

# LCS Bhopal 2035 and Other Activities in Bhopal



**Manmohan Kapshe**  
**Kshama Puntambekar**  
**Aashish Deshpande**



**17<sup>th</sup> AIM International Workshop**

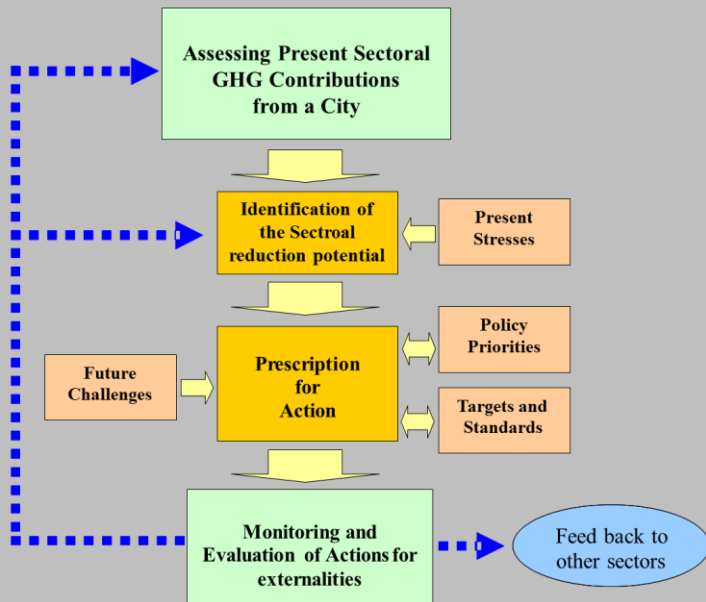
**NIES, Tsukuba, Japan**

**17-19 February 2012**

# Outline of Presentation

- Studies in 2011-12
  - Low Carbon Society Scenario: Toward 2035  
Bhopal
  - Building Sector Studies
- Dissemination Workshop and Publication
- Work in Progress
- Future Work

# Developing Low Carbon Cities: A Study of Bhopal, India



## LCS Study Methodology

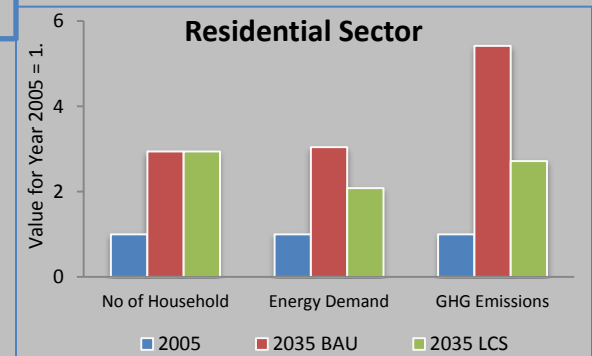
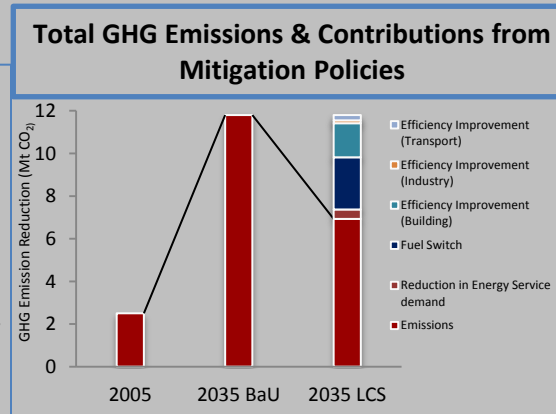
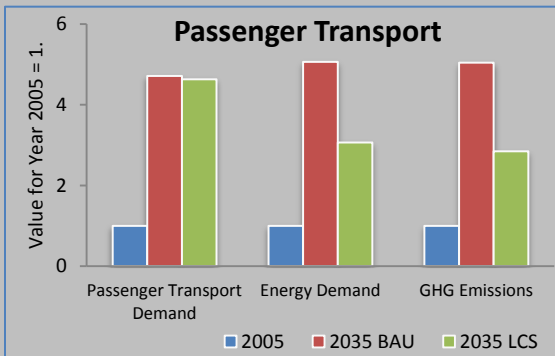
- Quantification of scenario estimates of Bhopal district
- Narrative storylines of likely future
- Description of sector-wise details of likely future
- Quantification of the macro-economic considerations and social aspects
- Identification of possible effective policy measures
- Develop action plan for policy measures

## Case Study Area: Bhopal

- The city is centrally located in India
- The climate is composite climate representing a large part of India
- The city has physical features like large water body, Hills and forests for analysis of local variations.
- A million plus city, it can represent many large Indian cities.
- Amongst the 21 fastest growing cities in India.

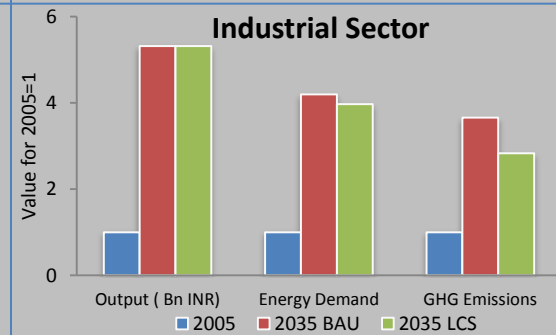


# Bhopal: GHG Emissions & Contributions from Mitigation Policies



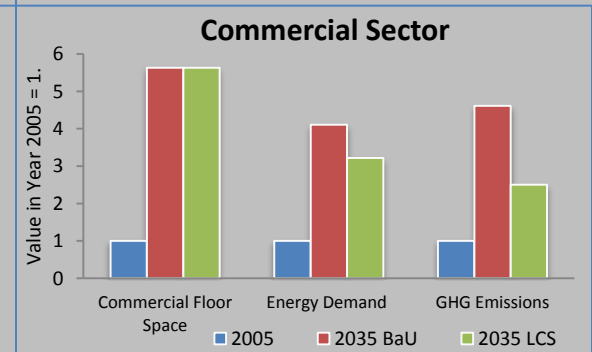
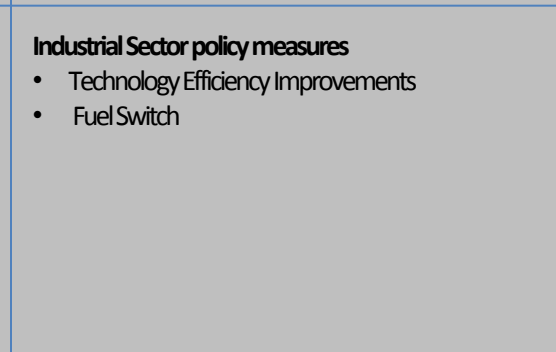
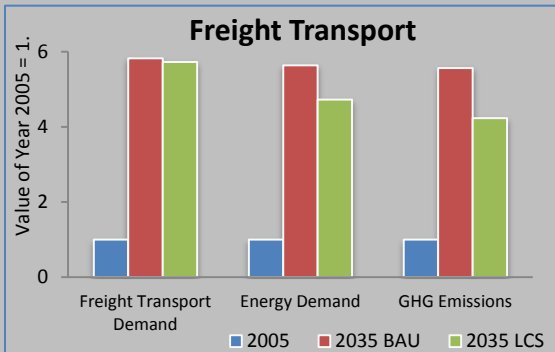
#### Transport Sector Policy Measures

- Technology Efficiency Improvements
- Fuel Switch
- Improved Traffic Management
- Shift to Public Transport and
- Implementing Integrated Transport Management System



#### Residential & Commercial Sectors' Policy Measures

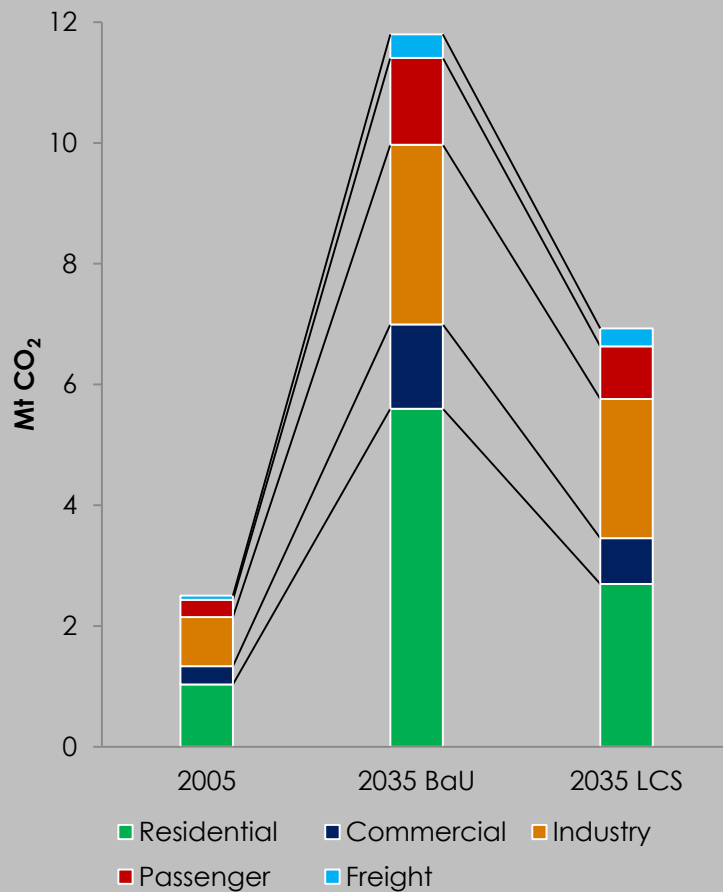
- Efficiency Improvements in End Use Devices
- Fuel Switch
- Behavioral Changes
- New Technology Adoption & Retrofitting
- Improved Material Efficiency in Buildings
- Change in the Nature of Power Supply



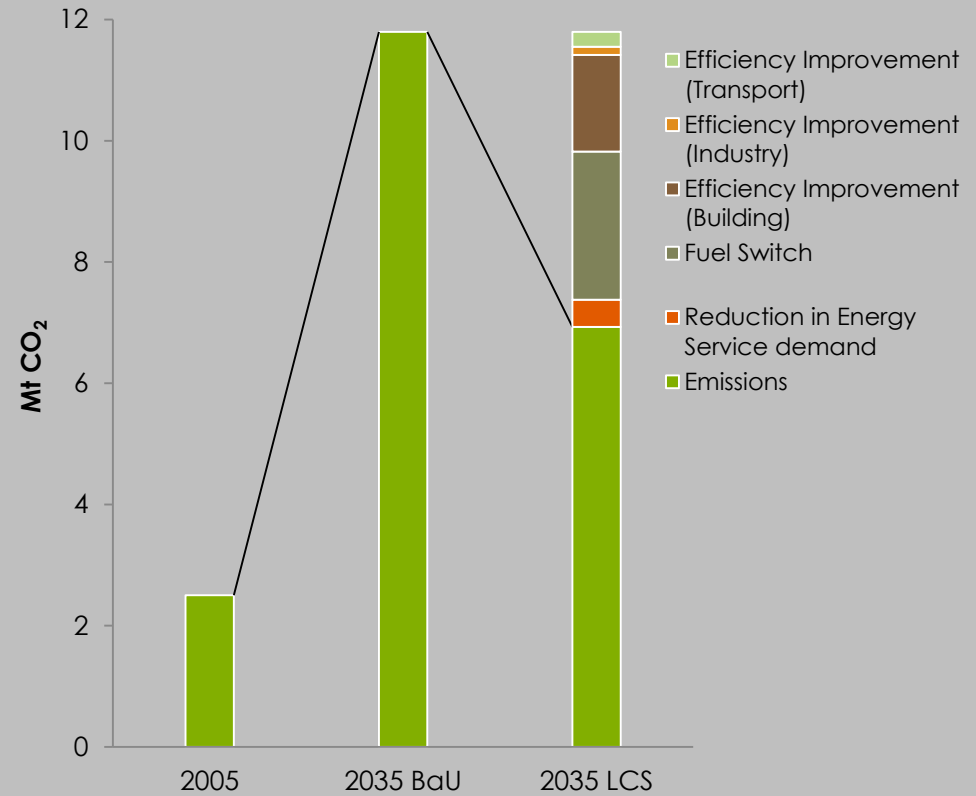
# GHG Emission Scenario and Interventions

## Mitigation Contribution

GHG Emissions Scenario



Mitigation Contribution



# Bhopal LCS: Seven Actions

Action 1:  
**Green  
Governance**

Action 7:  
**Rural  
Riches**

Action 2:  
**Holistic  
Habitat**

Action 6:  
**Nurturing  
Nature**



Action 3:  
**Sustainable  
Style**

Action 5:  
**Form and  
Flow**

Action 4:  
**Cellular  
City**

		SECTORAL CONTRIBUTION				
	ACTIONS	Residential	Commercial	Industry	Passenger Transport	Freight Transport
1	GREEN GOVERNANCE					
2	HOLISTIC HABITAT					
3	SUSTAINABLE STYLE					
4	CELLULAR CITY					
5	FORM AND FLOW					
6	NURTURING NATURE					
7	RURAL RICHES					

# Barriers to LCS Pathways

- No common generalized policies can be developed, Individual solutions are needed for each of the city
- Success depends on the participation of local government / people
- Almost no awareness in smaller cities
- Capacity building is slow and time taking
- Good quality infrastructure and services are almost always necessary that are already stressed
- Development priorities may not be in line with LCS objectives
- Economic implications are not easy to anticipate

# Dissemination Workshop: Report Publication

A one Day workshop for Dissemination of **Low Carbon Society Scenarios Bhopal 2035** was organised on 24 September 2011 at Bhopal.

This gave a platform at city level where researchers interacted with stakeholders and policymakers to integrate their knowledge and build relevant scenarios for transition towards a low carbon society.



Low Carbon Society Scenario

## Bhopal

2035



Maulana Azad National Institute of Technology, Bhopal, India  
School of Planning and Architecture, Bhopal, India  
National Institute of Environmental Studies, Tsukuba, Japan  
Kyoto University, Kyoto, Japan  
Mizuho Information and Research Institute, Tokyo, Japan



# Dissemination Workshop: some Images



International Workshop on Sustainable Futures  
– Vision for Bhopal , September 2011

# Response and Media Coverage

## स्कूल ऑफ प्लानिंग एंड आर्किटेक्चर

स्कूल ऑफ प्लानिंग एंड आर्किटेक्चर (योजना एवं वास्तुकला विद्यालय) मध्यभारत में झीलों की नगरी भोपाल में स्थित है। इसका लोगो मालवा आर्किटेक्चर के चिन्हों से लिया गया है। घुमवदार संरचना से बनी हुई पानी की श्रृंखलाएं समुद्री ताल जैसी दिखाई देती हैं। ये मांडू स्थित मालवाकंठ महादेव मंदिर का सज्जित चिन्ह है। गुच्छाभूमि में बनी तुनावादार श्रृंखलाएं के साथ यह लोगो अंग्रेजी के एस अक्षर जैसा दिखाई देता है जो कि ज्वालना का प्रतिनिधित्व करता है। पी अक्षर जगु का चिह्नक है

और ए अक्षर भूंद, अथवा जल का प्रतिनिधित्व करता है। इसके आधार में उदृत संस्कृत श्लोक समरंगन सूत्रभार की आचार संज्ञिता का परिचायक है जिसकी रचना भोपाल के महान राजा भोज ने की थी। इस श्लोक का अर्थ है कि किसी भी शिल्पकार को न सिर्फ वास्तुकला में सर्वश्रेष्ठ होना चाहिए बल्कि समवर्गी भी होना चाहिए। इस प्रकार का संपूर्ण संयोजन स्कूल ऑफ प्लानिंग एंड आर्किटेक्चर में स्टूडेंट्स का स्वागत करता है और उन्हें शक्य के बारे में जन्म के लिए प्रेरित करता है।

## 'Assist nature, don't fight it'

### ECO-FRIENDLY International workshop on sustainable future held

HT Correspondent

editorbhopal@hindustantimes.com

**BHOPAL:** Retired bureaucrat and prominent planner MN Buch on Saturday said that while planning development, one should assist nature and not fight it.

Speaking at the inaugural session of an international workshop on 'Sustainable futures: vision for Bhopal' organised by the School of Planning and Architecture (SPA), Bhopal, Buch said that nature has made Bhopal very amenable for sustainable development and it should be ensured that this natural incentive is not done away with. He said that Bhopal is basically a low profile city that is not suited for multistory or massive buildings and the presence of numerous lakes and hills prevents it from becoming large urban agglomerate. "Planning wise, it has to be a segmented cities and lakes should be protected and hills should be afforded to maintain the balance," the former bureaucrat said. He however added that this does not mean that there should



Retired bureaucrat MN Buch released 'Low Carbon Society Report, Bhopal 2035' in Bhopal on Saturday. PRAVEEN BAJPAI/HT

not be any commercial activity, but rather it should be in keeping with nature. Chairman of board of governors of SPA, Prof EPN Rebeiro inaugurated the workshop and spoke on topic 'planning for sustainability' wherein he emphasised the role of citizens and local representatives in planning.

Dr Sanjeev Singh, head of department of Architecture delivered welcome address while Prof Manmohan Kapshe, head of department of planning conducted proceedings and proposed vote of thanks. Prof Ashish Deshpande of National

Institute for Technical Teachers' Training and Research (NITT-TR) presented a brief on the report 'LCS Scenario Bhopal 2035' that was released on the occasion. Dr Junichi Fujino of National Institute of Environmental Studies, Tsukuba, Japan was also present.

The first technical session was on Low Carbon Society scenario while the second session was on sound material cycle society. Speakers from various institutes of country, Japan, Indonesia and Vietnam spoke during the sessions.

## Bhopal fast on way to fuelling global warming

**REPORT** But effective steps can reduce greenhouse gas emissions by 40%

sunday special

Sravani Sarkar

ssarkar@hindustantimes.com



Vehicular emissions are one of the major contributions to rising greenhouse gas levels in the city. MUJEEB FARUQI/HT PHOTO

**BHOPAL:** If things remain unchecked, Bhopal is likely to emerge as six-fold bigger contributor to global warming and climate change by way of increased greenhouse gas (GHG) emissions in another 25 years. However, sustained energy-efficient efforts could ensure that Bhopal cuts down on this projected increase of emission levels by at least 40%.

A study by Bhopal with emphasis on low carbon scenario in future, says that if things were left unchecked, the greenhouse gas (GHG) emissions in the city would rise by six times to 14.2 million tonnes of carbon dioxide (CO<sub>2</sub>) annually by 2035 from the current emissions of 2.5 million tonnes of CO<sub>2</sub> (data of base year 2005) – an increase of about six times. However, if corrective steps were taken, this increase could be cut down by as much as 40%, the report concludes.

A report, prepared after a 15 year study by two Bhopal-based and three Japan-based organisations, also proposes a seven-point action plan for achieving this notional reduction of GHG

emissions. It says that transport (39%) and residential (36%) sectors that are presently the main contributors to the emissions have to be targeted for achieving the best results.

The report – 'Low Carbon Society Scenario Bhopal 2035' – was released on Saturday at a programme hosted by School of Planning and Architecture (SPA), Bhopal.

The study assesses that of the total emission reduction potential, 50% would be due to fuel switch that is prominent in residential, commercial and industrial sectors; about 40% would be due to energy efficient improvements in residential, commercial and transport sectors while 10%

would be in the form of reduction in energy service demand in residential and transport sectors.

"We have suggested seven actions, most of which would have impact in reducing the emissions from residential and commercial sectors," Sheuli Mitra of SPA, one of the authors of the report said while talking to Hindustan Times.

The seven actions include green governance, developing holistic habitat, promoting sustainable style, developing cellular city, emphasising on form and flow (of transport), nurturing nature and promoting rural riches.

The report suggests with these actions, Bhopal would take prominent steps towards Low Carbon

### GREENHOUSE GASES

Greenhouse gases are those gases that trap heat in the atmosphere and proper amount of these gases are required to ensure that warmth is maintained in atmosphere. However, excess of these gases could lead to global warming and consequent climate change that could lead to dangerous consequences like coastal flooding, melting of glaciers and others. The most abundant greenhouse gases in the earth's atmosphere are: Water vapour • Carbon dioxide Methane • Nitrous oxide • Ozone

Society concept, which emphasises some level of attention to environmental protection as other socioeconomic development issues.

The study has been conducted by the Maulana Azad National Institute of Technology, Bhopal, SPA, Bhopal, National Institute of Environmental Studies, Tsukuba, Japan, Kyoto University, Japan and Mizuho Information and Research Institute, Tokyo, Japan.

The team of Aashish Deshpande, Manmohan Kapshe, Sheuli Mitra and Kshama Puntambekar conducted the study and compiled the report.

CONTINUED ON PAGE 7

**पर्यावरण हैदारी तकनीक**

वर्ष 2001 से 2013 के बीच भारत का कार्बन उत्सर्जन सालाना 3 प्रीसेंट की दर से बढ़ता आ अमेरिका में उत्सर्जन की अनुपातित है। 2013 तक अमेरिका और चीन के बाद भारत का तीसरा सबसे बड़ा प्रदूषक देश बन जाएगा। यदि भारत इस तरह की स्थिति से बचाना चाहता है तो उसे अत्यधिक ही अधिक पर्यावरण हैदारी तकनीक को अपनायन पर जान देना होगा।

प्र. अमित वर्मा, अध्यक्ष

**सुनियोजित हो विकास**

हो विकास हैदारी हो विकास का सबसे सफल तरीका है सुनियोजित विकास। इसके लिए हैदारी या पर्यावरण हैदारी पर काम होना चाहिए। सुनियोजित विकास का अर्थव्यवस्था, पर्यावरण और समाज को जोड़ना है। भारत में पर्यावरण का विकास के लिए ही और सुनियोजित विकास का विकास के कारण सबसे ज्यादा उत्सर्जन होता है। भारत के लिए सुनियोजित विकास है कि सकारण पर्यावरण और समाज को जोड़ना है और पर्यावरण की शिकंसे को मिलाकर ही है।

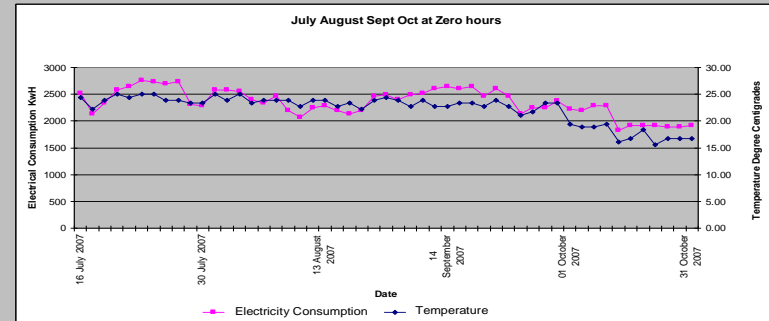
डॉ. अश्विनी कुमार, अध्यक्ष

# Building Sector Studies

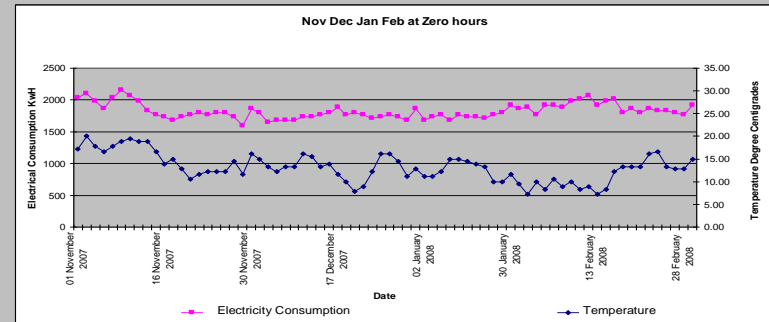
- Assumptions
  - The energy consumption in built environment is primarily a function of “Cooling” and “Heating” needs
  - Case Study Approach provides opportunity to study local variations and developing suitable actions
  - Building Design: Form (shape), Orientation, Materials and Technology play an important role
- Temperature change and electricity demand
  - Temperature data of the city analyzed for one year period
  - Seasonal variations in electricity consumption identified
  - Hourly temperature data and electricity consumption compared and analyzed
- Simulation
  - Double storey building considered with select parameters
  - Six alternate configurations analysed
  - Software used for simulating the building.

# Findings: Temperature Effect

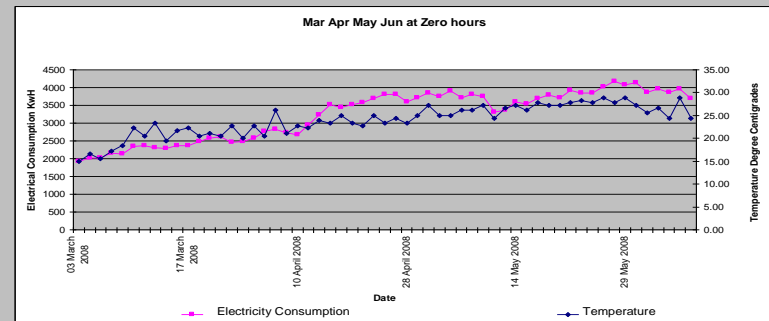
- Electricity consumption in buildings is dependent on many factors.
- It is necessary to eliminate the effects of other influences to bring out the effect of temperature.
- Marked seasonality and periodicity in electricity demand
- Electricity consumption well correlated with temperature change
- The correlation is more prominent during night hours
- CDD and HDD analysis more useful



**July-Aug-  
Sept-Oct**



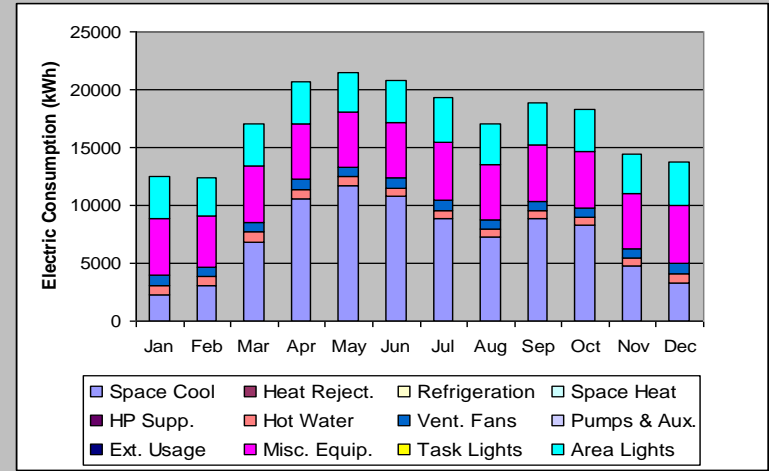
**Nov-Dec-  
Jan-Feb**



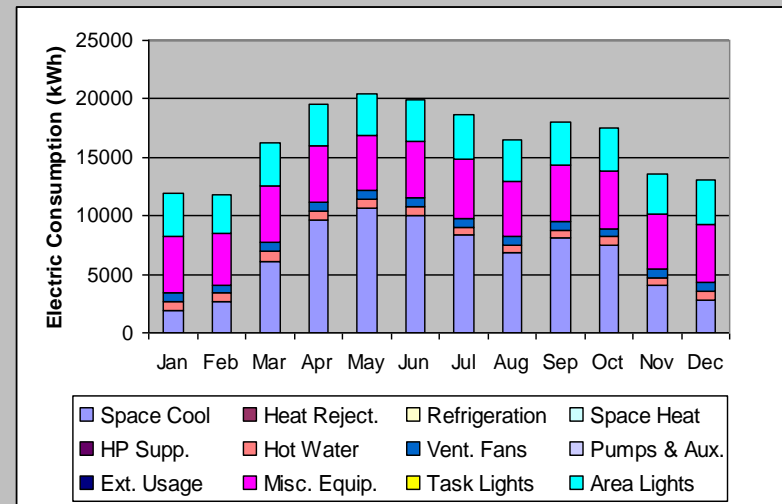
**March-Apr-  
May-June**

# Findings: Simulation

- Building with longer axis north-south consumes the highest energy
- The most efficient orientation is obtained when longer axis is north-east to south-west
- Energy consumption well correlated with temperature change
- Highest energy consumption in summer months
- Space cooling requires maximum amount of energy
- Suitable construction material or provision of adequate insulating material may further reduce energy consumption



**Longer axis north-south**



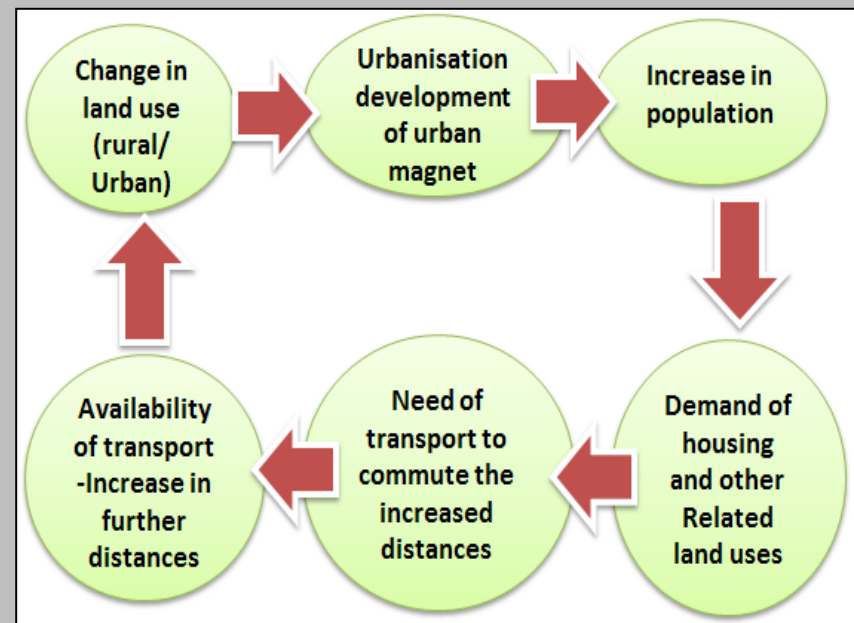
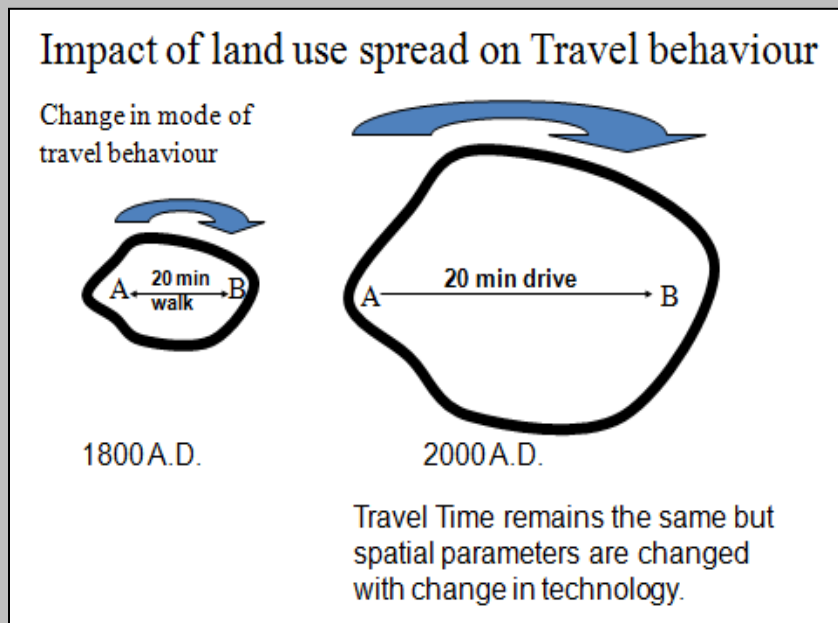
**Longer axis north-east to south-west**

# Works in Progress

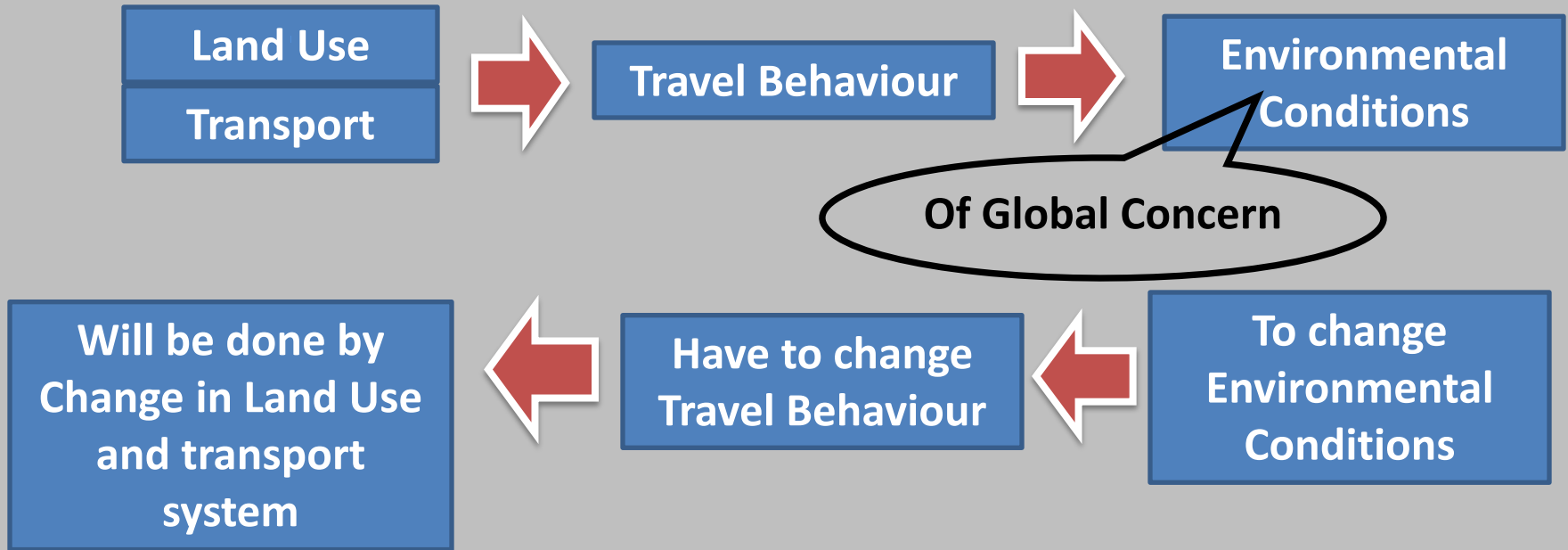
- A study on developing city level Low Carbon Society Scenario and policy design using computable general equilibrium model.
- A Study on transition in Indian Coal sector: climate policy assessment using AIM/Enduse model.
- A study on energy and emission dynamics in Indian residential sector.

# Future Work: Landuse and Travel Behaviour

Vehicular movement causes environment pollution and energy consumption. This is dependent on the travel behaviour which is a response to the landuse assigned and transport facilities available. Land use and Transport Planning go hand in hand and a change in mode of travel changes energy and emissions.



# Relationship in Landuse and Travel Behaviour



## Cause – Effect Relation (Causal Relationship)



Travel Behaviour is Human Response to the Land use and Transport Systems



# Dimensions of travel behaviour

Based on the type of variables included, the three dimensions in travel behaviour research are categorised as:

---

## Spatial Dimensions

The spatial location of the activity is responsible for the travel behaviour. At times the location also decides the frequency and mode used for the travel.

Land Use Systems  
Transport Systems

---

## Socio-Economic Dimensions

The social need and the economic capacity for the travel decides the frequency and mode used for the travel.

Social Systems  
Economic Systems

---

## Behavioural Dimensions

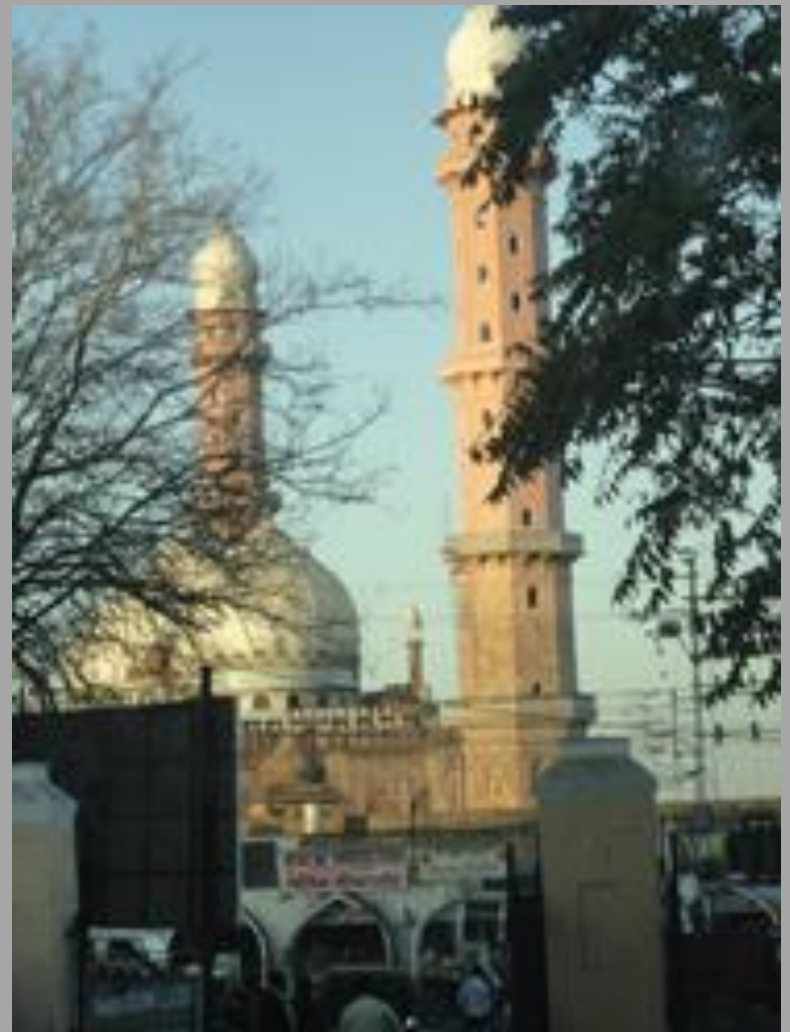
Response of an individual for any activity depends upon the basic behavioural attitude influenced by the then circumstances generated for the travel.

Individual Preferences

---

# Other Future Activities

- Linking LCS studies to future projects and services at city level
  - Changing the Building Code/ Standards
    - Increased efficiencies in thermal conditioning
  - Attention to transportation and Infrastructure sector
  - Effect of financial mechanisms to provide incentives
  - Working-out specific local requirements and actions
- Sectoral studies using AIM/Enduse model
- Extending AIM/ExSS model applications in other Indian cities
- Applications of urban economic models in evaluating development policies targeting spatial profiles (e.g. structural densities, housing prices etc.)
- Consultation and participation of the local governments and policymakers for responses, awareness and capacity building



Thank you...

[mkapshe@gmail.com](mailto:mkapshe@gmail.com)  
[kshamapuntambekar@yahoo.com](mailto:kshamapuntambekar@yahoo.com)  
[aashish.deshpande@gmail.com](mailto:aashish.deshpande@gmail.com)