°C. The IESS-2047 tool was developed by the erstwhile Planning Commission, Government of India (GoI) and later refined by its successor NITI Aayog. The year 2047 has been selected as the cut-off for the projections as it represents India's centenary year of national freedom, and is very close to the much referred timeline of 2050. The calculator is essentially a tool that can be used to explore the implications of different levels of 'effort' or ambitious targets deemed feasible that can be made in selected sectors to move towards more energy-efficient outcomes and towards different levels of supply of alternative energy sources. The tool further helps in assessing the implications of these 'efforts' in terms of GHG emissions, energy security, land requirements and budgetary implications.

Ahluwalia *et al.*[4] outline the scope for a LC growth path for India that would greatly reduce the level of emissions compared to a BAU projection for the same growth rate of GDP. BAU scenario leads to a total GHG emission of 10,027 $MtCO_2e$ or around 10 $GtCO_2e$ in 2047. Under the LC scenario, GHG emission reduces to 5.6 $GtCO_2e$ (Figure 1). In pursuit of Article 4(1) of the Paris Agreement, it is not only important for India to reduce the absolute emissions but it is also required to determine 'when and how' to achieve peaking of emissions[5]. An important difference between the BAU and LC scenarios is that there is no peaking of the GHG emissions within the 2047 horizon in the former, but in the latter emissions peak in 2042 at a level of about 6000 $MtCO_2e$ (i.e. 6 $GtCO_2e$).

The LC scenario results in a net saving of 4.4 $GtCO_2e$ in emissions by 2047. This scenario is in fact a combination of energy efficiency and clean energy measures, which reduces the emissions intensity of the GDP, and shifts the composition of energy towards cleaner sources. Figure 2 shows specific mitigation actions that bring about these savings in the emissions. One of the key findings of the study is that although public attention focuses heavily on deploying LC technologies in the electricity and fuels sector, almost 86% of the reduction in emissions in the LC scenario comes from interventions focusing on energy efficiency measures, building better cities and encouraging behavioural changes among consumers (Figure 2). Ahluwalia *et al.*[4] explain that this is partly because the technologies in use, and the systems we have today, are much less energy-efficient than is now possible.

According to them, development of sustainable infrastructure constitutes a key mitigation strategy for India, as much of its infrastructure is still to be built or replaced – which paradoxically provides the country a 'late comers' advantage. For example, it is estimated that 70% of the commercial buildings that will be needed in India by 2030 are yet to be built. Such a situation provides an opportunity to leap-frog by incorporating into the new buildings the higher standards of sustainability that are now feasible. However, India being a developing country cannot achieve this transformational leap-frogging without support from the international community in terms of both technology transfer as well as finance. At the national level, regarding the policy interventions that are required for the LC scenario Ahluwalia *et al.*[4] argue that no single policy intervention will achieve the structural changes needed to move to the LC scenario; they consider energy pricing to be a critical tool in this regard. They argue that prices of fossil fuels should be set at levels which not only avoid subsidies, but also reflect social costs associated with the usage of fossil fuels.

A clean energy pathway has implications for local pollution, human health, water availability and, most importantly, for GHG emissions and global sustainability. It is estimated that coal power generation in India resulted in 80,000 to 115,000 premature deaths and 20,000,000 asthma cases in 2010–11 alone[6], and the world's coal power plants consume water equivalent to meet the most basic needs of around 1 billion people[7]. Mitavachan and Srinivasan, from a life-cycle perspective, conclude that the energy costs for coal power generation are much higher than solar photovoltaic (PV) plants when social and environmental costs are taken into

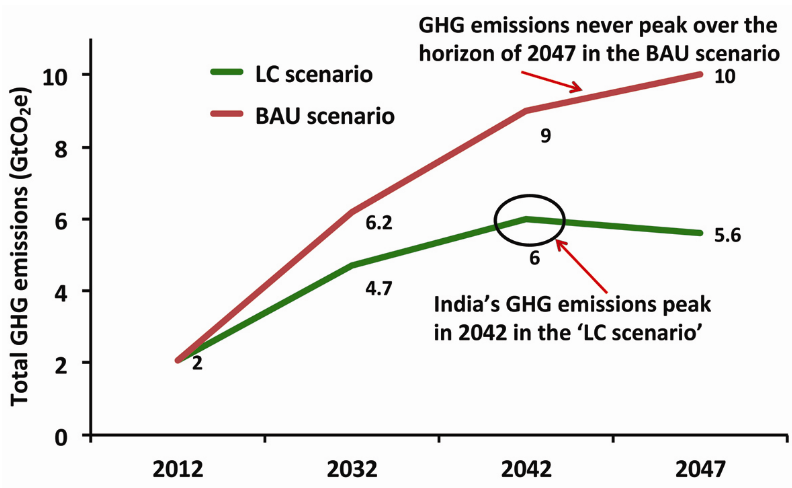

Figure 1. Total greenhouse gas (GHG) emissions under the low carbon (LC) and business-as-usual (BAU) scenarios.

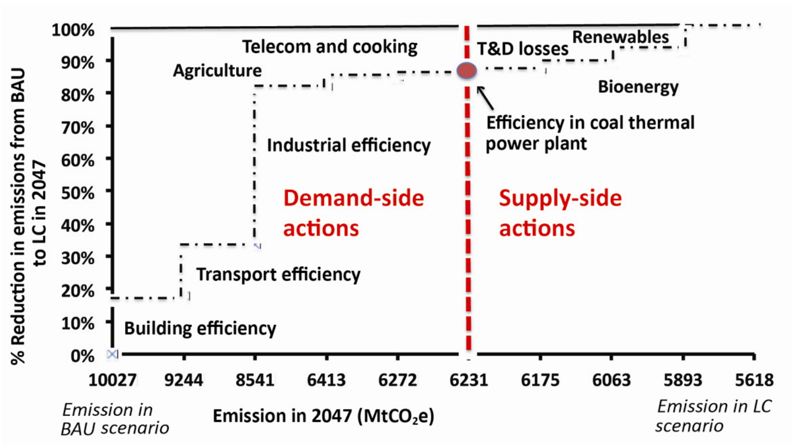

Figure 2. Illustration of relative mitigation benefits from the key mitigation measures. (Mitigation measures considered under building efficiency category are: increase in high rise buildings, very high increase in percentage of buildings using energy-efficient insulation and also a very high penetration of smart appliances; under transport efficiency are: increasing use of mass public transport, and electric vehicles; under industrial efficiency are: energy efficiency and electricity grid shifts in the cement and steel industries.)

account[8]. It is estimated that today's coal power plants emit 20 times more GHG emissions, cause 30 times more local air pollution and grab 40 times more water than solar PV plants in India[8].

Implications of the LC and BAU scenarios for meeting India's climate pledge and the global goal of stabilizing warming below 2°C are discussed below.

India's climate commitment

Ahluwalia *et al.*[4] project emission intensity of the Indian economy for the BAU and LC scenarios over the period 2013–2047, whereas India's NDC aim for 2030 goals compared to the 2005 base. Hence, Ahluwalia *et al.*[4] and the Indian NDC goals are generally not comparable. Ahluwalia *et al.*[4] argue that India's NDC target of 33–35% reduction in emissions intensity over the period 2005–2030 is likely to be met under both the LC and BAU scenarios. The Planning Commission's Expert Group report on LC strategies for inclusive growth[9] on the other hand, concludes that under the BAU scenario (i.e. BAU inclusive growth (BIG) scenario), emission intensity of the GDP over the period 2007–2030 declines by only 22%, but under the LC inclusive growth (LCIG) scenario it declines by 42% over the same time-period. Figure 3 shows a comparison of reductions in emissions intensity from Ahluwalia *et al.*[4] and the Planning Commission report[9].

India's First Biennial Update Report to UNFCCC[10] showed a reduction of 12% in the country's emissions intensity over the five-year period of 2005–2010; a further reduction of 23% in the next 15 years to meet the NDC goal of 35% reduction looks like an easy target. However, it should be kept in mind that till date Indian economy largely relied on the growth of the services sector. For poverty and unemployment eradication a greater push to manufacturing and power generation is required, which is reflected in the new government initiatives such as 'Make in India' and 'Electricity for all'. 'Make in India' campaign aims to increasing the share of manufacturing in GDP to 25% by 2022 from 17% at present. Making the manufacturing sector the engine of India's growth, rather than the services sector (which has been the prime driver of GDP growth in recent years) implies a significant acceleration in the amount of energy required to fuel India's development. IEA[1] estimates that generating US$ 1 of value added through expansion of industry requires at least ten times more energy than US$ 1 of value added from the less energy-intensive services sector. We believe that India will be able to meet its NDC goal of reduction in emissions intensity but with considerable 'effort' in green policy push.

While, Ahluwalia *et al.*[4] focus on the economy-wide commitment related to GHG intensity, other dimensions of India's climate commitments are worth mentioning here. In addition to the GHG intensity-based targets, India has also pledged to increase its forest cover so that an additional carbon sink of 2.5–3 billion tonnes of CO_2 (1 billion tonne = 1 giga tonne) is created by the year 2030. This goal implies that India will be adding up to 200 $MtCO_2$ per year in terms of forest carbon sinks. Indian forests currently sequester a little less than 200 $MtCO_2$ per year[10]. Given the challenges of shortage of land, high population pressure, high mortality rate of saplings and low natural vegetation productivity in India, achieving this additional carbon sink in this short period (2016–30) is a challenging and ambitious goal[11].

Further, the target of increasing non-fossil fuel-based electricity capacity from 30% at present to 40% by 2030, is again an ambitious goal, especially so as

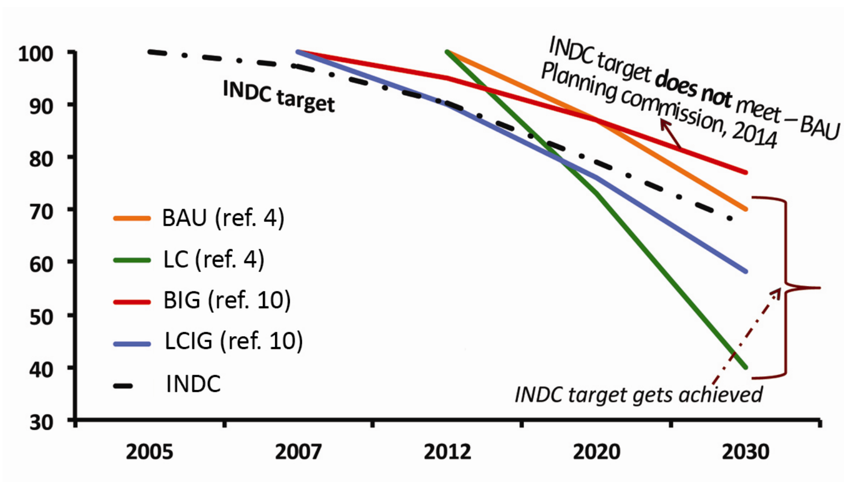

Figure 3. Projected change in emission intensity of GDP (on PPP basis). (Initial emission intensity of GDP values from each report is normalized to 100.)

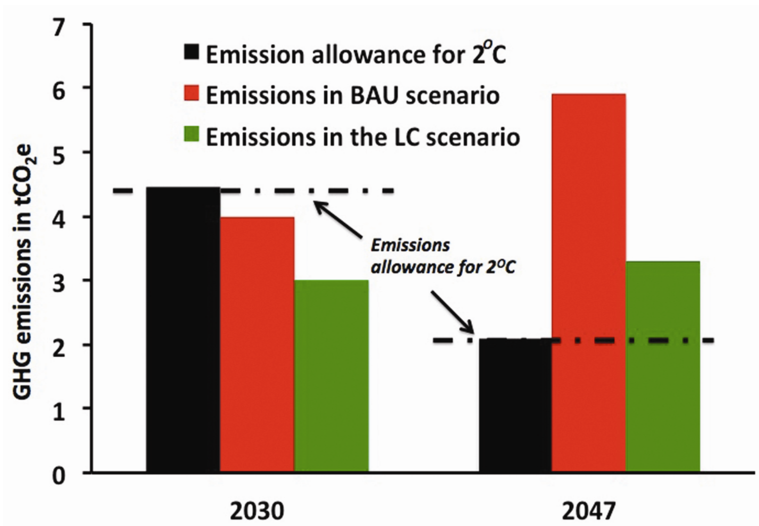

Figure 4. Comparison of per capita emissions from India under the BAU and LC scenarios in 2030 and 2047 with the per capita allowance of emissions consistent with the 2°C pathway.

India's cumulative installed capacity is set for a rapid expansion to 1100 GW in 2040 compared to 290 GW now[1]. We believe that India's NDC targets are achievable, but meeting these targets requires significant additional efforts.

The global goal of limiting warming to 2°C – looking beyond NDCs and the 2030s

At the Paris Conference the world agreed to limit warming to 2°C and make efforts to limit it to even 1.5°C. There are multiple approaches for allocation of carbon budget among the countries. One of the well-established methods for future emissions allocation is known as the 'equity-based framework of contraction and convergence', as described by Gignac and Matthews[12]. This basically means that all countries, irrespective of their past and current emissions, contract their emissions and converge to a per capita equity point at a specific future date, i.e. 2030 or 2047. A global annual GHG emission of about 38 $GtCO_2e$ (or 4.4 tCO_2e in terms of per capita emissions) in 2030, and 20 $GtCO_2$ (or 2 tCO_2e in terms of per capita emissions) in 2047 is consistent with a 2°C pathway. Ahluwalia *et al.*[4] estimate that per capita emission in India will reach 4 tCO_2e and 3 tCO_2e in 2030 under the BAU and LC scenario respectively. Thus, over the time horizon of 2030 both the scenarios are consistent with limiting warming below 2°C. However, in 2047 per capita emission in India under the BAU scenario will exceed 5 tCO_2e and under the LC scenario it will increase to 3.2 tCO_2e per. Thus, in 2047 neither the BAU nor the LC scenario is consistent with limiting warming below 2°C. This finding is consistent with a previous assessment[12], which suggests that while India's climate commitments are consistent with the 2°C goal in 2030s, beyond 2030s India must have to take deep emission cuts. However, the country will find it increasingly difficult to meet the steep emission requirements in the post-2030 world if it gets locked in GHG-intensive infrastructure in the initial years.

Figure 4 further underlines the urgency of all countries, including India, to explore the possibility of accelerating the transition to a LC path. It is especially important to avoid the lock-in of carbon-intensive infrastructure, which may become stranded in future. Ahluwalia *et al.*[4] suggest that much of this transformation depends on our lifestyle and behavioural choices.

Is the LC scenario technologically and financially feasible? The scenario looks realistic, as the GHG emission trajectory of the LC scenario of Ahluwalia *et al.*[4] is comparable to an earlier LC scenario (LCIG scenario) developed by the Planning Commission, GoI. Our assessment suggests that the LC scenario generally constitutes mitigation actions that are feasible. One possible exception could be the optimistic assumptions in the buildings sector. Here LC scenario assumes dramatic increases (from 0% and 10% at present to 80% and 100% in 2047) in the penetration of 'energy-efficient insulations' and 'high-efficiency appliances'. These assumptions may turn out to be unrealistic in the event technological and policy environment fails to evolve favourably. From the cost perspective as well the LC scenario looks realistic, and in fact turns out to be a profitable proposition compared to the BAU scenario in the long run. Without the consideration of discounting, the LC scenario is estimated to result in a net saving of US$ 8.3 trillion over the period of 35 years (i.e. 2013–2047); however if a discount rate of 6% is applied, then the net saving reduces to US$ 1.8 trillion. However, initial years are likely to be financially painful as the additional capital cost is incurred in these years and the fuel savings are materialized in the later years. At the end we should be aware that the calculator upon which the LC and BAU scenarios are based, is not a structural model of the economy where critical inter-related macro-economic and sectoral variables are determined within the model. Rather it is a 'calculating tool' which allows the user to simulate the effect of alternative assumptions about energy efficiency and alternative sources of energy. The fact that projections from Ahluwalia *et al.*[4] are generally comparable with those from IEA[1] and Planning Commission[10], provides us confidence regarding this tool.

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