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Where is the hope? Blending modern urban lifestyle with cultural practices in India

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Driving economic growth through a low carbon trajectory will be a challenge as well as an opportunity for India in next three decades with a billion plus population. Cities are going to play a major role in this rapidly urbanising India. The scope of this article is to focus on some of the ongoing city-scale actions, which clearly indicate that India can strengthen its response by going beyond its NDCs. A combination of technology penetration, individual behaviour, community actions and policy interventions is driving such experiments. Ongoing investments in infrastructure are targeted towards creation of new facilities as well as modernisation of existing, and traditionally sustainable practices such as public transport, shared mobility, walking, cycling and rickshaw rides. Policies, supplemented by statutory mandates, are trying to command and regulate, nudge and incentivise climate responsive actions. Shifting public preferences towards star-rated household appliances is emerging as a social norm. Increased concern towards local air pollution is also driving changes. Large construction projects are being mandated to comply with building codes. Urban rooftops are facing competing demand from solar panels, organic gardens. Participation in the process of change is thus defining a new urban lifestyle, efficiently and sufficiently, energised by modern energy forms, and is thus paving the way to a new low emission future for India with global mitigation benefits.

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Introduction

India announced its pledge of reduction in emissions intensity of Gross Domestic Product (GDP) by 33–35% below 2005 levels and increased share of non-fossil fuel to 40% in power generation by 2030 [1]. Despite challenges, continuous efforts are being put forward towards rapid installation and deployment of solar, wind and other renewable sources in a significant manner. Respective policy guidelines [2–6] consistent with commintments, are developed to initiate and speed up such deployment processes within and beyond city limits. The industrial sector has also successfully reduced its energy intensity over the past years and is expected to remain on a similar trajectory in the future ([7,8] and references therein, [9]). While these efforts are quite in line with what India has committed in its Nationally Determined Contributions (NDCs), 1.5°C warming goal calls for contributions beyond NDCs. The main drivers that India had emphasised on so far are: enhanced share of renewable sources in power generation and main streaming principles of energy efficiency, especially in the industrial sector. Actions in additional sectors are expected to contribute to achieve a deeper cut in emission beyond NDC. Looking at the eight missions in National Action Plan on Climate Change (NAPCC), other than the mission on sustainable agriculture and partly the mission on Himalayan ecosystems, all others can be experimented at the city level in an effective manner. Thus it is clear that cities can play an important role in achieving any additional emission reductions beyond what is stated in the NDCs.

India is experiencing rapid urbanisation and increase in the middle class population, who largely determines national consumption trajectory — given their aspirations and somewhat consumerist lifestyle [10,11]. Left unattended, this is not only expected to increase emissions from cities, but will also make them particularly vulnerable to the effects of climate change and extreme events [12,13••]. At the same time, consolidation of human population in the cities can provide a unique opportunity to move towards low carbon societies with increasing individual participation in the process of decarbonisation [14•,15]. While the transport/mobility and building sectors in Indian cities are expected to become major emitting sources, they, at the same time, have strong techno-economic feasibility for emission mitigation [16••]. Therefore, cities can serve as 'laboratories' where top

down rules and routines of urbanisation can be redefined through low-carbon narratives — such as more pedestrian and cycling lanes, better public transport, mixed-use zoning, more green space, scientific waste handling, etc. [17,18,14•,19,20]. In this league, if individuals also respond through participation in mitigation actions, augmented emission reduction beyond NDC can be expected to contribute towards the '1.5°' goal.

India, in this context, appears to be an important case for several reasons. The country, with a billion plus population, is yet to peak in terms of economic growth and population. It has been projected that by 2030, about 40% of the population in India will live in urban areas, and there will be at least 60 cities with populations over a million (http://www.india.uitp.org/sites/default/files/pictures/PTI%20Magazine%20-%20Dr%20Ekroop%20Caur.pdf). Therefore, for the coming three decades, channelling economic growth through a low carbon trajectory will be a challenge as well as an opportunity. In this article, we identify and highlight transformative actions, which present a clear case for going beyond India's NDCs. Strengthening responses to go beyond NDCs is a necessary step towards the 1.5°C goal. The actions that we present below are expected to result in relatively lower per capita energy demand, lower aggregate energy use and emission intensity in the future as compared to the scale of mitigation that current practices can deliver. We focus on the new actions that show clear signs of being successful solutions in near terms through accelerated implementation to realise the potential. On the basis of recent evidence and literature, this article focuses on some of the emerging low carbon practices in Indian cities with an emphasis on the transport/mobility and the building sector. There is a need for such systematic documentation and assessment of emerging local actions to shed light on technologies and practices that has the potential for fulfilling the ambitious emission reduction goals [21,22]. Access to such detailed evidences and an understanding of the dynamics of scaling up of local actions are also important to reduce the uncertainty about future emissions scenarios. So, the primary focus of this article is on evidences and examples, — which have potential to drive the transformation in Indian cities. We intend to show how new urban spaces can be a source of mitigation and how city lives are going to be less emission intensive.

Mobility style

Of the approximately 79 million Indian urban households, the mobility style is still predominantly dependent on the use of public transport (46% have no private transport equipment), bicycle (42%) and very limited dependence on privately owned four wheelers (10%) [23]. Therefore, the story concerning the mobility sector in Indian cities has two sides. On the one hand, historically, it is predominantly hydrocarbon-based — like in most other cities in the world, and therefore, is a major source of emission [24]. But on the other hand, only 10% of city dwellers in India, on an average, have privately owned four-wheelers. Mega cities such as Mumbai and Kolkata are the best representations of this public transport dependent lifestyles. Both the cities have historical advantages of well spread-out infrastructure of public transport, especially roads for buses, and inner-city mass rapid transit systems — like railways in Mumbai and both railways and metro-railways in Kolkata. Efforts are augmented by introduction of metro railways in Mumbai and expansion of metro-railway networks in Kolkata. Cities without such historical advantages, such as New Delhi, Ahmedabad, Bangalore, Hyderabad, Jaipur and Lucknow tend to have higher shares of private transport than the national average [25,23,26]. However, these cities are also gradually adopting the actions for expanding public transport infrastructure. Therefore, long term transformative change in mobility systems and style in Indian cities will depend on public transport infrastructure expansion, acquisition/adoption of appropriate technology, (e.g. energy efficient private and public modes of transport electrical vehicles, etc.) and behavioural choices (choice in favour of public transport, shared transport, cycling, etc.). All of these individual choices also require appropriate investment in infrastructure, organisation, markets and governance practices. This article is trying to reflect on those actions which are indeed targeting this interplay between individual choices and socio-institutional dynamics in India.

Comprehensive Mobility Plans and Master Plans for cities such as Kolkata, Pune and Delhi have set a target of achieving 90% modal share in the form of public transport so that this system of mobility can become a game changer [25]. Expansion of infrastructure for improvement of public transport is taking place at a very fast pace in all the cities through new investments in compatible infrastructure, technological advancement in equipment, and top down policy push through legislative enactments. The National Urban Transport Policy (NUTP) introduced under the Urban Renewal Programme of India (2006–2014, labelled as JNNURM) is advancing sustainable mobility practices through public transport service under a legislative framework across cities in the country (http://www.india.uitp.org/sites/default/files/pictures/PTI%20Magazine%20-%20Dr%20Ekroop%20Caur.pdf).

In order to promote such modal shifts, several infrastructural arrangements are being promoted to influence the passenger-behaviour. The central assumption behind these experiments in the mobility sector is that people are willing to use non-personalised transport provided efficiency, availability, adequacy, safety and comfort are ensured. Initiatives such as massive expansion of metro-rail networks (http://www.india.uitp.org/news/

pune-metro-project), introduction of air conditioned buses in the cities with high temperature and humidity in the summer months, etc. are addressing this demand (http://cstc.org.in/web_press_airport.php, Shamik Pal, Lifestyle and Climate Change: An Empirical Study with Special Reference to India (Ph.D. thesis), Jadavpur University, India, 2015). A good example in this context is Bangalore Metropolitan Transport Corporation (BMTC), providing feeder bus services to and from metro railway stations to ease the continuity of the mobility service. BMTC has also planned to provide electric bikes at five metro stations. Bengaluru airport will be the first one in India with a metro network providing space for private companies to set up booking kiosks for last mile connectivity. All these are expected to ease the access to public transport and achieve the target. Awareness building and publicity based measures are also in place to promote such modal shifts and create user preference. 'Bus-day' celebration by the citizens in Bengaluru, in 2010, to popularise public transport for daily commuting within the city, started as a symbol of 'green-behaviour' and 'environmental citizenship' [27]. This is now observed officially by BMTC each year. However, impact and hence the continuity of such behaviour beyond symbolic celebrations need more assessment. The State Pollution Control Board in Karnataka has measured that the local air pollution remains less on this day relative to other days [25]. However, it is difficult to assess how such symbolic events and moral norms can have long term effects beyond the specific day, which shows the need for more permanent solutions through incentive design in order to transform behavioural changes to habits.

Shifts towards public transport system are not only backed by policy and practice in India. Investment commitments also play a crucial role in it. Within the public transport system there is also a shift taking place, where fuel efficiency and fuel switch to achieve multiple sustainable development goals is a priority. Under the framework of JNNURM, new fuel efficient transport equipment are identified for diffusion with appropriate financial and cost-sharing mechanisms between the federal and the state governments. This is also providing a scope for the private investors. This is facilitating emergence of manufacturing units aiding job creation at various nodes of the supply chain. This is also in line with the age-old cultural perception in India that public transport operated both by government and private sector are an inclusive mode to provide access to affordable mobility services [28,13••,17]. A number of other experimentations that are being introduced, include fuel-efficient vehicles (all major cities), bus rapid transit systems (e.g. Ahmedabad, Pune, Kolkata), mass rapid transit systems (Kolkata, New Delhi, Bangalore), electric rickshaws (New Delhi, Kolkata and various other cities), promotion of different modes of non-motorised transport (e.g. Bhubaneshwar, Ahmedabad) [13••,29,30], etc. The National Electric Mobility Mission Plan 2020 aims to accelerate the growth of the electric and hybrid components of the automobiles. The procurement of fuel efficient hybrid and electrical buses in Indian cities has reached 8760 by the end of 2016 [31]. The Department of Heavy Industries launched FAME (Faster Adoption and Manufacturing of Hybrid & Electric Vehicles) in April 2015 to promote manufacturing of electric and hybrid vehicles in India. As a part of the National Electric Mobility Mission Plan, FAME has a corpus of about Rs. 8 billion (US$123 million) to invest in electric mobility based initiatives within 2017 [31]. A Government purchase policy for e-cars is also in place [32]. The overall change in the practice in this sector can be categorised as 'fit and conform' in cities like Kolkata and Mumbai to 'stretch and transform' in new cities [33].

Changing user behaviour in India is also a new trend in case of usage of privately owned vehicles. An all-India primary survey based household level study carried out in 2014 [D Chakravarty, Rebound Effect: Empirical Evidence from Indian Economy (Ph.D. thesis), Jadavpur University, India, 2015] shows that saving personal fuel bill is a major factor determining ownership and usage of private cars. People are observed to usually keep a fixed budget for transport fuel. Although the regulatory norms in urban India allows 15 years of lifetime for a car, in practice, households tend to change their cars in 3–10 years on an average to take advantage of fuel efficiency of new cars in the face of rapidly rising fuel price in India. Theoretically and empirically it has been established in the literature that efficiency increase and rebound suppressing prices strategically managed can help in realisation of full technical potential of efficiency gain. Narratives of past studies [34–38] with the apprehension that rebound effect will increase energy use more than proportionally as a result of energy efficient practices is also showing gradual reversal with rising energy prices, changing promotional materials, awareness programmes, regard for environmental value etc [39–41]. Limited but observed super conservationist [39,40] behaviour in Indian mobility sector and residential sector strengthen the role of worldview, preference pattern and social position of the user, level of awareness, enviornmental value consciousness and the role of promotional materials. 'Conscious lifestyle-choice making' households are buying fuel efficient cars, reducing fossil fuel use for mobility services, and opting for shorter route — even when it is a more congested route, to save on personal fuel bill. Responses from households reveal that this is due to their adequate awareness about the properties of an efficient and fuel saving car, self-motivation for energy savings and the motivation to stay within personal travel budgets. Awareness about the adverse impacts from high levels of vehicular pollution in the city and market penetration of alternative cleaner fuel (LPG,CNG) based cars both influence individual's technology acquisition

behaviour [40] and preference for public transport. Household preference survey also brought out the fact that comfort and availability of public transport reduces private vehicle use, which is a significant behavioural response. Top down policies to promote modernised public transport in India given the user preference for comfortable public transport are quite in line with what is [3] mentioned in literature: '*If voluntary increases in pro-environmental behaviour are to make a meaningful contribution to reducing energy use and carbon emissions it is crucial that programmes promoting pro-environmental behaviour deliver both substantial and durable change*'. Environmental beliefs, social norms, and influence of community become important factors in this context [42•,43,44,45••,46].

In India in the above mentioned textbook-style experiments, new innovations are being institutionalised as norms to transform the way socio-technical trajectories function. We see that in all these experiments, as mentioned in literature [47], there is a process of articulating expectations through mass media, civil societies and promises of sustainability gains. Also, this is taking place through the formulation of relevant policies, discussion with variety of stakeholders, initiation of new protection (e.g. for electric vehicles) and withdrawal of some old ones (removal of subsidy on diesel and petrol), shared financial mechanisms within the federal system, building of robust network(s) through supply chain creation, learning (particularly, of the second order), and, finally, upscaling and mainstreaming relevant practices into the market mechanism. In these experiments around modernisation and expansion of public transport service facility, the overwhelming emphasis is on learning and participation of different actors including government, policy makers, urban designers, private sector, members of the civil societies and individuals. This has made the process markedly different from a stereo-typed top-down approach followed in the conventional urban development in India [18,21,28,13••]. However, to scale up further sustainable mobility pattern there is more scope in India to consider the interplay of individual behaviour, supply side penetration of cleaner fuel, efficient equipment, lesser congestion through traffic management and appropriate infrastructure availability, non-price regulatory mechanisms, promotion of low carbon strategy through non-motorised transport, establishing cleaner fuel use as social norm, better information dissemination through promotional materials, improving comfort in public transport system, etc. ([40], D Chakravarty, Rebound Effect: Empirical Evidence from Indian Economy (Ph.D. thesis), Jadavpur University, India, 2015, Shamik Pal, Thesis, Lifestyle and Climate Change: An Empirical Study with Special Reference to India (Ph.D. thesis), Jadavpur University, India, 2015). In the past, much publicised National Biodiesel Mission of 2003 in India has failed to achieve the target of cleaner fuel penetration by 2017 because of failure in articulation of expectations and creation of appropriate supply chain. Similarly, in the intermediate means of transport (IMT) segment, currently dominated by hydro-carbons, the penetration rate of alternative cleaner fuel based modes (e.g. electric rickshaws) is much slower than the potential. This is due to conflicts (social, political and legislative) with the hydrocarbon regime along with varying cultural bias for rickshaws despite very fast technology development in this segment [13••]. In Kolkata there is a clear cultural bias towards rickshaws while in New Delhi it is not. E-rickshaw technology is readily available but policy inertia, institutional preparedness, competition with the incumbent technology based on hydrocarbons being the causes for delay in transforming the IMT segment in India. Faster transformation of the urban mobility style in all possible ways simultaneously (expansion of the cultural symbol of non-motorised cycles and public and mass transit system plus efficient equipment emissions plus fast electrification of urban transport system supplemented by cleaner electricity generation) in India can help in accelerating the pace of uptake of available low carbon solutions in near term along with demand reductions which are necessary to avoid delay in mitigation and to keep emission trajectory compatible with 1.5°C.

Building norms and appliance use style

The built environment, the building sector and the energy use behaviour of the dwellers are important determinants of emission from cities [48,49•]. In India, the growth of the building sector is 7–8% per annum [50] but built environment is predominantly characterised by cultural practice of mixed use zoning in India. The statutory norms also make it mandatory for any new large building footprint to comply with the energy conservation building codes (ECBC) (https://beeindia.gov.in/content/ecbc) and encourage mixed zoning. The codes have been developed to mandate the use of new constructions material and increase efficiency of energy use, both at the construction, as well as in the operational phase. Owing to statutory norms, the execution of a project is monitored through a system of evaluation and issuance of environmental clearance certificates by the statutory bodies — both at the central and the state levels. All such steps are being taken to make the expansion of urban built environment without locking in urban India into a high emission pathway. In 2003 built up area following green building codes was 20 000sq.ft. In 2017, with more than 4264 green buildings projects, the footprint, as registered with the Indian Green Building Council (IGBC), is more than 4.66 billion sq.ft. Of this 1126 Green Building projects are certified and are fully functional now. This growth has been possible with the participation of all stakeholders in the green building movement. (https://igbc.in/igbc/redirectHtml.htm?redVal=showAboutusnosign&id=about-content). There is also a need for extension of building codes to all

building types and just not to the large construction projects with large carbon footprints.

Along with the infrastructure development, various supportive renewable energy policies are augmenting the process of a deep de-carbonisation of power supply in near term in a cost effective manner. A case study of five residential complexes in India shows that the total annual savings through solar rooftops range between INR 296.4 million and 0.74 million [51]. As of December 2016, India's total installed rooftop solar capacity was estimated to be 1247 MW, the largest one (7.52 MW in one roof) being in Amritsar, Punjab [52]. Incentives in this sector are in the form of net-metering (Mumbai, Chennai, Kolkata), banking of excess generation (Mumbai), subsidy for domestic consumers (Chennai) [53,54] (http://www.ncpre.iitb.ac.in/research/pdf/Estimating_Rooftop_Solar_Potential_Greater_Mumbai.pdf), etc. However, such subsidies and incentives are preplanned and regulated. Over time, these subsidies are planned to be phased out with the onset of market mechanisms. In fact, sustainable roof-top scale up is a major intervention towards climate change mitigation. White and 'green' (vegetated) roofs have begun replacing conventional black (dark-coloured) roofs in India as well to mitigate the adverse effects of dark impervious urban surfaces. The experience is similar to other countries like US, Australia, Brazil, etc. [48,55]. The Bureau of Energy Efficiency (BEE) has also made recommendations for the buildings on this line. They have advised that the buildings with lightly coloured, more reflective roofs can use up to 40% less energy for cooling than buildings with darker roofs (http://shaktifoundation.in/wp-content/uploads/2014/02/cool-roofs%20manual.pdf). The Rooftops and the vertical walls in the cities and the railway stations are also becoming spaces for growing vegetation with sequestration capacity and multiple co-benefits like employment generation to growing organic vegetables (http://thelivinggreens.com/). With the emergence of new green entrepreneurs, the expansion of such services are seeing meteoric rise as new service supply chains are emerging with potential for reducing space cooling demand. Solar roof top installations are making conscious choice and effort to reduce air-conditioning demand (http://readepaper.anandabazar.com/guest/1-9-24@12@2017-1001-wl.html, p. 14).

The household energy demand increases with an increase in income, resulting in changes in the standards of living and increase in the ownership of energy dependent electrical appliance and equipment [44,56–59]. Literature shows that along with incentives and barriers, 'motivation', 'socio-demographics', 'moral norms', 'energy-saving awareness and attitudes', 'regulations and policies', and 'informational and promotional activities' are found to have important influence on behavioural change, which are extremely relevant for a city-scape [39,60,44,42•]. A marked growth in the appliance holding pattern is visible in India and, the growth is expected to continue for the coming decades. By 2030, the stocks of fans and TVs are estimated to increase by a factor of 3; refrigerators by a factor of 7 and ACs by a factor of 17 [61••,62]. But interestingly, to keep per capita per equipment energy consumption low, the BEE in India has designed and implemented a major experiment (http://beestarlabel.com) which is now fully integrated with the market mechanism to enhance penetration of star rated energy-efficient appliances for every new purchaser. It started in 2007 — with commissioning of annual assessments by an independent agency, the National Productivity Council (NPC). This resulted in a clear shift in the preferences of households — as the appliance owners started replace less energy-efficient (but low initial-cost) appliances to star rated, high energy-efficient appliances, mostly with higher initial-cost. The retailers of star rated technologies motivated buyers by engaging pretrained selling agents on shop floors to create energy saving awareness and attitudes through informational and promotional activities. This has been achieved through market forces on supply side and consumer focused strategies [63] and training but without mandate or incentive in the form of subsidy. The rate of uptake of star rated fans — a dominant space-cooling technology in India — has reached almost 100%. Five star rated refrigerators, TV and ACs have shown significant increase [61••,62]. In the literature, this is termed as 'acquisition behaviour' that involves reduction in the energy use by adopting energy efficient household appliances without shifting from the present pattern of lifestyle [64,44]. In Indian context, a study, (Shamik Pal, Thesis,Lifestyle and Climate Change: An Empirical Study with Special Reference to India (Ph.D. thesis), Jadavpur University, India, 2015) based on six hundred randomly selected households in Kolkata, shows that frugal behaviour and conscious decisions to save on energy bill drives appliance usage pattern after adoption and adoption as well across income groups.

Steep market penetration of energy efficient appliances in India has revealed an appreciable momentum. However, to achieve a faster pace in the near term mitigation strategies — compatible with the 1.5°C goal, there is scope for some additional aggressive policy shift. All appliances holdings in the urban household can be made energy efficient with each new installation. Often, exchange of old appliances with new ones is being encouraged through short term market incentives by the manufacturing companies to boost their individual sales. The pace can be accelerated with additional policy support borrowing the lessons learnt from the mobility and industry sectors. In the Indian cities fuel switch from diesel to LPG/CNG for the auto rickshaw sector within a defined, time was accomplished by cash incentive scheme. When the conversion was complete, the incentives were withdrawn.

In India, over the past two decades, in the buildings and construction sector, there has been a rise in investment and market penetration of new efficient household appliances, capacity building through education programmes and entrepreneurial development. This is accompanied by policy formulation through building code design and implementation through the BEE and legislative orders across all states. In the East Asian countries, the rapid growth in urbanisation was accompanied by a steep hike in capital investment. This is quite in contrast with Africa where the rapid growth of urban centres, at an early stage of development, is not accompanied by such a boost in capital investment and infrastructure development. The rate of capital investment in India is also below the international standards leaving scope of accelerating actions in sustainable and green infrastructure development (http://www.dannyleipziger.com/documents/GD_WP7.pdf).

Concluding remarks

The near term mitigation potential within city limits and new emerging cities in India is much more than what is realised so far. Much faster penetration of technology and behavioural change need accelerated scaling up of strategically designed incentives, public policy in transport sector and buildings sector along with capital investments and infrastructure design. New urban living and mobility styles are emerging at a time in India when actions and awareness towards multiple sustainability goals are also in interplay with a hike in energy price. So, the infrastructure design is clearly emerging keeping in view the long term goals of sustainability gains by avoiding lock-in in a high carbon emitting city lifestyle. The individuals are trying to keep the energy bills within budgetary limits through conscious choices. There is a clear shift towards expansion and enhanced use of the public transport system, which is, culturally and historically, a dominant mobility style in India. A strategic move towards electrification of the mobility sector in the urban India is emerging supplemented by growing renewable energy based electricity generation. Policy interventions, legislations and infrastructure development are also driving such changes in appliance ownership and living and mobility styles in cities which can contribute to additional emission reduction beyond what is targeted in the NDCs but is required for achieving the 1.5°C goal.

Conflict of interest

None declared.

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