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Urbanisation and Managing Energy: Opportunities and Challenges

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Abstract

As the world gets increasingly urbanised, there will be a consequence for energy generation, consumption and distribution. As the world population increases, there will be an increased demand for services- healthcare, transport, housing, infrastructure, information technology among others. The growing economies like India would have even greater challenges. The choice of forms of urbanisation should needs to be assessed. What kind of cities would be sustainable is a question that needs more exploration? Walkability, compact housing, sustainable transport, alternate forms of energy generation are all aspects which need to be looked into . The paper focuses on what forms of urbanisation should India look at and how energy choices should be built in the planning process.

INDRODUCTION

Urbanization is an indication of transformation of an economy from a rural to a modern industrial one (Datta, 2006). As Indian economy grows, there will be increased urbanisation. By 2030, the GDP of India on the conservative side would have multiplied by five times, This would lead to 590 million people live in cities which would be nearly twice the population of the United States (Sankhe et al., 2010). Cities will produce a greater than seventy percent of Indian GDP and 70% of new employment will be generated in the cities. As urbanisation increases there will be an implication for how energy would be generated, distributed and consumed. With increased urbanisation in India, 700-900 million sq. metres of commercial and residential space would need to be built or a new Chicago every year (Sankhe et al., 2010). There is a massive investment coming in the infrastructure such as 2.5 billion square metres of roads to be paved.

India's urban population as per 2001 census was 290 million and 340 million as per 2008 census. By 2030, the urban population would be 590 million (Sankhe et al., 2010). With increased unbanisation the number of million plus cities have increased from 5 in 1951 to 23 in 1991 and to 35 in 2001 (Datta, 2006). Bhagat (1992) has attributed urbanisation to mainly three components:

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1. Natural increase
2. Net Migration
3. A real reclassification

Datta (2006) points out that urbanisation process in India is not mainly 'migration lead' but a product of demographic explosion due to natural increase. The migration of people to cities has not happened due to urban pull but due to rural push. This migration leads to very poor quality of urbanisation with emergence of slums, unhealthy living conditions in the paucity of water, healthcare, shelter and access to other basic amenities of life. Datta (2006) has pointed that poor quality of rural urban migration has led to poor quality of urbanisation (Bhagat, 1992).

As urbanisation continues, there are number of areas which need to be addressed.

- What would be the nature of growth of these urban areas?
- What kind of ecological footprint is being thought of?
- Whether sustainability has been incorporated in the planning process?

OBJECTIVE

This paper analyses the process of urbanisation in India and looks at energy consumption patterns. It also assesses how urbanisation could include sustainability and better energy management practices could be adopted for future growth.

ECOLOGICAL FOOTPRINT & ENERGY CONSUMPTION

Sanyal et al (2013) remark, "In 1992, William Rees developed the concept of the 'Ecological Footprint to assess the reliance of the planet on its natural resources and ecological assets.

It is a measure of how much biologically productive land and water an individual population or activity require to produce all resources it consumes, to absorb the waste it generates using available technology and practices. At a macro level, per capita footprint for India is 0.8 hectares as compared to average per capita ecological footprint of 6.43 global hectares. As urbanisation happens in India, it could adopt different approaches to build its cities.

There are number of factors which impact the ecological footprint. Some of these factors are : total population; total land area; density of population; urban form; transport system; built environment/buildings; energy supply/usage; water supply/usage; waste generation and management.

Two different trajectories for urban futures could be followed. For example it would be interesting to look at the Atlanta urban growth model or the Barcelona urban growth model. The comparison of both the cities' urban growth as derived from Sanyal et al (2013) is indicated in the table below:

Table 1: Per capita footprint 13 global hectares

Parameter	**ATLANTA**	**BARCELONA**
Density of population	6 people per hectare in 1990	17,6137 people per hectare
Longest possible distance between two points within built up area	137 kms.	37 kms.
Per capita CO2 emissions	400 metric tons	138 tons
Metro network & usage by the population	74 kms. and 4% population within 800 m of metro station	99 kms and 60% of the population within 600 m of a metro station
Trips by mass transit	4.5%	Fraction of 30%
	Requires additional 3400km of metro tracks and 2800 new metro stations	Barcelona does that with 99 kms. of tracks and 136 stations 3.26 global hectares
Percapita footprint	13 global hectares	3.26 global hectares

Source: Derived from Sanyal et al (2013)

Barcelona provides a higher standard of living than that of Atlanta but at a fourth of the environment cost. The difference is whether the city is being built through sprawls or clustered habitat. The population density (people/sq.km) in Atlanta is 700 while as in Barcelona it is 4850 (www.citymayors.com, 2007). A 2003 analysis from the World Bank showed that an increase of 1 percent in urban population increases energy consumption by 2.2 percent. (Das, 2008)

In terms of energy consumption, 16% of the global population in the OECD countries, would consume, by the year 2030, more than 40% of energy and the balance about 84% of the global population in the non-OECD areas would consume a little less than 60% of the total energy consumed in the world (Shahi, 2013).

If one looks at the energy requirement, there are various sectors which would require additional energy. For example, industry, buildings and transport sectors would require huge energy consumption. In the industry

segment, steel, aluminium, cement, paper, chemicals, food are some of the key energy consumers. As new cities are being created, with increased urbanisation the form of residential and commercial buildings will play a key role as to how the energy is generated, consumed and managed. The transport sector also has to have clear priorities and build in energy efficiency in terms of meeting the growing requirements in a sustainable manner. The transport sector is the second largest contributor to energy related GHG emissions in India and its share in national GHG emissions has increased from 6.4 percent to 7.5 percent between 1994 and 2007 (Deng et al., 2011)

Improving energy efficiencies in the domain of industry needs to look at how different technologies could be deployed meaningfully so that energy consumption is sustainable.

THE POWER SCENARIO IS INDIA

To deliver a sustained economic growth rate of 8% to 9% through 2031- 32 and to meet life time energy needs of all citizens, India needs to increase its primary energy supply by 3 to 4 times and electricity generation capacity about 6 times. As a result energy service demand growth rates will keep on increasing because of accelerated industrialization, urbanization, and an emerging consumer society (Ministry of Power, 2013)

The total installed capacity of power and the contribution of power produced by various sectors is indicated in the Table 2. The composition of the sources of energy is indicated in table 3. There are two broad insights from the data presented in Table 2 and Table 3. The first is that for power generation, the states have a bigger role. There is a bigger role which could be played by the private sector and also more pragmatic deployment of technology could lead to reduction in power losses as well as better fuel management and distribution strategies. There is also a higher degree of reliance on the non renewable sources of fuel. India will have to be more proactive in investing in solar and other sustainable forms of fuel. Nuclear energy is a high risk strategy and could have serious environment implications. India could leverage its technological know-how in the realm of wind energy and deploy it more effectively with greater incentives and policy measures could encourage industry to make investments in this area. Table 4 highlights the sources of energy from renewable power. Wind power energy has been channelized well which could be enhanced further. The solar power energy needs

more investments and policy support to make it commercially viable for adoption by the industry and individual housing. The storage and transmission aspects need more technologies investment and research for commercial adoption.

Table 2: Total Installed Capacity for Power from different sources

Sector	**MW**	**%age**
State Sector	86,343.35	40.77
Central Sector	62,963.63	29.73
Private Sector	62,459.24	29.49
Total	**2,11,766.22**	

Table 3: Sources of Energy

Fuel	**MW**	**%age**
Total Thermal	**141713.68**	**66.91**
Coal	121,610.88	57.42
Gas	18,903.05	8.92
Oil	1,199.75	0.56
Hydro (Renewable)	39,416.40	18.61
Nuclear	4,780.00	2.25
RES** (MNRE)	25,856.14	12.2
Total	**2,11,766.22**	**100**

Renewable Energy Sources(RES) include SHP, BG, BP, U&I and Wind Energy

SHP= Small Hydro Project ,BG= Biomass Gasifier ,BP= Biomass Power,

U & I=Urban & Industrial Waste Power, RES=Renewable Energy Sources
Source : Ministry of Power, Govt. of India, Downloaded from http://powermin.nic.in/JSP_SERVLETS/internal.jsp
The data is as on 31.10.2012

The details of sources of new and renewable energy are mentioned in the table below:

Table 4 : Sources of Renewable Energy

New & Renewable Energy				
Cumulative deployment of various Renewable Energy Systems/ Devices in the country as on 31/01/2013				
Renewable Energy Programme/ Systems	**Target for 2012-13**	**Deployment during**	**Total Deployment**	**Cumulative achievement up to 31.01.2013**
		January, 2013	**in 2012-13**	
I. POWER FROM RENEWABLES:				
A. GRID-INTERACTIVE POWER (CAPACITIES IN MW)				
Wind Power	2500	131.3	1199	18551.7
Small Hydro Power	350	10.1	110.93	3506.24
Biomass Power	105	-	98.5	1248.6
Bagasse Cogeneration	350	41.3	295.7	2280.93
Waste to Power -Urban		-	6.4	96.08
-Industrial	20	-	-	-
Solar Power (SPV)	800	60.23	295.3	1236.48
Total	**4125**	**242.93**	**2005.78**	**26920.03**

Source : http://mnre.gov.in/mission-and-vision-2/achievements/ Govt. of India, Ministry of New and Renewable Energy 2013

Shahi (Ministry of Power, 2013) remarks, "In the profile of energy sources in India, coal has a dominant position. Coal constitutes about 51% of India's primary energy resources followed by Oil (36%), Natural Gas (9%), Nuclear (2%) and Hydro (2%). To address the issue concerning energy consumption, and more particularly, the need for enhancing the energy supply, India has accorded appropriate priority to both - supply side management and demand side management." India is one of the very few countries which has been successful in employing wind turbine technology and today of the total capacity of 1,25,000 MW in the country about 5% is constituted by the various non-conventional sources of generation, wind

being the largest contributor (Shahi, 2013).

On the basis of random sampling studies conducted on various segments of energy consumption, it has been established that over 20% of energy is wasted because of in-efficient consumption. The Government of India enacted a legislation called Energy Conservation Act in the year 2001. The Bureau of Energy Efficiency (BEE) has been put in place in pursuance to implementation of this law.

Industrial Sector in India

The industrial sector consumes about half of the total commercial energy available in India, 70% of which is in energy available sectors – fertilizers, aluminium, textiles, cement, iron and steel and paper – 15-25% of this is avoidable; 5-10% energy saving is possible by better housekeeping (Clean Technology Fund Investment Plan for India, Oct-3, 2011). The Bureau of Energy Efficiency (BEE) has been established from March, 2002 under, the Ministry of Power, Govt. of India for spearheading the improvements of energy efficiency of the economy through various regulatory and promotional instruments. Energy efficiency is the greenest opportunity in India. The low carbon market is worth $135 billion by 2020 and the energy efficiency market is worth $77 billion by 2020. measures and another 10-15% is possible with low cost retro use of efficient devices. Companies plan to spend over 12% of their budgets on energy efficiency investments. For example, Mahindra & Mahindra are targeting 5% of reductions in emissions by 2014. Wipro plans to reduce 49% of Co2 – e/IFTE equivalent relative to 2009 by 2015 (CII, CDP India 2001, 2010).

Green Buildings and Habitat

India would have to look at multiple aspects in improving the quality of life and lower energy consumption in the housing and commercial sector. Green buildings would have to be built in order to reduce energy consumption.

Green Building Council of India (2013) defines green buildings as,

"A green building is one which uses less water, optimises energy efficiency, conserves natural resources, generates less waste and provides healthier spaces for occupants, as compared to a conventional building."

The vision of Green Building Council of India is to enable a sustainable built environment for all and facilitate India to be one of the global leaders in sustainable built environment by 2025. A National Mission on Sustainable Habitat has been initiated in India. It is one of the eight climate change

missions of India. It is a recognition of the fact that climate change is likely to have impacts on river systems, sea levels, and in temperature, all of which result in change in energy consumption along with socio-economic and demographic linkages. The rural and landless populace is more likely to bear the brunt in cases of forced migrations as with little technical skills, they are forced to live a life of penury in urban areas.

The National Mission on Sustainable Habitat has been established with the following objectives-

- To reduce energy demand by promoting alternative technologies and energy conservation practices in both residential and commercial areas.
- Better Urban Planning with a view to enable better disaster management; promoting patterns of urban planning that enable lesser use of private and more usage of public transport. It also involves promoting and encouraging use of lesser polluting vehicles.
- Encourage community involvement and dialogue for more sustainable pattern of development; participation of stakeholders.
- Conservation of natural resources such as clean air, water, flora and fauna that are the keystones of sustainable human habitats.

India is a world leader in the green building sector(Accenture, 2012). The Green Building Council plans to apply the green practices to a 1 billion square feet area (up from a current half a billion square feet) and train 5000 accredited professionals in such practice.

Public Transport

World marketed energy consumption was about 505 quadrillion Btu in 2008. There are four major energy end-use sectors: commercial, industrial, residential, and transportation.

Table 5: Energy End Use by Different Sectors

	Energy End-Use[1]	Electricity Losses[2]	Total Energy Use[3]	Share of Total Energy Use
End-Use Sectors				
Commercial	28	32	60	12%
Industrial	191	64	255	51%
Residential	52	37	89	18%
Transportation	98	2	100	20%
Total End-Use Sectors	369			
Electric Power Sector[3]	194			39%
Total Electricity losses[2]	135			
Total Energy Use	505			

1 Includes end-use of electricity but excludes losses
2 Generation, transmission, and distribution losses
3 Includes electricity losses
Learn More:
International Energy Outlook 2011
International Energy Outlook (Appendix D1)
Created: January 30, 2013

Source U.S. Energy Information Administration, How much Energy is consumed in the world, by each sector, January 30, 2013, http://www.eia.gov/tools/faqs/faq.cfm?id=447&t=1

According to Table 5 has enumerated the end energy use by different sectors, the report of Urban India (2013), "The transport sector plays a crucial role in energy use and emission of GHGs. In 2004, transport energy use amounted to 26 per cent of world energy use and the transport sector was responsible for about 23 per cent of the GHG emissions (International Energy Agency (IEA), 2006). The 1990-2002 growth rate of energy consumption in the transport sector was the highest among all the end use sectors. Each gallon of gasoline when burnt, pumps 28 pounds of CO2 into the atmosphere. In India, transport which includes road, rail, aviation and navigation has been a major contributor to GHG emissions.

Integrated Energy Policy (IEP, 2006) states that no economic substitutes are obvious for the transport sector at least till 2031-32. Therefore, energy efficiency of vehicles, use of mass transport, pedestrianisation, cycling and transport demand management measures have to get high priority. Among transport sub sectors, road transport is the main source of CO2 emissions which accounts for 90 per cent of

total transport sector emissions. Considering this, the emphasis in this mission is mainly on measures to reduce emissions from operation of road transport. From an energy conservation perspective, public transport makes the most optimum use of the available road space and fuel by transporting the maximum number of people per unit of road space and passenger kms/litre.

In Delhi, the share of public transport has fallen from 60% ten years ago to 45% and that is the fundamental reason for the pathetic commuting in Delhi. The capital has around 81 lakh vehicles with 1400 new ones getting registered everyday (Kumar, 2013). The Delhi Master Plan aims at an 80:20 mix of public and private transport for 2021. More than 70% of air pollution in the city is attributed to vehicular pollution.

An Economic Times Report (2013) elaborates that initiatives like Delhi metro can make a big impact on the energy consumption and emissions as well. Delhi metro with its 190 km network and 143 stations as in March 2013 ferries 2.3 million passengers a day. On account of Delhi metro, 1.2 lakh vehicles have gone off the road on a daily basis. In addition, the reduction in fuel consumption has declined by 1.06 lakh tonnes. The savings in fuel costs is Rs 1.6 crores and 1.8 lakh tonnes reduction in pollutants.

The composition of vehicle population in India is skewed towards personal transport. In Bangalore for example, the vehicle population ratio is 1:3(Abraham, 2013). Bangalore does not have a well networked metro as yet. Currently it just services 1%of the population. Over 40 lakh commuters use the 5000 odd public buses in Bangalore and 1 lakh use autorickshaws. But these vehicles occupy just 2% of the road space. Bangalores 35 lakh commuters who use private vehicles take up 90% of the road space. The story in Kolkata is no different. Traffic volume in Kolkata has increased by 15-20% since 2012. Road space in Kolkata is down to 6-8% earlier as compared to the global phenomenon of keeping 30% for road space (Himatsingka,2013).

The table 6 gives an insight into the growth of vehicular traffic in four leading metro cities in India.

Table 6: Vehicles and Roads in four metros in India

	Delhi	Mumbai	Bangalore	Kolkata
No of vehicles registered everyday	1400	400	1000	350
Total vehicles as on date	81 lakh	20 lakh	38.8 lakh	11.69 lakh
Road length	33,198 kms	2000 kms	11000kms	1870 kms
% increase of road length(10 years)	10.42%	10%	56.3%	33.19%
% increase of vehicular traffic(last 10 years)	50.61%	80%	62%	53.25%

Source: Kumar(2013) and State Traffic Police Departments

Urban India (2013) mentions that the bulk of increase in private transport is seen in two wheelers. India is expected to have a population of 236 million two wheelers in 2035 up from 35.8 million in 2005 which, reflects a large increase. The National Urban Transport Policy (NUTP 2006) has set the national guidelines for action framework for urban transport in cities. It has laid major emphasis on promoting investments in public transport in Indian cities as well as measures that make its use more attractive than in the past. Towards this end, the policy states that the central government would encourage all state capitals as well as other cities with a population of more than one million to start planning for high capacity public transport systems, and promote shift from personal modes of transportation to public modes of transportation. It provides for integrated land use and transport plans in cities, coordinated planning for urban transport, people oriented equitable allocation of road space, capital support in the form of equity participation and or viability gap funding, innovative financing, dedicated urban transport funds, non-motorised transport, car restraint measures, clean fuel and vehicle technology, private sector participation, and pilot projects in cities to establish models of best practices.

To meet the challenges of urbanisation, an integrated effort is required by various government bodies, industry, civil society, funding agencies and policy makers. To address urbanisation with a sustainable future for energy management, substantial efforts are required. A focussed solution specially for intensive energy consuming industry sectors is required. Technologies that could reduce energy consumption or the ones which bring in more efficiency should be looked at Deng et al (2011) in their 'Ecofys Energy Scenario' postulate that an energy system can be created by 2050 which sources 95% of its energy from sustainable sources. A alternate sources of energy should be tapped such as solar, bio sources such as bio algae, bio crops, residual & waste, geothermal, wind, wave and tidal. For industry, as per the Ecofys Energy Scenario by Deng et al (2011), all sectors of the industry must deploy increased use of recovered input materials. Stringent norms for using best available technologies for all new plants should be implemented. Also existing plants should optimise and refurbished to meet performance benchmarks. In steel industry, by 2050, through the increased adoption of smelt reduction process, the fuel consumption and energy requirement can be brought down drastically (Kim, 2002; Worrell, 2008). In the cement industry, energy intensity can be reduced from 5-6 GJ Per tonne to 3 GJ per tonne. Instead of deploying carbon intensive tinker production, blast furnace lags, fly ash or natural pozzolanes can be deployed. Likewise in paper the use of recycled pulp provides an energy saving of 30-40%.

In the buildings to manage the future energy intensity, Deng et al (2011) advise, "60% of the heating needs could be abated by insulating walls, roofs, and ground floors, replacing old windows with highly energy efficient window and by installing ventilation systems with heat recovery mechanisms. The water heating requirement should be met by local solar thermal system and heat panel. Cooling would be provided by local renewable solutions."The transport sector is the second largest contribution its energy related GHG emissions in India & its share in national GHG emissions has increased from 6.4 percent to 7.5 percent between 1994 and 2007 (INCCA 2010). India imports about 80 percent of its petroleum requirements, a significant part of which is used for transport (Clean Technology Fund Investment Plan for India, Govt. of India, 2011).

In the transport sector, huge energy savings can be possible by integrating, walkability in lives of people. A shift from car travel to human powered travel as walking and cycling could be much more healthy. A shift from business travel to video conferencing could also greatly reduce carbon foot pring. Moving over to safe and sustainable public transport system could check the unbridled growth of individual car sales. The policies around stringent emissions norms, incentives to push for green technologies and high taxes and tariffs could help make consumers shift to more sustainable practice. Building sensitivity and campaigns around awareness of impact on energy consumption and environment would go along way in impacting the attitude of the people. Building in sustainable future, energy and environment courses at school and colleges should be mandated by the policy. There should be online programs where ordinary citizens could be introduced to these areas. Incentivisation and certifying professionals and inducing policy level guidelines and norms for future building should be initiated. Appropriate governance mechanisms should be incorporated for driving the agenda for energy efficiency.

The Govt. of India Report (2011) has put together an agenda for developing Clean Technology Fund Investment plan where funding will not only come in from the government but other multilateral financing agencies as well. There are various issues its be addressed such as access to finance, cost of finance, resource, developing a sustainable manufacturing ecosystem. The government estimates for public and private sector spending are estimated at $300-$500 billion over the next five years (Business Week, 2010). So how these get built and energy and sustain ability considerations are built in the investments will have a great impact in urbanisation and energy consumption.

India must develop model regions/cities which are ecosystem of sustainable but innovation of working together is required.

As per the estimates of McKinsey Global Institute Analysis (2012)

"As urbanisation increases in India, the Indian cities will need capital

funding of $1.2 trillion and a total of $2.2 trillion over the next 20 years. The $ 2.2trillion includes 1 trillion dollars on administrative expenses. This would include expenditures on water, sewage, solid waste, storm water drains, urban roads, mass transit, affordable housing."

There are also different models available for financing the urban growth. These could be a mix of property taxes and user charges, grants from central and state governments, land, debt ad public private partnerships (Sankhe et al. 2010). New York gets 62% of its funds from property taxes and user charges while Shanghai gets 50% of its funding from the same source.. London gets 70% of its financing as grants from central and state governments.

India will have to work its strategy to raise adequate financing for its urbanisation. Its per capita expenditure is very small as compared to the global cities which explains the deficiencies in its service offerings.

There should be an integrated approach towards building liveable and sustainable cities. It is an experience element which the policy makers need to keep in mind. Energy considerations would be important aspect. How people travel, how power gets generated, what kind of transport would people deploy are all elements which have to be built in the planning of new cities. Walkability, safe public transport, alternate and sustainable forms of energy deployment and waste recycling are important considerations in planning the new cities.

NOTES

1 crore = 1,00,00,000
1 lakh = 1,00,000
1 million = 10 lakhs

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