Janmejay Sahoo

M.Tech, Disaster Mitigation and Management, Indian Institute of Technology, Roorkee.

E-mail Id: Janmejay_bablu @hotmail.com

Evolution of Sectoral Energy Consumption in India

Abstract

The increasing dependence on energy plays a significant role in shaping out our future energy demands and economic growth. The main concerns regarding this approach are related to the limited availability of energy sources and their impact on global climatic conditions. These impacts are further exaggerated due to the lack of a coordinated approach towards reducing energy consumption for a sustainable alternative. The article focuses on the end-use energy consumers which are primarily agricultural, transportation, industry, residential and commercial sectors and how the use of technology and urbanization has impacted them. Using the contribution of these sectors and the population growth, alternative future scenarios were developed and compared, where the advantages of an energy-efficiency approach was exhibited. At an urban level, these sectors were associated to different land uses and their potential to improve energy efficiency was explained using various techniques and indicators. One of the primary goals of this article was to explain the methodologies to achieve energy efficiency in communities, which was explained using the role of comprehensive technologies like GIS and integrated approaches under urban planning. Case studies of Bangalore and Massachusetts were elaborated to comprehend such initiatives at a city scale and how they can be implemented in reality. Exploring these questions sets a course for informing local land use decisions that impact energy consumption.

Introduction

Need for Study

Energy plays a significant role in the operation and functioning of the world's economy. As a crucial input to agricultural production, transportation, industry, trade and commerce, dependence on energy will keep on growing as world population increases and standard of living improves. The shift towards urbanization, increased mobility and a comprehensive global economy will further accelerate our dependence on energy use. Recent studies of international energy trends indicate that under "conventional development strategies," global energy consumption is anticipated to double by 2030 as it was in the early 1990s (Critical Trends: Global Changes and Sustainable Development, 1997).

Presently, the vital issue related to energy is its role in the global climate change. Extraction and use of energy through conventional techniques produce greenhouse gases leading to global warming. Global warming is a fateful phenomenon that leads to devastating disasters caused by extreme and erratic climatic events. Sustainable development is essential to tackle and mitigate the impacts of this global climate change. It incorporates the needs of present generations without compromising the ability of future generations to meet their needs (Our Common Future, Brundtland Report, 1987).

Energy extraction, transmission and use are fundamental to the interaction between humans and the environment. Improvements in the way energy is ultimately consumed have effects which cascade all the way back up the supply-chain.

How to cite this article:
Sahoo J. Evolution of Sectoral Energy Consumption in India. *J Adv Res Alt Energ Env Eco* 2016; 3(3&4): 49-60.

ISSN: **2455-3093**

End-use improvements increase the lifespan of current energy resource infrastructure and reduce the need for new energy supplies. Improving the efficiency of energy use have significant benefits in capital constrained developing nations which face high capital costs for new generation units, transmission and distribution systems.

Efficiency improvements do not necessarily require new engineering solutions or end-use technologies. Enhancements are also possible if organizations and individuals change the way they use existing technologies. Promulgating the benefits of energy efficiency among all concerned, from policy-makers and manufacturers to consumers have a great effect on the rate at which new technologies are adopted. Therefore, research and development is necessary to comprehend the expansive potential of such measures for sustainable development.

Objectives

It is important to study the transformation in sectoral energy consumption through the years to identify methods and techniques for management of energy use in urban areas. Objectives formulated for this purpose are:

- To study the trend and pattern of end-use energy consumption in the urban environment
- To identify methods and techniques for assessment and management of energy use in urban areas

Scope of the Study

The study shall be focused on scenarios in the urban environment as they are the major end users of energy in the rapidly developing nations. The end-use energy consumption analysis relates to different sectoral energy uses, efficiency and their comparison. This may be associated to the changes in technological, organizational, social or cultural aspects of each sector.

The concern for use efficiency arises from initiatives to reduce the wastage of resources by an approach that maintains an overall energy balance. Comprehensive technologies such as geographic information systems (GIS) and database management systems may be used combined with different parameters and indicators for monitoring and managing the energy use. The study will focus on analysis of such technologies and develop a base that may be worked upon later for detailed proposals.

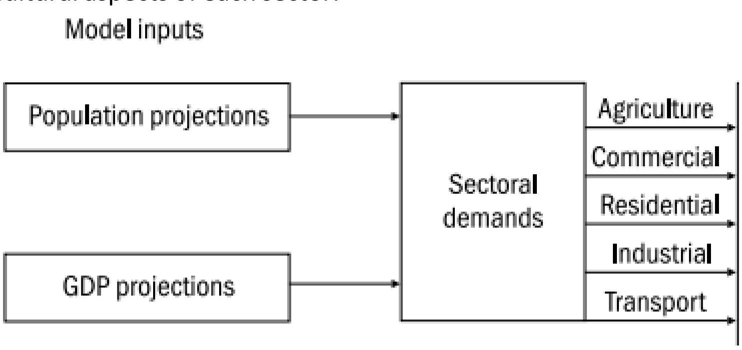
Pattern of Energy Consumption in India

Introduction

Energy has been universally recognized as one of the most important inputs for economic growth and human development. There is a strong two-way relationship between economic development and energy consumption. On one hand, the growth of an economy, with its global competitiveness, hinges on the availability of cost-effective and environmentally sound energy sources, and on the other hand, the level of economic development has been observed to be dependent on energy demand. India ranks fifth in the world in terms of primary energy consumption, accounting for about 3.5% of the world energy demand, as per data presented by Niti Ayog (India Energy Security Scenarios, 2015). Indian economy is assumed to grow at 7.4% CAGR (compound annual growth rate) between 2012 and 2047 (India Energy Security Scenarios, 2015). The economic activity so generated will lead to demand for energy as well.

Sectoral Classification

Energy demand is driven by the GDP (gross domestic product) and population growth. Different GDP growth rates can be used to develop various scenarios of economic growth while the population projections can be considered to reflect trends in population growth.



Source: Author, 2016

Figure 1.Energy End-Use Sectors

These population and GDP figures can then be used to estimate end-use demand in the five sectors of the economy, which are agriculture, commercial, residential, industrial, and transport over the modelling period. These five sectors coincide with the different land uses that are found within and adjacent to the urban areas. A detailed analysis of the interaction and inter-relatedness of these uses at a city level can help us understand the energy consumption in a more comprehensive manner.

Residential Sector

Residential sector comprised of 22% of the overall electricity demand in the base year 2011-12 (IESS, 2047). Increasing urbanization, pattern of urbanization and rising income levels in both urban and rural areas are factors responsible, for big push to demand for electrical appliances resulting in manifold increase in the electricity demand from the residential sector.

Commercial Sector

Commercial buildings sector contributed 15% of the electricity demand in the year 2011-12 (IESS, 2047). The drivers for electricity demand in buildings are the rising share of services sector in the GDP, levels of urbanization and penetration of high-efficiency appliances in this sector.

Industry Sector

Industry sector comprised of 43% share of the overall electricity demand in India in the year 2011-12 (IESS, 2047). Steel sector alone contributes to 25% of the industrial electricity demand, followed by cement and aluminum sector (IESS, 2047). Drivers for industrial electricity demand are the increased demand for materials in buildings, transportation, capital goods and infrastructure. These levers also form the basis of the modeling of economic demand for metals and materials in consonance with rising per capita income levels. The material demand thus obtained could be met by various technologies, fuel choices leading to different levels of energy demand for the same levels of economic demand.

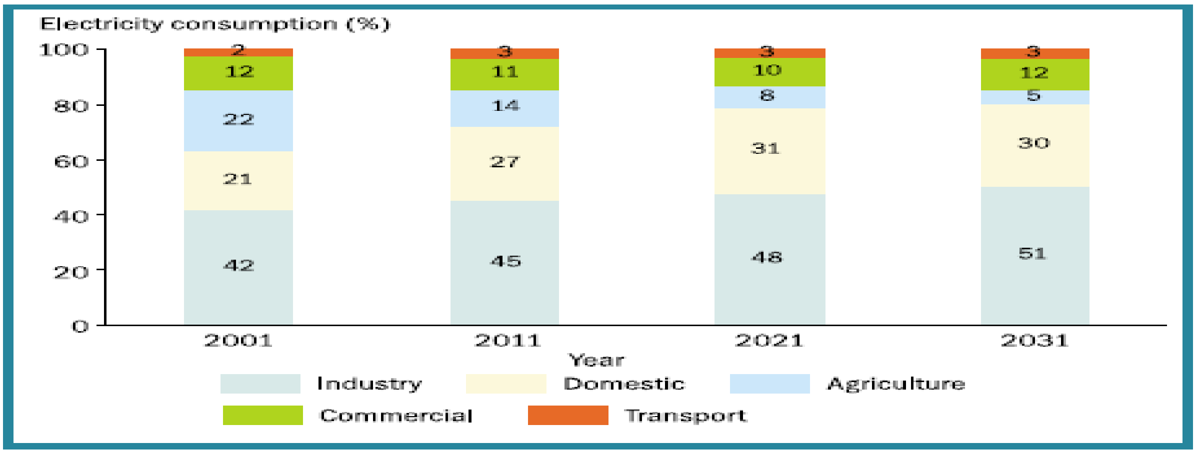
Agriculture Sector

Agriculture sector contributed to 17% of the overall electricity demand in the country in 2011-12 (IESS, 2047). Increased mechanization and shift to ground water irrigation across the country is driving the pumping and tractor demand in this sector, and hence the large diesel and electricity demand in the agricultural sector. Sustainability and subsidy concerns have made replacement of diesel pumps in agriculture with electricity and solar-based pumps imminent, which is likely to be the policy driver.

Transportation Sector

This sector contributed to 4-5% (IESS, 2047) of the electricity demand (rest from oil). Penetration of electric vehicles and fuel switch to electricity will drive electricity demand in this sector. Two major structural aspects of transportation are related to energy efficiency. First, the rail-dominant economy of the1950s gave way to the road-dominant economy of the 1990s, reaching 81% of the sector’s energy consumption (TERI, 1997). Second, inadequate public transport systems and increasing incomes have led to a rapid increase in personalized modes of transport.

Sector-Wise Comparison



Source: TERI, 2006

Figure 2.Trend in Sectoral Energy Consumption in Trend Based Scenario

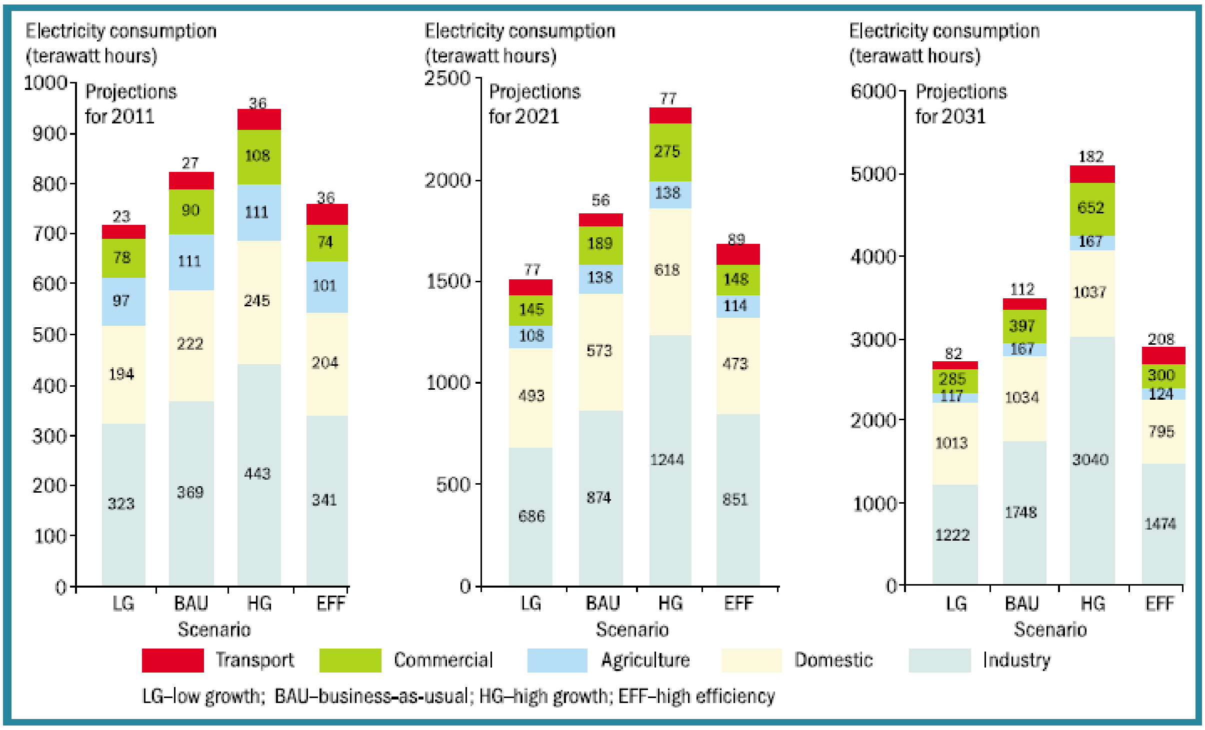
ISSN: 2455-3093

In recent years, many manufacturers in industrialized nations have moved energy-intensive industries to developing countries, often to take advantage of cheaper labor, less stringent environmental regulation, and lower overhead and transportation costs. Many of these countries (Brazil, China, India, and Indonesia) also need their own basic product industries. Household appliances, cookers, and water heaters have become more energy efficient in higher-income developing countries. But the rapid acquisition of household devices has far outpaced the impact of greater efficiency. Higher lighting levels, increased office automation, and other developments have also contributed to rapidly rising electricity use in this sector (IEA, 1997). Transportation accounts for a rising share of energy use in higher-income developing countries. Growing numbers of vehicles, often rising at 1.5 times the rate of GDP growth, have dominated the transportation energy use picture. But increased urbanization and traffic congestion and reduced occupancy have eaten up many of the improvements in vehicle technology. Overall, a better understanding is needed to be developed to improve the behavioral and organizational aspects of end-use energy efficiency for a sustainable future.

Alternative Future Scenarios

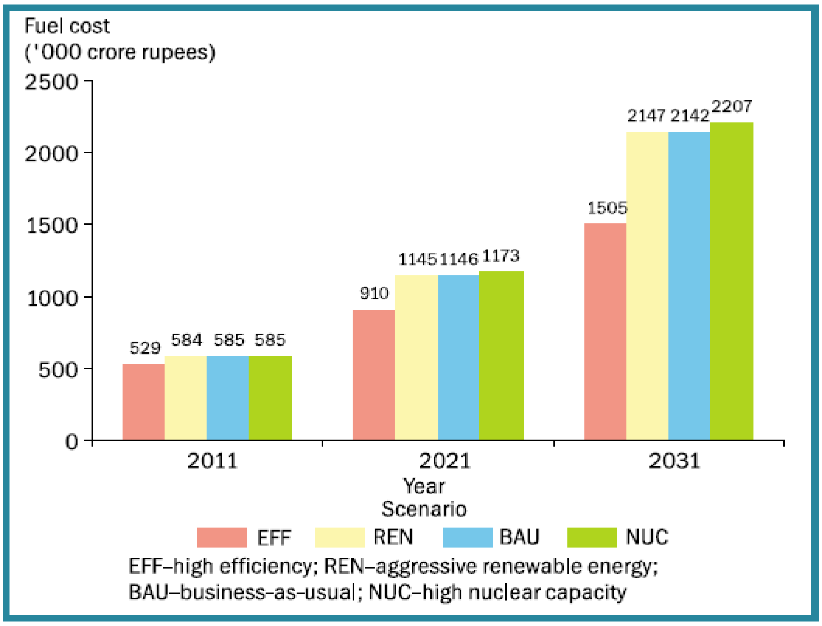
A probable method to explain the gravity of the situation is by modeling alternate future scenarios using different assumptions and growth rates as have been explained in the previous sections. Government of India, in association with TERI (The Energy and Resource Institute) has developed such an initiative at a national scale. According to the current trends and growth patterns, the total electricity consumption increases by 8.9 times over the modeling time frame. This increase is mostly in the industry and residential sectors, and by 2031, these two sectors will account for nearly 80% of the total electricity consumption as compared with 63% in 2001. The consumption in the domestic sector increases by 12.6 times during the modeling time frame.

The percentage share of the industrial sector in total electricity consumption will increase from 42% in 2001 to 51% by 2031. During the same period, the percentage share of domestic sector in the electricity consumption will increase from 21% to 30%. However, there has been a decline in the percentage share of the agriculture sector in total electricity consumption, from 22% to 5% over the modeling timeframe. The share of the commercial and transport sectors in electricity consumption has remained constant over the 30-year modeling timeframe. The model focuses on four approaches which are low growth, business as usual, high growth and high efficiency.



Source: TERI, 2006

Figure 3.Energy Consumption for Alternative Scenarios



Source: TERI, 2006

Figure 4.Cost of energy in Alternate Scenarios

For the purpose of explaining the benefits of the energy efficiency approach, two parameters can be explained in detail: one is related to consumption levels and the other related to cost of energy.

From the above figures, we can deduce that energy efficiency can be a preferred approach for the future since it emphasizes on reducing the overall energy demand and providing more productivity per unit energy consumed. The lower cost of commercial energy is an additional advantage. To explain the energy-efficiency approach, we can take the example of household sector where results can vary depending on:

1. Economic variables:
    a. Total household expenditure.
2. Demographic variables
    a. Rural/urban location,
    b. Number of household members.
3. Dwelling attributes
    a. Covered area of dwelling,
    b. Construction type,
    c. Dwelling type.

Total monetary expenditure (which is used as a proxy for income) of households is the most important economic variable influencing total household energy requirements.

Table 1.Energy Requirement on the basis of income criteria

	Household expenditure groups	Direct energy in GJ per capita p.a.	Indirect energy in GJ per capita p.a.	Total energy in GJ per capita p.a.
URBAN	Bottom 40%	2.97	3.17	6.14
	Middle 50%	4.28	5.95	10.23
	Top 10%	7.36	14.53	21.89
	Average	4.02	5.58	9.60
RURAL	Bottom 40%	2.93	2.55	5.48
	Middle 50%	4.06	4.20	8.26
	Top 10%	5.56	9.11	14.67
	Average	3.73	3.97	7.70
ALL-INDIA	Bottom 40%	2.97	2.65	5.63
	Middle 50%	4.08	4.59	8.67
	Top 10%	6.04	10.94	16.98
	Average	3.80	4.37	8.17

Source: Cross-sectional variations in total household energy requirements in India, 2004.

ISSN: 2455-3093

Methods for Management of Energy Use

Necessity for Management of Economic and Environmental Resources

Different energy technologies and management systems will be required by country and region, depending upon available local resources, skills, and initial economic, environmental and social conditions. In a period of resource constraint and climate change, cities are beginning to translate their strategic concern about their ability to guarantee resources into strategies designed to reshape the city and its relations with resources and other spaces in three critical ways.

First, the strategic protection of world cities. Central to the strategies of 'cities' is investment in generating a systemic understanding of the city-specific and long-term effects of climate change, especially in relation to flood risk and temperature rise and the development of systemic responses through strategic flood protection, green infrastructure and retrofitting to deal with increased temperatures. Second, the construction of more self-reliant urbanism. Cities have usually sought to guarantee their reproduction by seeking out resources and sinks from locations usually ever more distant. Yet this traditional approach is now being challenged as cities seek to re-internalize resource endowments and create the recirculation of wastes as they withdraw from reliance on international, national and regional infrastructures. Third, the development of new networks of global urban agglomerations. New networks of social interests speaking on behalf of selected cities are constituting their interests in initiatives like the C40 and the Clinton Climate Initiative. Collectively, these cities are working together to develop self-reliant urbanism. For example, they are developing common measurement tools so that cities can establish a baseline on their greenhouse gas emissions, track energy usage and share best practice to inform mitigation and evaluation activities.

Maintaining Energy Balance through Urban Planning

Urban planning is a technical and political process concerned with the use of land, protection and use of the environment, public welfare, and the design of transportation, communications, and distribution networks. Urban planners in the field are concerned with research and analysis of various sectors of development by assessing financial, organizational and socio-cultural aspects of the community.

Analytic understanding of these processes of 'system innovation' and socio-technical transitions is established on an interrelated three-level framework of landscape (macro), regime (meso) and niche (micro). The concept of 'landscape' is important in understanding the broader 'conditions', 'environment' and 'pressures' for transitions. The landscape operates at the macro level, focuses on issues such as political cultures, economic growth, macroeconomic trends, land use, utility infrastructures, and so on (Geels, 2002) and applies pressures on existing socio-technical regimes, creating windows of opportunities for responses (Geels and Schot 2007).

Indicators

Energy efficiency may be defined as the amount of input required to achieve a standard level of service. Increase in energy efficiency is when either energy inputs are reduced for a given level of service, or there are increased or enhanced services for a given amount of energy inputs. Energy efficiency indicators are built to understand trends in the consumption of a sub-sector or an end use which could be more or less aggregated and sophisticated based on data availability.

Techniques to Improve Energy Efficiency at Community Level

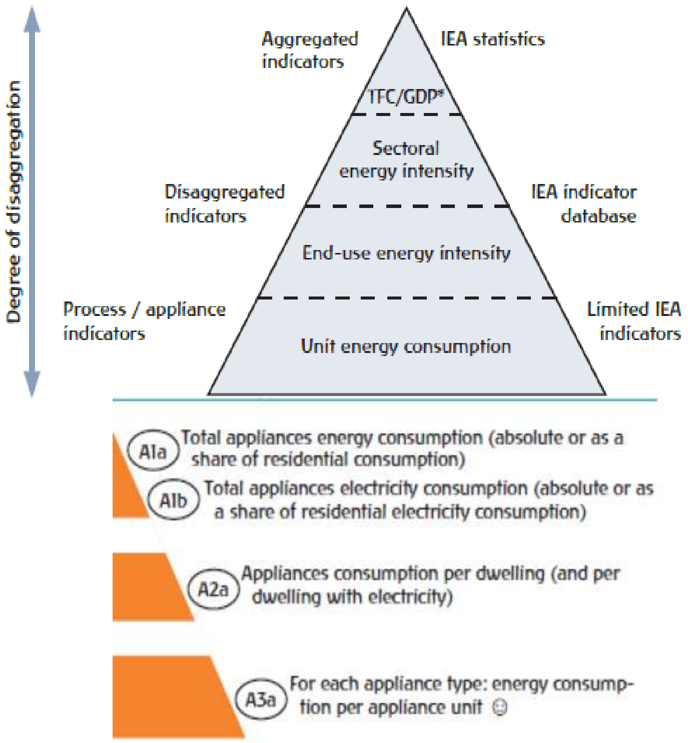
Enhance Building Design and Siting

If energy efficiency is a priority in a community's master plan, then design standards can be incorporated into the planning board's subdivision regulations. Communities may also adopt building codes more stringent than state codes, thus resulting in greater energy savings for community members. Communities may also incorporate energy-efficiency standards and renewable energy generation requirements in their zoning ordinances.

Apply Smart Growth Principles

Adopting regulatory standards based on the concepts of "smart growth" can also help you manage land use to reduce the demand and associated costs for energy while achieving many other benefits for community development. New Hampshire statutes define smart growth as the development and use of land in ways that are appropriate to our traditional and historic landscape, including denser development of existing communities, encouragement of mixed uses, protection of villages, planning to make communities more walkable.

ISSN: 2455-3093



Source: Energy Efficiency Indicators, IEA, 2014.

Figure 5.Energy Use Indicators

Incorporate Energy Efficiency Strategies into Municipal Policies

Energy efficiency can save communities significant cost. Considering setting policies for green building design or LEED (leadership in energy and environmental design) is a green building certification program that recognizes best-in-class building strategies and practices) certification in new buildings; consider retrofitting existing facilities to be more energy efficient.

Form an Energy Commission

They can be created for the purpose of study, planning, and utilization of energy resources for municipal buildings and built resources and for making recommendations to local boards and committees pertaining to municipal energy plans and sustainable practices, such as energy conservation, energy efficiency, energy generation, and zoning practices.

Role of GIS in Improving Energy Efficiency of Urban Areas

Geographic information systems have experienced growing utilization in the energy sector around asset management and identification, grid analytics, and renewable energy systems (ESRI, 2007; ESRI 2010; Simmins et al. 2012; Lopez et al. 2012).

Deployment of GIS for energy efficiency is comparatively less utilized, and existing work has largely been focused on applying spatial analytics for identifying residential energy efficiency opportunities due in part to low-cost national datasets with demographic and building profile characteristics. Utilities and energy efficiency programs are important to understand how geographically discreet regions and locations consume. It is important to note at this point in the process that results are only as accurate as the combination of the data provided, the base layers, and the composite locator acceptance thresholds.

Case Study: Bangalore

Bangalore city has developed spatially in a concentric manner. A comparative assessment of future land use pattern and current land use pattern based on surveys conducted in 2003 is given below.

ISSN: 2455-3093

Table 2.Existing and Proposed Land Use in Bangalore

Land use	Proposed Land use (2011) sq. km	Distribution (%)	Existing Land use (2003) sq. km	Distribution (%)
Residential	243.69	43.16	159.76	37.91
Commercial	16.43	2.91	12.83	3.04
Industrial	38.44	6.81	58.83	13.96
open spaces	77.88	13.79	13.10	3.11
public and semi public uses	49.08	8.69	46.56	11.05
public utilities		0.00	2.49	0.59
offices and services		0.00	4.27	1.01
transport and communication	116.97	20.72	88.31	20.96
Unclassified	22.14	3.92	35.26	8.37
Total	564.63	100.00	421.41	100.00
Agriculture			649.24	
lake and tank			39.02	
Quarry			9.61	
Vacant			187.72	
Total			1,307.00	

Source: BDA Masterplan, 2031.

It is observed that both in existing and proposed land use pattern, residential buildings have the highest percentage in Bangalore followed by transport, industrial, open spaces and others. It is to be noted that the permissible land uses in residential category are: plotted residential developments, villas, semidetached houses, apartments, hostels, dharmashalas, multi dwelling housing, service apartments, and group housing.

The land use categories and zoning guidelines also have an important role to play in the consumption of energy by different sectors. The use permissibility refers to the activities that are allowed to function on a designated piece of land.

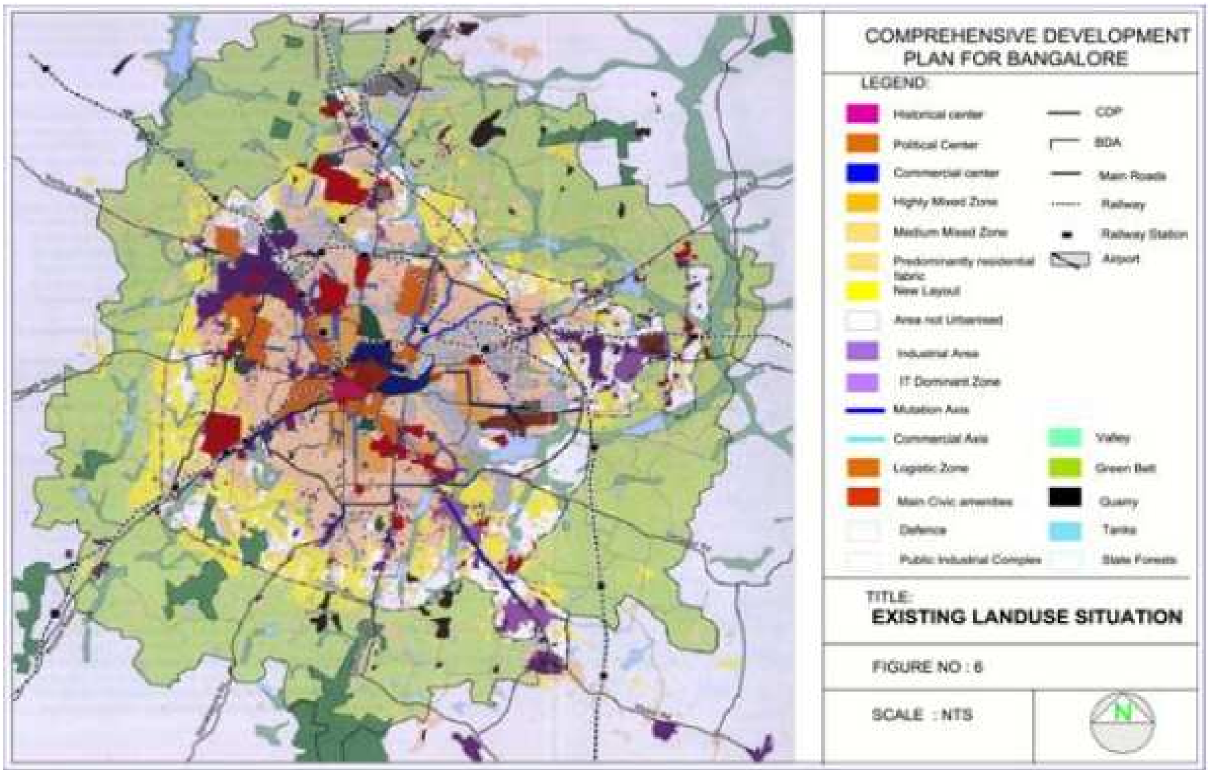
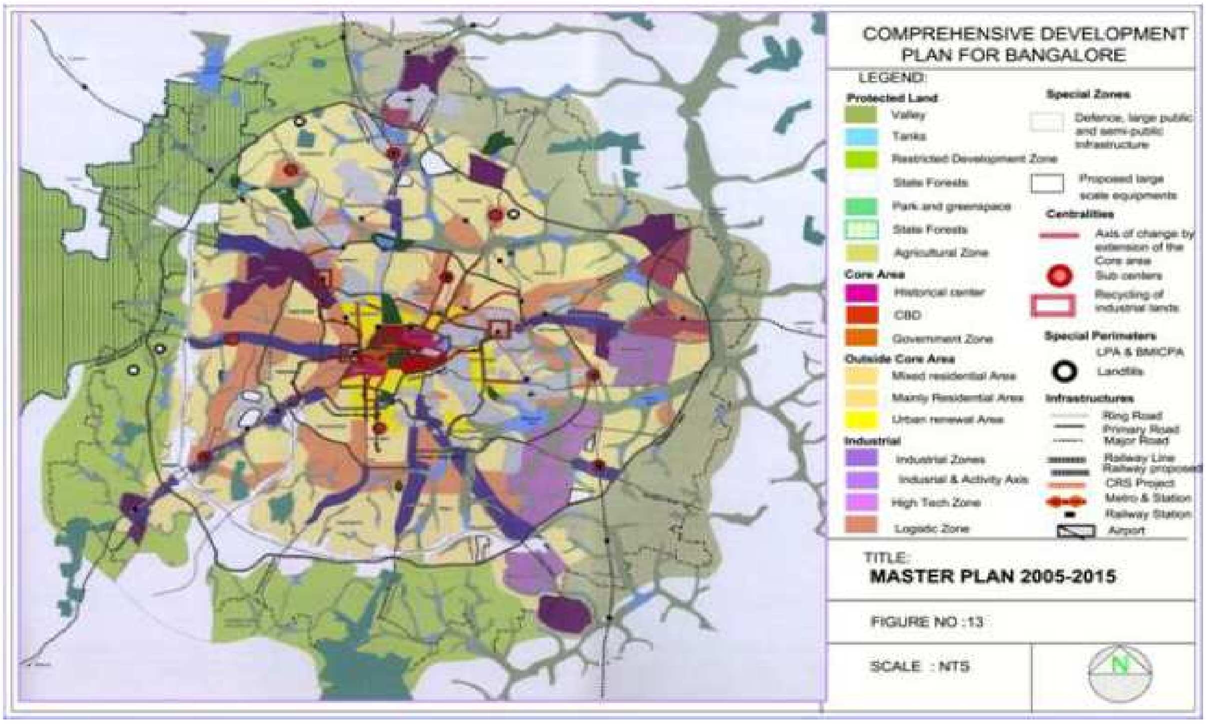


Figure 6.Existing Land Use plan of Bangalore, 2005

ISSN: 2455-3093



Source: BDA Masterplan, 2031

Figure 7.Proposed Land Use Plan of Bangalore, 2015

Current Energy Consumption Analysis

Table 3.Energy Use by Building Category, 2007

Building Categories	Sales (MkWh)	Percentage (%)
Residential	2684	32.8%
Commercial	2459	30%
Industrial	2425	29.6%
Irrigation & Agriculture	69	0.8%
Water Supply / Street lighting	444	5.4%
Others	91	1.1%
Total	8172	

Source: BESCOM (Bangalore Electricity supply company Ltd), 2007

As can be seen in the land use pattern, residential area is highest in Bangalore city, and energy consumed by residential area is also highest followed by commercial and industrial sector. However, it is important to observe that the intensity of power consumed by commercial sector is much higher than any other building sector. The intensity of energy usage/sq. km of built up area in residential is 16 kWh/m^2, commercial has 159 kWh/m^2 and Industrial has 42 kWh/m^2. Thus it was very important to attain energy-efficient commercial buildings in the city of Bangalore. Moreover, the commercial building area is increasing every year in Bangalore, with more and more buildings with high glazed area which are more energy intensive than old office buildings.

To calculate the energy intensity of various building typologies, following data was used:

1. For residential buildings, from BDA total plot area under residential land use was collected. This is 159.76 sq. km. Average FAR in Bangalore considered is 1. Therefore, total residential built up area is 159760 m^2
2. From BESCOM, electricity consumed from residential area was collected. This is 2684 MU.
3. Thus annual energy intensity of residential buildings in Bangalore city is = 2684*1000 kWh/159760 m^2 = 16 kWh/m^2

Following similar calculations for commercial and industrial building sector, it is found out that energy intensity for commercial buildings is 159 kWh/m^2/annum in Bangalore and that for industrial is 42 kWh/m^2/annum. Thus developing regulations and guidelines for commercial buildings will be a very important part of this project.

ISSN: 2455-3093

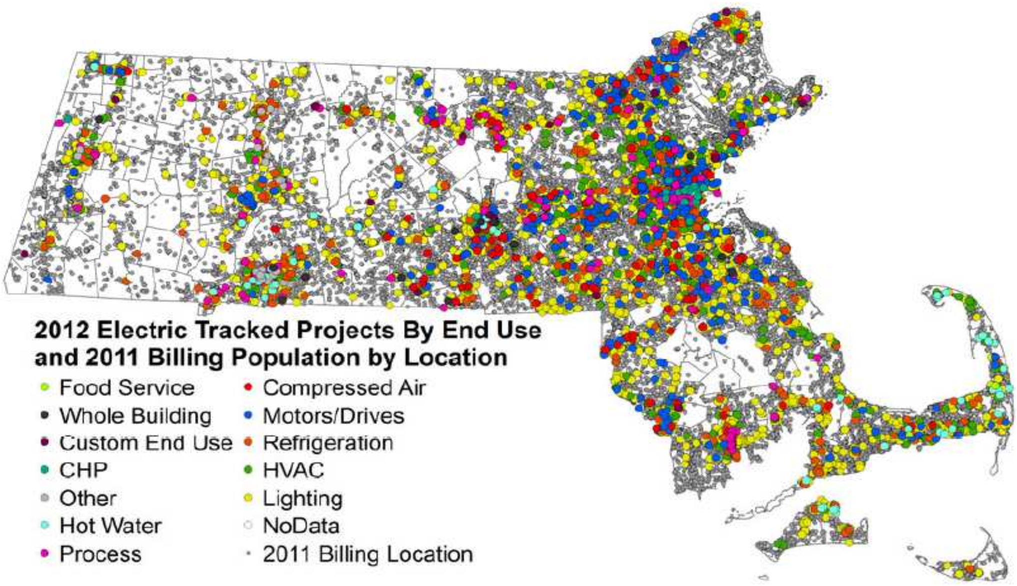
Current Practices to Achieve Energy Efficiency in Bangalore City

In order to meet the current energy demand of Bangalore metropolitan and to reduce the gap between demand and supply of power, KPTCL and BESCOM are establishing infrastructure, Environmental building policies, regulations and guidelines for Bangalore city while upgrading operation and maintenance facilities. There are some existing policies and programs to achieve energy efficiency at city level, state level and nation level. These are described below.

Following are the energy efficiency measures taken at the city level:

1. AT&C (aggregate technical and commercial losses) losses are reduced.
2. Integration of a few energy efficiency features in building regulations of Bangalore.
3. Integration of few renewable energy features in building regulations of Bangalore.
4. Existing electricity tariff plan provides lower rate for buildings that are more energy efficient than others.
5. Currently, some best design practices are followed in Bangalore city.
6. Create awareness among architects and independent builders regarding energy-efficient design principles.
7. Integration of energy-efficiency requirements, benchmarks and renewable energy within the existing building codes of Bangalore.

Case Study: Massachusetts



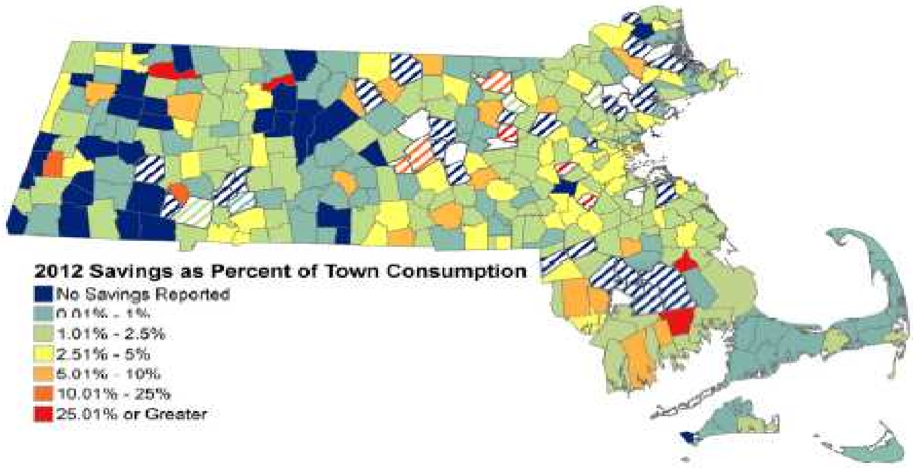
Source: Watts, Where, and Why? Using GIS to Identify Energy Efficiency, 2013

Figure 8 : Commercial and Industrial Energy Saving Initiatives

The case study is based on the research conducted by DNV GL (a risk management company), for identifying energy-efficiency opportunities in Massachusetts using GIS. The first thing that was undertaken by them was dot mapping in order to assess the awareness of people with respect to energy-efficiency initiatives. Dot maps are a useful first view of the utility data. We can see that as one might anticipate the projects are concentrated around the Boston area and that in the sparser populated western regions of the state we have few projects corresponding to a smaller customer base. These checks confirm that the base layer that will feed into the geographic analyses does not contain any unexpected data considerations.

Figure 9 is the preliminary snapshot of where raw reported commercial and industrial energy savings were the highest. The raw amounts of energy saved correspond closely with the regions of high commercial and industrial population densities.

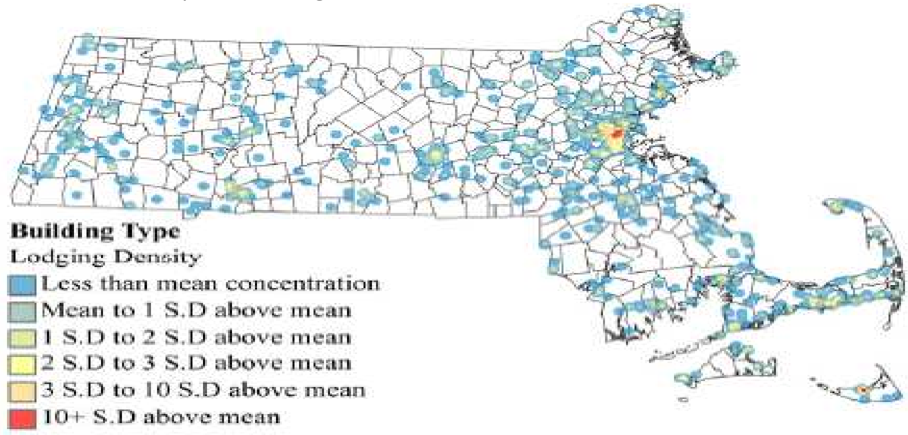
ISSN: 2455-3093



Source: Watts, Where, and Why? Using GIS to Identify Energy Efficiency, 2013.

Figure 9.Energy Savings

GIS was also utilized to map the net residential densities and was added to the data as a thematic layer, as we can see in Figure 10, but the spatial linkages and interactions among the different uses were not prominent in the study.



Source: Watts, Where, and Why? Using GIS to Identify Energy Efficiency, 2013.

Figure 10.Residential Densities

A similar system developed by RAMtech is used by the Tamil Nadu Electricity Board in Chennai to identify complaints and associate them with each other for identifying trends and patterns.

Conclusions and Work Prospects

Conclusions

From the overview of the article, we can understand that improving energy efficiency has significant consequences over the future energy demand and therefore climate change parameters. Study of individual indicators relating to end-use energy consumption sectors is necessary for such an approach. The initiatives can be deployed in various methods, but to coordinate and monitor the processes a spatial database management like GIS (which integrates spatial and attributional data) can play a pivotal role. Urban areas are the main bearers of these energy demands that are linked to different land uses and their per unit energy consumption based on technological and economic capabilities. An approach to integrate and harmonize this usage through a comprehensive system can help attain a sustainable energy balance for the future.

Future Work Prospects

Local decisions about energy and land use affect everything from municipal and personal budgets, to sense of place and economic growth. Land use refers broadly to how we modify or conserve land, as for example in agriculture, industry, housing, transportation, recreation, and open space. In turn, how we manage and use land impacts how much energy is consumed by local governments, businesses, institutions, and residents. Generally speaking, the energy we use is derived from oil, gas, solar, hydropower, geothermal, nuclear, and other forms of energy in order to generate electricity for lights and appliances, power our automobiles, and run industry. Land use significantly drives a community's energy consumption, which not only impacts the environment, but also has a range of effects on household and municipal budgets.

Planners, community decision makers and civic leaders have the ability to influence how efficiently energy is used in a community. We can start by identifying all the ways in which energy is used. For example, as opposed to a more traditional village development pattern, "sprawl" development places greater demands on personal transportation, movement of goods and services, sewer and water infrastructure, and local distribution of electrical supply. This information brief explores the tools and approaches that can be employed in land use planning to enhance energy efficiency in our communities.

References

1. Chaturvedi V, Eom J, Clarke LE et al. Long term building energy demand for India: Disaggregating end use energy services in an integrated assessment modeling framework. Energy Policy. 2014. Accessed from: http://www.sciencedirect.com/science/article/pii/S030142151200986X on 3rd April, 2016.
2. Connors R. Stephen. Issues in Energy and Sustainable Development. M.I.T. Energy Laboratory. 1998. Accessed from: <http://web.mit.edu/connorsr/www/docs/Connors_SustDevel_Jun98.pdf> on 2nd April, 2016.
3. Darby S. The effectiveness of feedback on energy consumption. A Review for DEFRA of the literature on metering, billing and direct displays. 2006. Accessed from: <http://www.usclcorp.com/news/DEFRA-report-with-appendix.pdf> on 2nd April, 2016.
4. Graczyk, Dagmar et al. Understanding energy challenges in India: Policies, players and issues. *International Energy Agency* 2012. Accessed from: <https://www.iea.org/publications/freepublications/publication/India_study_FINAL_WEB.pdf> on 2nd April, 2016.
5. International Energy Agency. Worldwide trends in energy use and efficiency. 2008. Accessed from: <https://www.caseplace.org/pdfs/All-IEA-2008-Worldwide%20Trends%20in%20Energy%20Use%20and%20Efficiency.pdf> on 3rd April, 2016.
6. James E. Payne. Survey of the international evidence on the causal relationship between energy consumption and growth. *Journal of Economic Studies* 2010. Accessed from: <http://www.emeraldinsight.com/doi/pdf/10.1108/01443581011012261> on 2nd April, 2016.
7. Lahiri S, Babiker MH, Eckaus RS. The effects of changing consumption patterns on the costs of emission restrictions. Cambridge, MA: *MIT Joint Program on the Science and Policy of Global Change* 2000. Accessed from: <http://w3.mit.edu/globalchange/www/MITJPSPGC_Rpt64.pdf> on 3rd April, 2016.
8. Mindali O, Raveh A, Salomon I. Urban density and energy consumption: A new look at old statistics. Transportation Research Part A: Policy and Practice. 2004. Accessed from: <http://www.sciencedirect.com/science/article/pii/S0965856403000946> on 3rd April, 2016.
9. Nolon JR. Land use for energy conservation and sustainable development: A new path toward climate change mitigation. *Journal of Land Use & Environmental Law* 2012. Accessed from: <http://www.jstor.org/stable/42842922> on 2nd April, 2016.
10. Pachauri S. An analysis of cross-sectional variations in total household energy requirements in India using micro survey data. Centre for Energy Policy and Economics, Swiss Federal Institute of Technology Zurich. Accessed from: <http://www.sciencedirect.com/science/article/pii/S0301421503001629> on 2ndApril, 2016.
11. Safirova E, Houde S, Harrington W. Spatial development and energy consumption. Accessed from: <http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1087042> on 2nd April, 2016.
12. The Energy and Resources Institute. National Energy Map for India: Technology Vision 2030. Summary for policy-makers. 2006. Accessed from <https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwi29sbeq5jMAhVEEpQKHZqsBmEQFggbMAA&url=http%3A%2F%2Fwww.teriin.org%2Fdiv%2Fpsa-summary.pdf&usg=AFQjCNHda4PqjeAY2df7ZstJSLB_6TBO4A&bvm=bv.119745492,d.dGo> on 3rd April, 2016
13. The Energy and Resources Institute. Development of building regulations and guidelines for energy efficiency, Bangalore City. 2009. Accessed from: <http://toolkits.reeep.org/file_upload/107080292_1.pdf> on 2ndApril, 2016.
14. Weber C, Perrels A. Modelling lifestyle effects on energy demand and related emissions. Energy Policy. 2000. Accessed from: <http://www.sciencedirect.com/science/article/pii/S0301421500000409> on 3rd April, 2016.

ISSN: 2455-3093