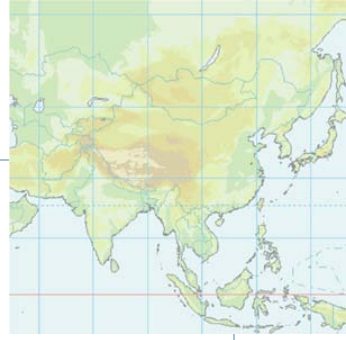
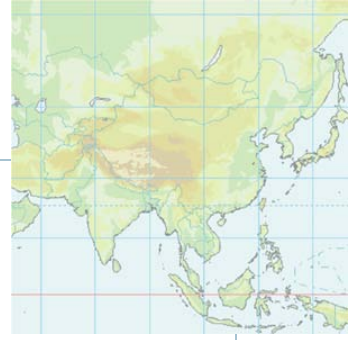


Low Carbon Society: *A Green Roadmap for India*

Aashish Deshpande
National Institute of Environmental Studies, Tsukuba, Japan
Maulana Azad National Institute of Technology, Bhopal, India

P.R. Shukla
Indian Institute of Management, Ahmedabad, India

Transition Towards Low Carbon Societies in Thailand and Asia
[Dialogue between policy makers and researchers and cross sectoral approach]
17-18 November 2010,
Bangkok, Thailand.



Presentation Outline

- India's Commitments, Actions and Drivers
- Developing National LCS Roadmap
- Developing Regional LCS Roadmaps
  - Case Study: Ahmedabad, India
  - Case Study: Bhopal, India
- Building Sector Studies
- Actions & Barriers for LCS Pathways

India: Commitments, Actions and Drivers

Commitments and Actions

Copenhagen Commitments

- 20 to 25% Emissions Intensity Reduction from 2005 to 2020
- Per Capita Emissions Below OECD Average (through 2100)

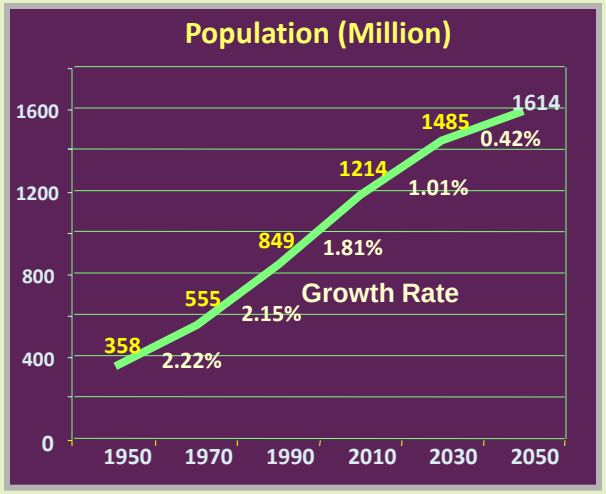
National Climate Change Action Plan - 8 National Missions

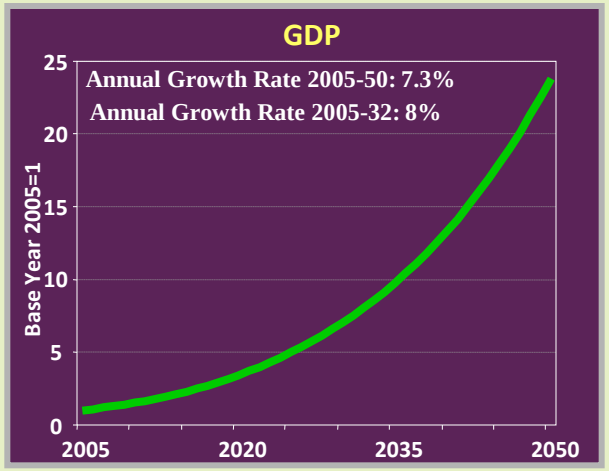
1. Solar Energy (20 GW by 2022; 2 GW off-grid; 20 m sq. m collectors)
2. Enhanced energy efficiency (Avoided capacity of 19000 MW by 2014-15)
3. Sustainable habitat
4. Water Sector (20% water use efficiency improvement)
5. Sustaining the Himalayan eco-system
6. A "Green India" (20 Mil. Hectare afforestation by 2020; Forest cover from 23 to 33%)
7. Sustainable agriculture (micro irrigation promotion in 40 m ha)
8. Strategic knowledge for climate change

Domestic Actions

- **Carbon tax on coal to fund clean energy**
  - US $1/ton on domestic & imported coal; funds to be use for Clean Energy
- **Enhanced Energy Efficiency measures**
  - **National Solar mission** (20 GW by 2022; 2 GW off-grid; 20 m sq. m collectors)
- **Mass Distribution of CFLs**
  - Potential reduction of 6 GW of electricity demand

Drivers of Economy



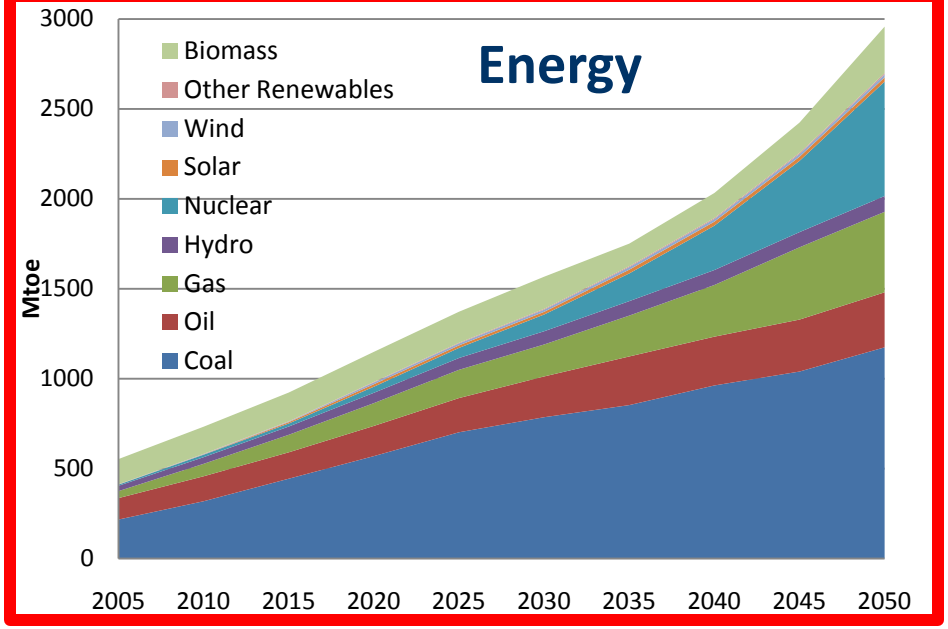


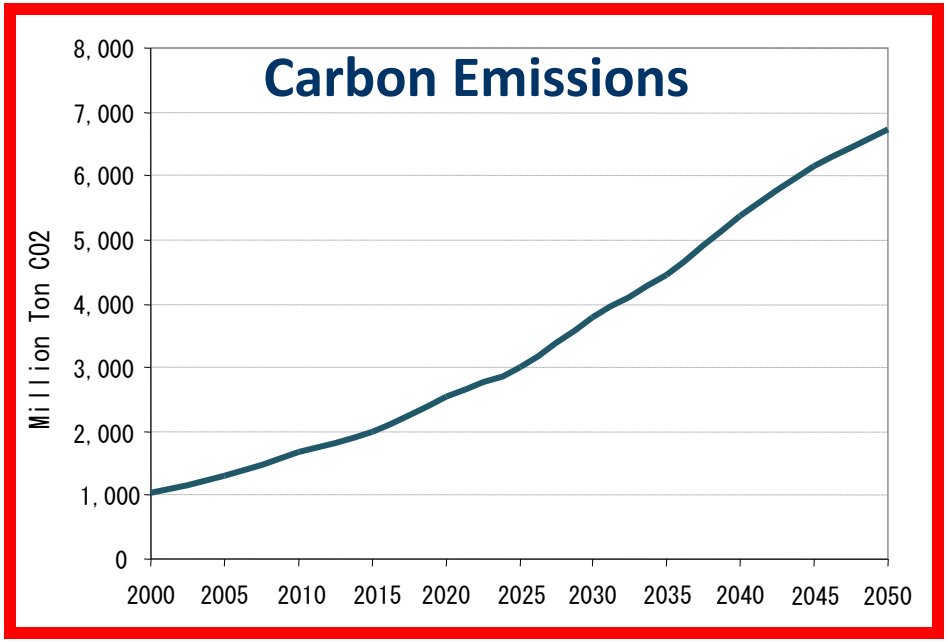
BAU Projections: Analysis with ANSWER-MARKAL Model

Assumptions

From 2005-2050:
Annual Economic Growth: 7.34 %
Annual Population Growth: 0.8 %

Absolute Growth in 2050 over 2005
Economy 24 times
Population 1.43 times



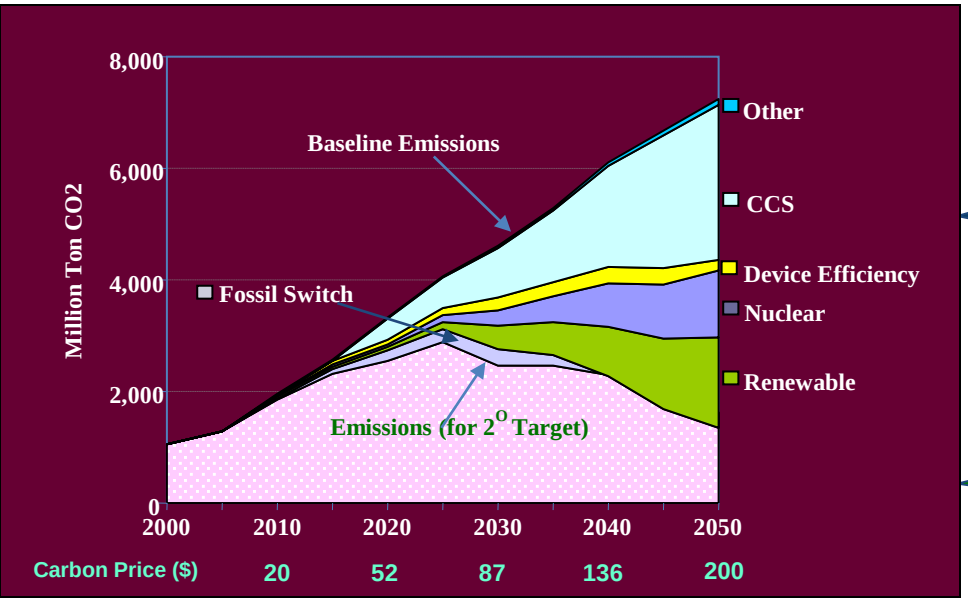


Results: Energy and Carbon Intensity

Annual Improvement From 2005-2050:
Energy Intensity: 3.0 (%)
Carbon Intensity: 3.6 (%)
Decarbonization of Energy: -0.6 (%)

Ratios: 2050 over 2005
Final Energy Demand: 6.27
Energy Intensity: 0.26
Carbon Intensity: 0.19

Mitigation Options: Perspectives



Conventional Approach: transition with conventional path and carbon price

- High Carbon Price
- Climate Focused Technology Push
- Top-down/Supply-side actions

Technology Co-operation Areas

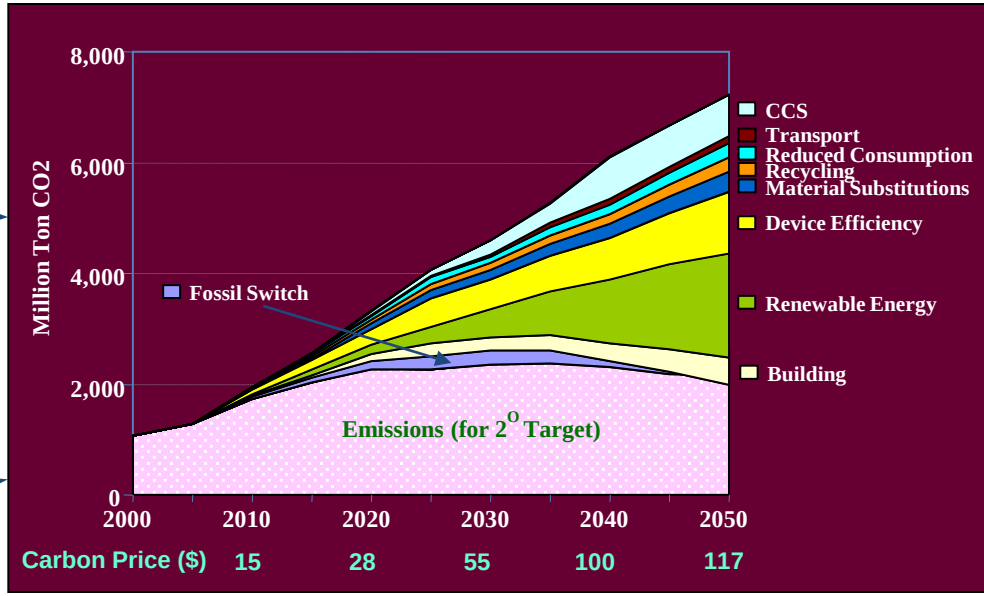
- Energy Efficiency
- Wind/Solar/Biomass/Small Hydro
- Nuclear/CCS

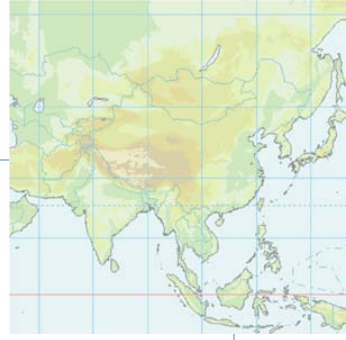
Sustainability Approach: aligning climate and sustainable development actions

- Low Carbon Price
- Bottom-up/Demand-side actions
- Behavioural change
- Diverse Technology portfolio

Technology Co-operation Areas

- Transport Infrastructure Technologies
- 3R, Material Substitutes, Renewable Energy
- Process Technologies
- Urban Planning, Behavioral Changes

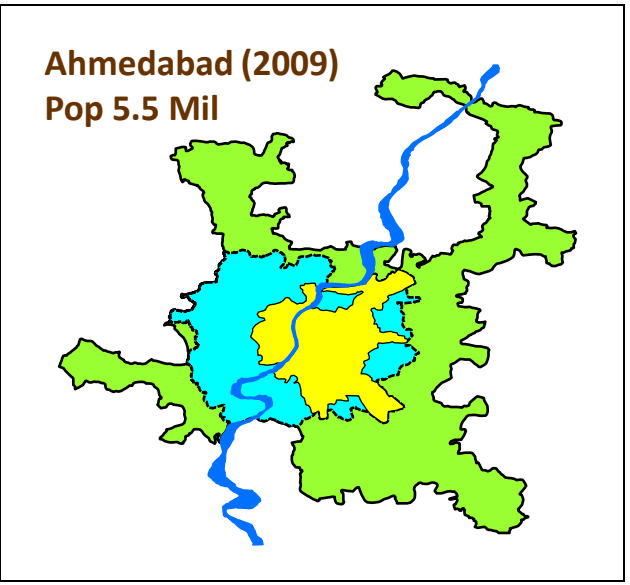


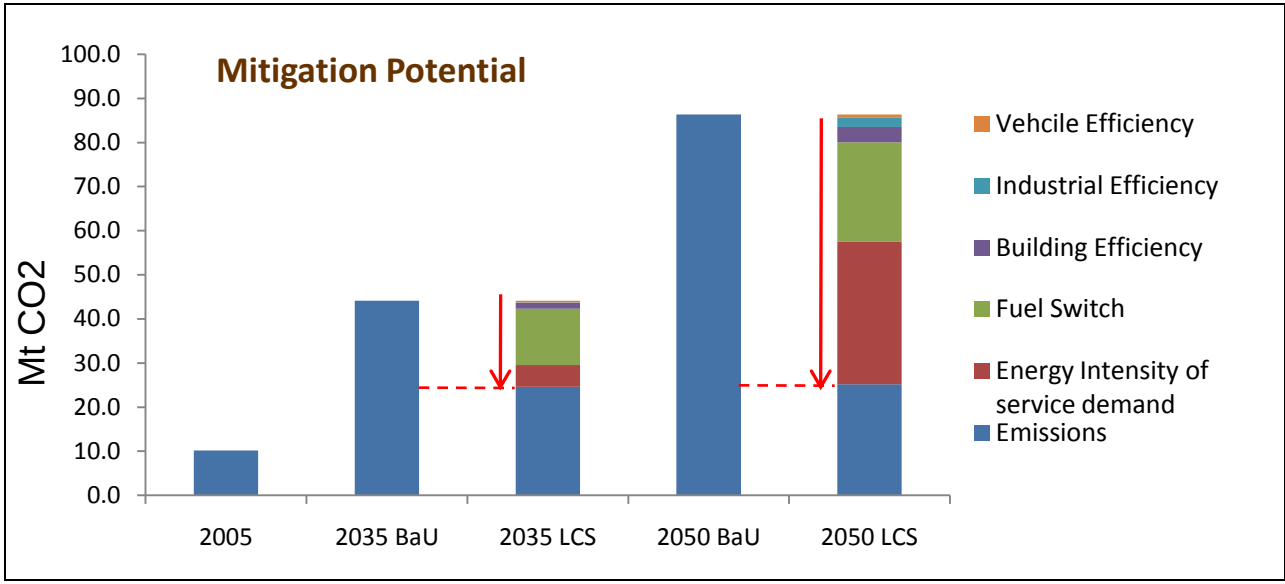


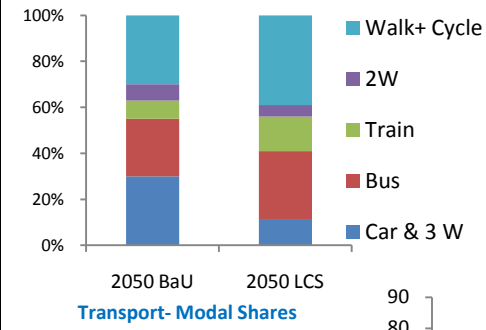
Low Carbon Society

Case Study: Ahmedabad, India

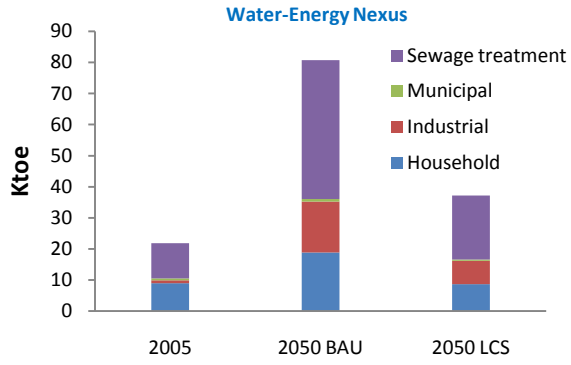
Co-benefits in City Planning: Ahmedabad

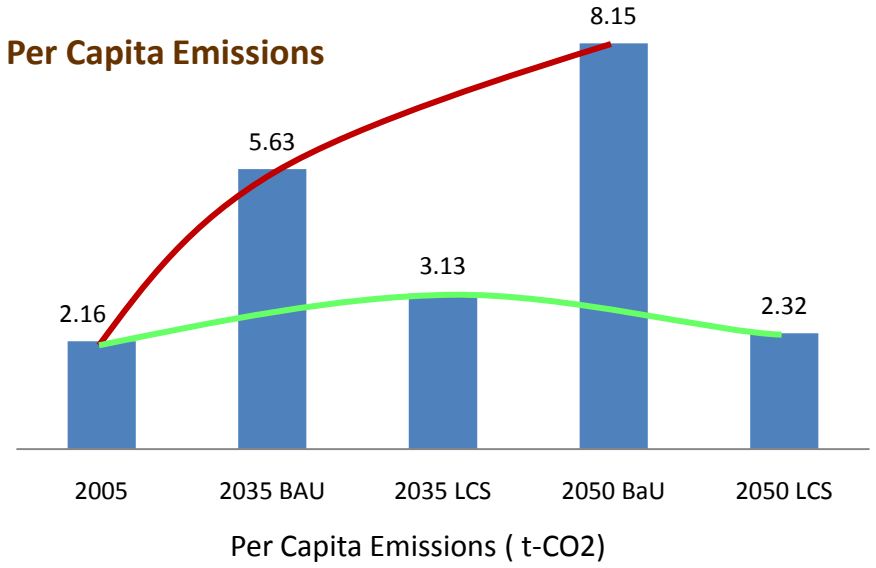




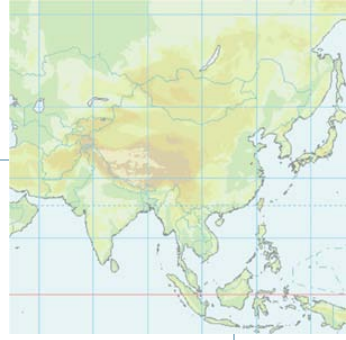


Sustainable Low Carbon Infrastructures





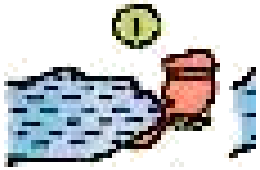
Analysis with AIM/EXSS Model



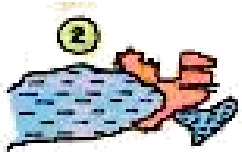
Low Carbon Society

Case Study: Bhopal, India

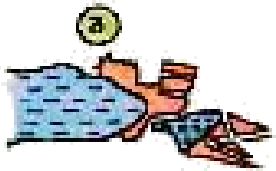
Bhopal: Chronological Development



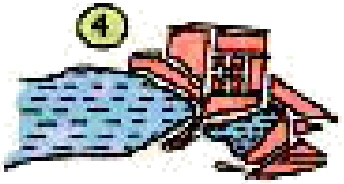
1010 - 1200 AD



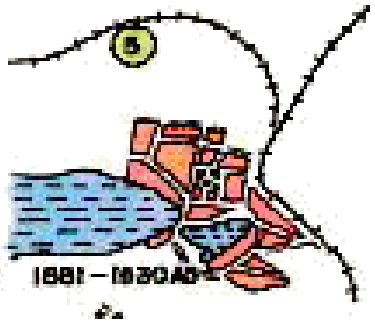
1201 - 1800 AD



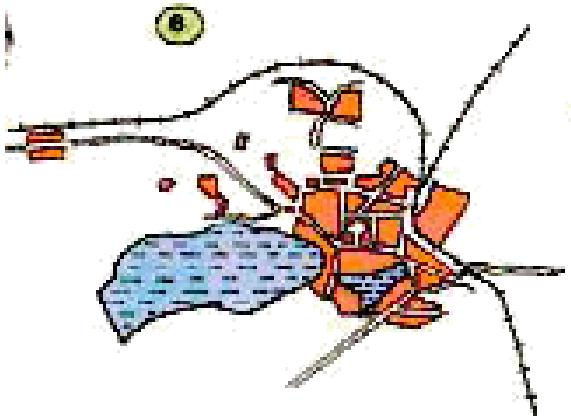
1801 - 1850 AD



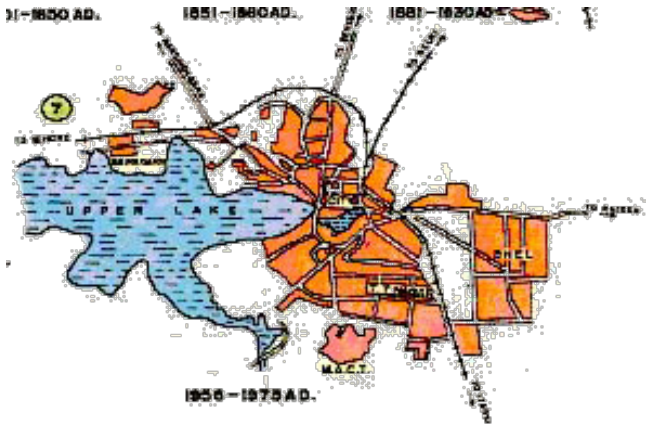
1851 - 1880 AD



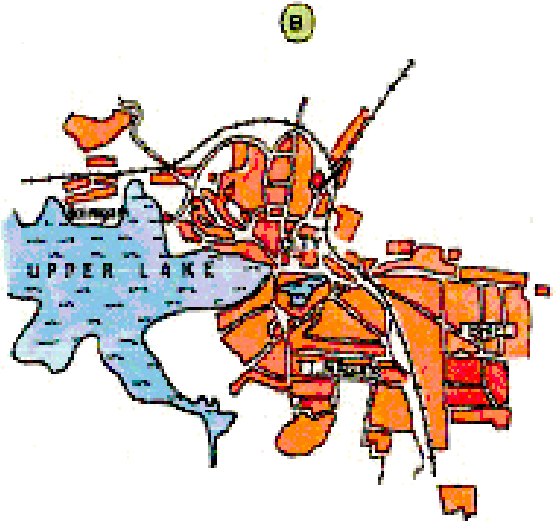
1881 - 1930 AD



1931 - 1955 AD

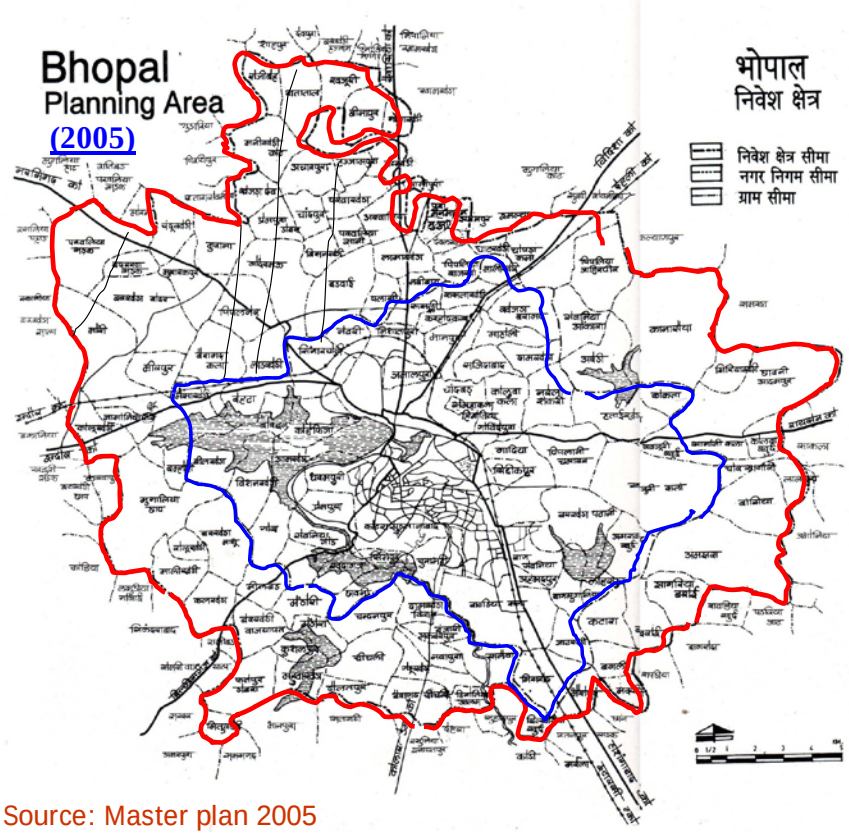


1956 - 1973 AD

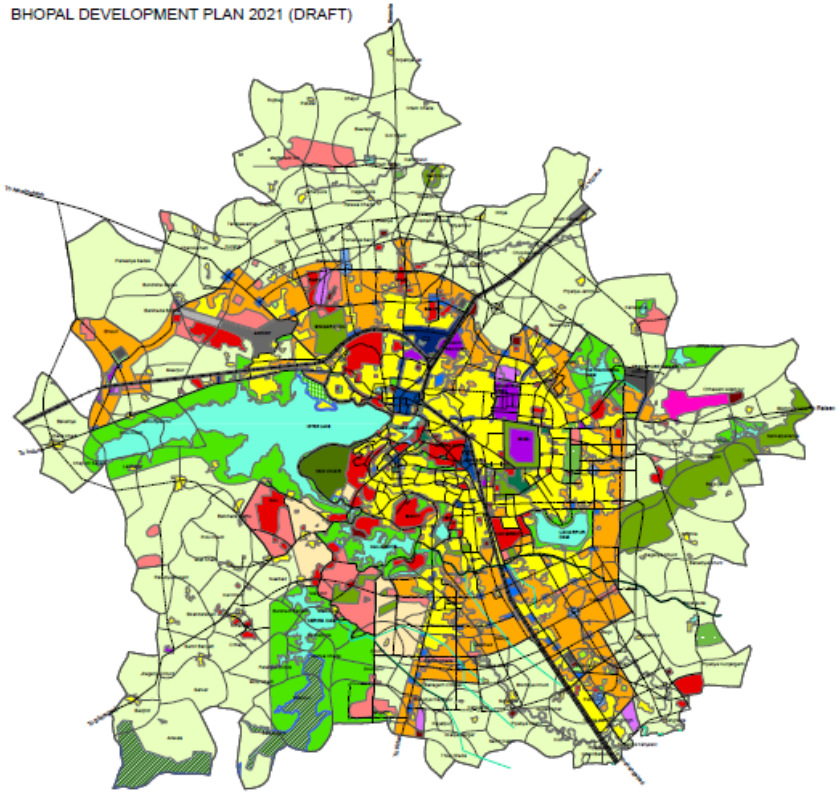


1974- 2000 AD

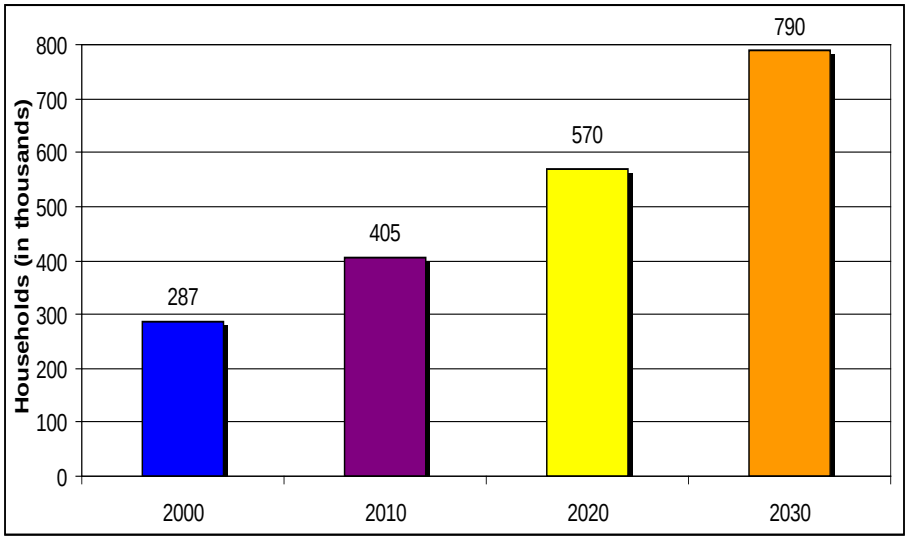
Landuse 2021



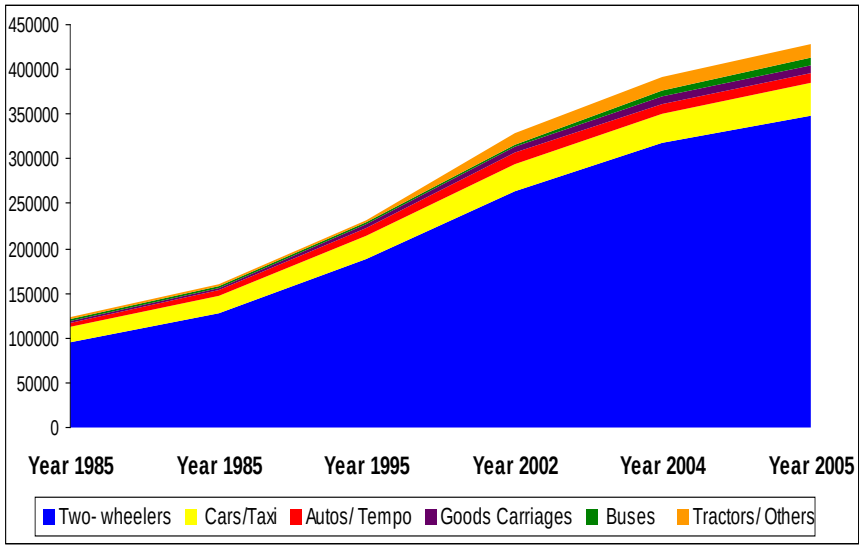
Source: Master plan 2005



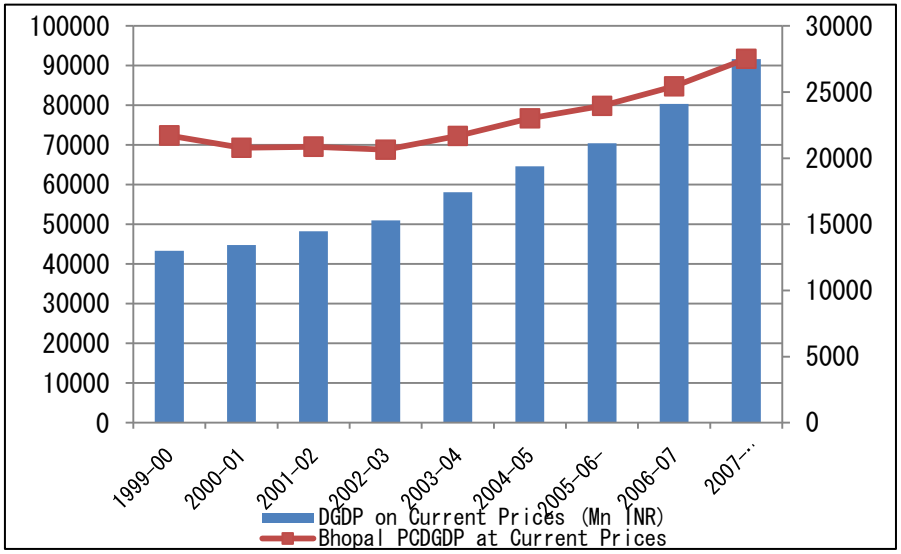
Drivers of Change-Bhopal

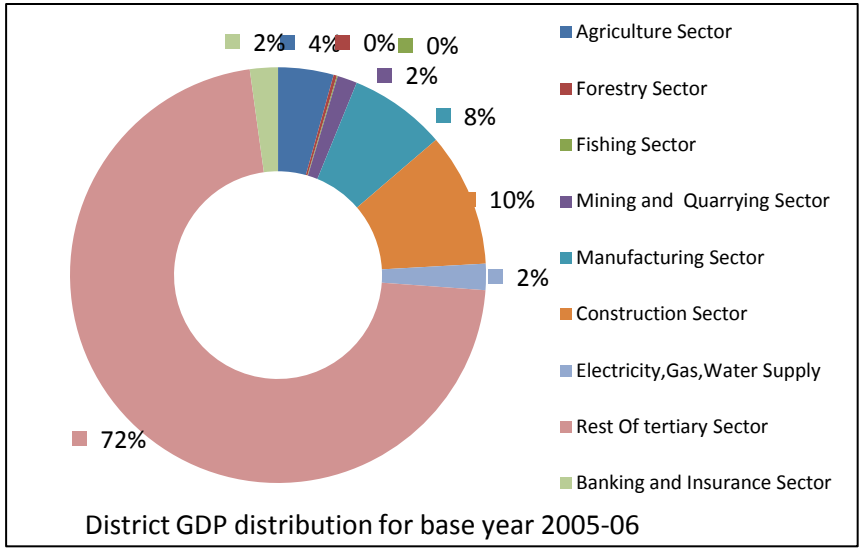


Population trends



Transport trends

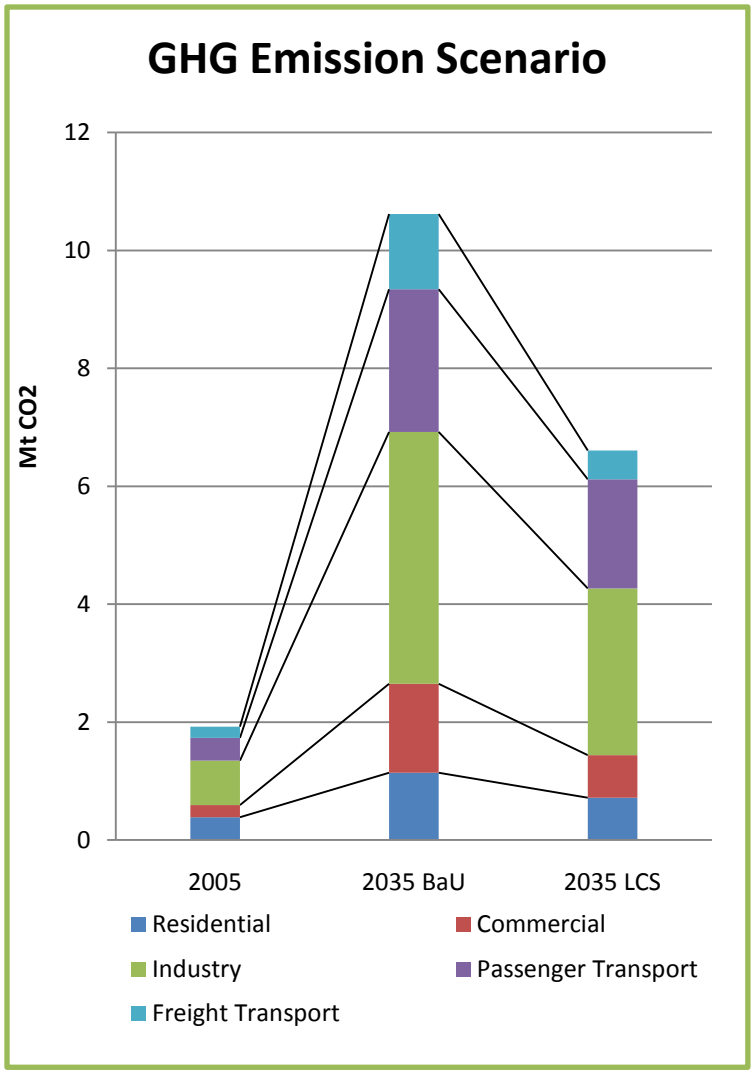


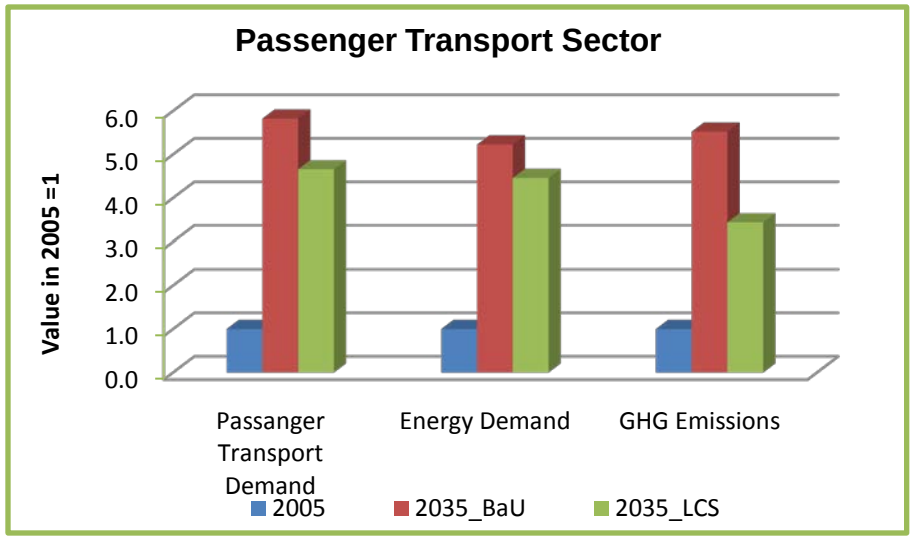


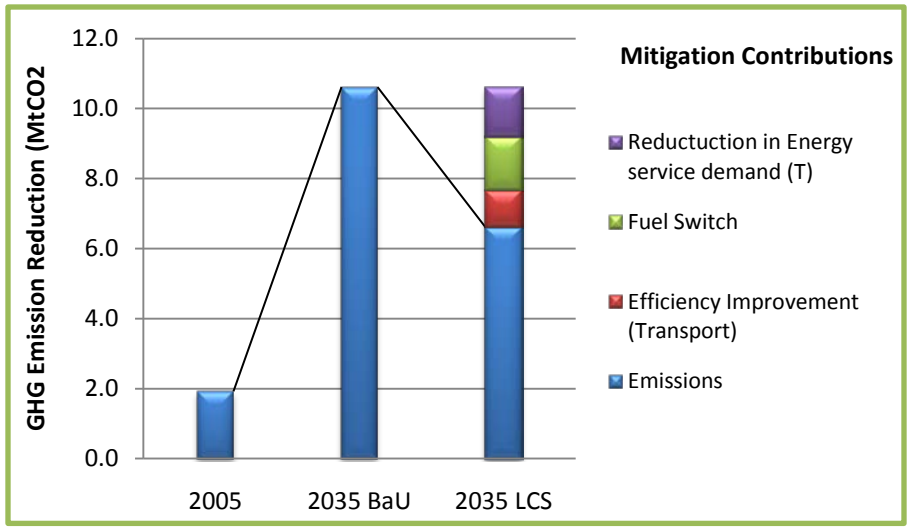
Economic trends and sectoral distribution of District GDP

Bhopal LCS Scenario Development

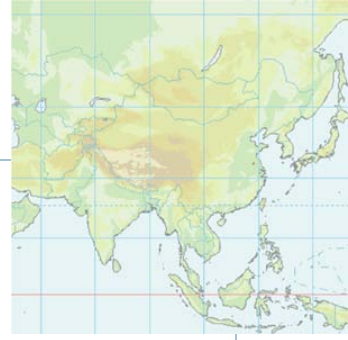
Preliminary Results with Transport and Energy Sector Intervention







Analysis with AIM/EXSS Model



Building Sector Studies

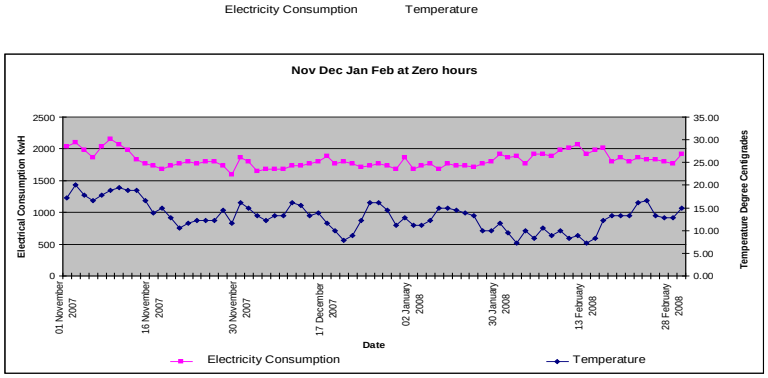
Building Sector Studies

- 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 analyzed.
  - Software used for simulating the building.

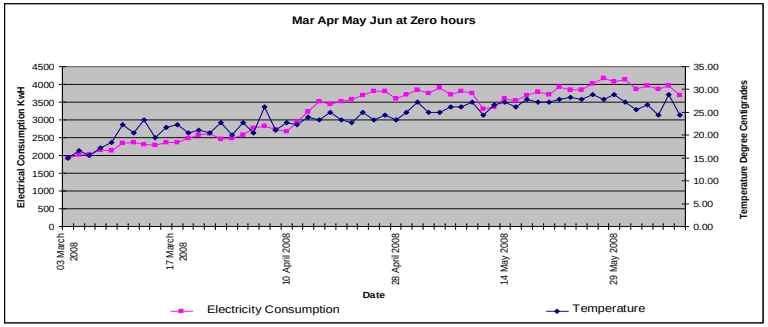
Emerging Findings: Temperature Effect

- 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



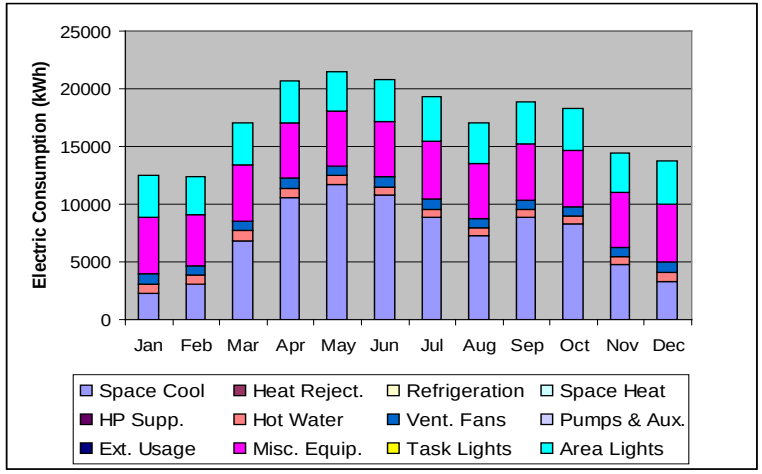
Nov-Dec-Jan-Feb



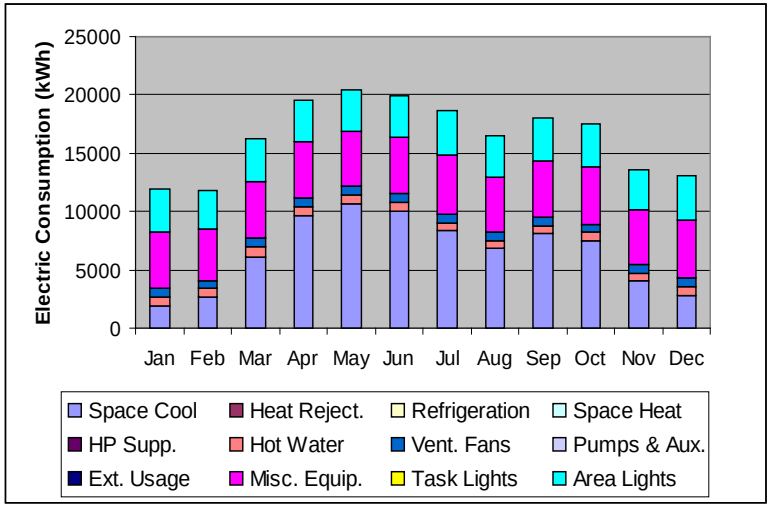
March-Apr-May-June

Emerging Findings: Simulation

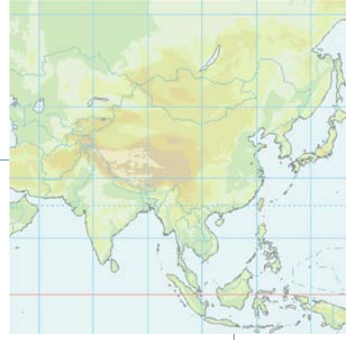
- Building with longer axis north-south consumes the highest energy
- The most efficient orientation is obtained when longer axis is north-east to south-west
- Energy consumption well correlated with temperature change
- Highest energy consumption in summer months
- Space cooling requires maximum amount 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



Low Carbon Society

Actions & Barriers

Actions: Residential Sector

- ***Energy audit programmes***
  - Conducting energy audits to evaluate the most cost effective improvements.
- ***Fiscal Incentives***
  - Loan, grants, and incentives programmes for energy conservation measures
- ***Energy code for New buildings***
  - Encourage or require increased installation of efficient lighting systems
  - Requirement of more efficient heating and cooling systems
  - Increase window insulating values and requirement of shading devices
- ***Harnessing renewable energy***
  - Use of renewable energy sources to meet rapid growth of energy demand, supporting economic development without increasing atmospheric greenhouse gas concentrations.

Actions: Transport Sector

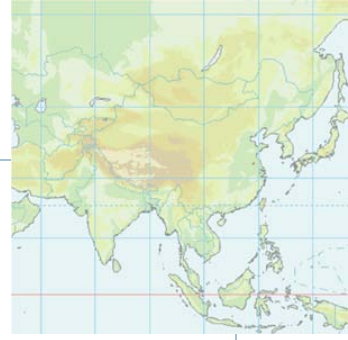
- ***The cost-effectiveness of technology-specific policies:*** to be carefully considered like banning certain vehicles or prohibiting traffic in certain areas.
- ***Use of alternative fuels*****:** vehicles using LPG/CNG emit considerably less particulate matter than conventional diesel.
- ***Traffic management measures:*** such as coordination of traffic lights, zebra crossings, side paths, left turns which yields significant economic benefits because it decreases congestion and improves mobility.
- ***Demand management:*** through provision of public transport, fiscal measures, area wide licensing, pricing instruments such as differential pricing for access, and preferential treatment of high-occupancy vehicles. Public transport dedicated bus.
- ***Use of non-motorized transport (NMT) mechanism*****:** to be promoted by curtailing motorization and elimination of impediments to NMT. Government intervention, like introducing stringent parking restrictions and constructing safe bicycle routes.
- ***Inspection and maintenance*** *of vehicles and retirement and scrapping;* retirement and scrapping of old vehicles and improved maintenance.

Actions: Transport Sector

- ***Fiscal measures:*** Higher taxation on purchase of new vehicles and for polluting fuels providing indirect incentive for penetration of cleaner fuels and technologies.
- ***Equitable allocation of road space:*** Reserving lanes and corridors exclusively for public transport and non-motorized modes of travel
- ***Parking in city centres and commercial areas:*** Provision of planned parking spaces away from busy commercial areas with park and ride facilities
- ***Freight traffic management:*** *Staggered f*reight and passenger traffic
  - By enforcing the use off-peak passenger travel times to move freight.
  - By using and developing by-passes for the through traffic.
- ***Private sector participation:*** for activities like the operation and maintenance of parking facilities, certification facilities, repair facilities, construction and management of terminal facilities, etc.
- ***Public awareness and cooperation:*** To organise awareness campaigns on the ill effects of the growing transport problems in urban areas with aim at encouraging individuals, families and communities to adopt “Green Travel Habits”.

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.



Thanks for your attention!