Technology Options for Emission Mitigation in Indian Residential and Transport Sectors

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Presentation Sequence

- Background
- Residential and Transport Sectors
- Modelling the Select Sectors
- Scenario Definitions
- Results and Findings

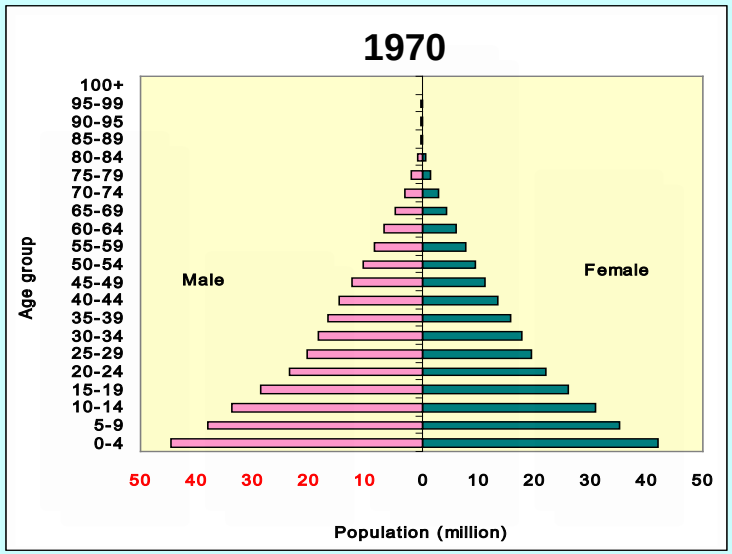
Million Plus UAs/Cities India: 2011

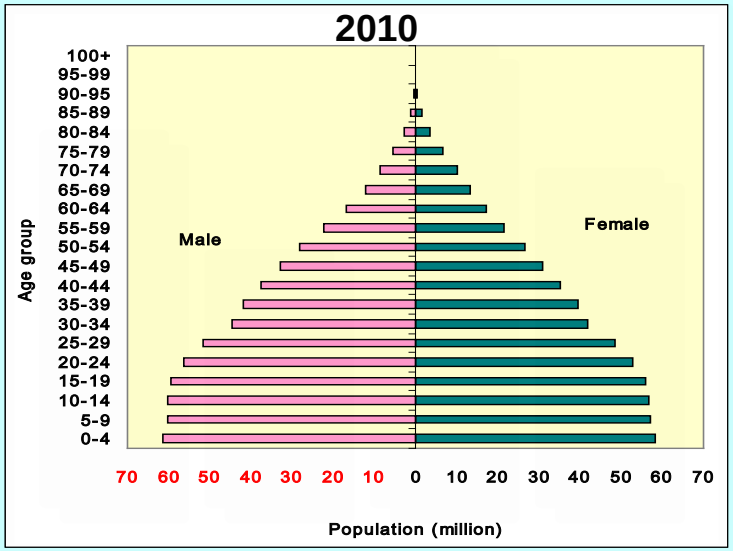
53 Million Plus UAs/Cities in India with population of one million or more. In Census 2001 the number was 35.

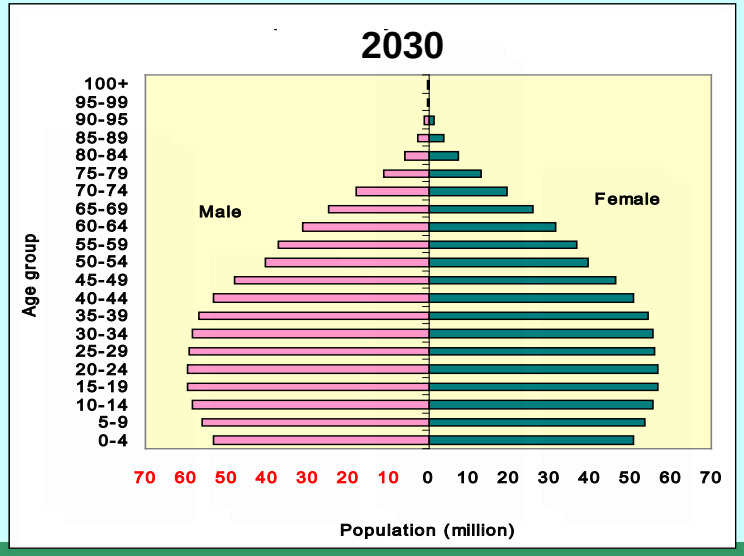
Mega UAs/Cities

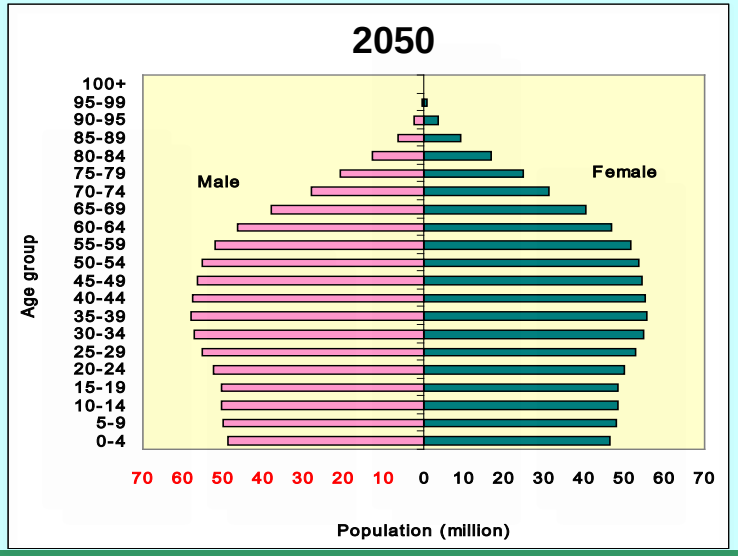
- Three megacities in India as per Census 2011 with 10 million or more population
- These are:
  - Greater Mumbai UA 18.4 million
  - Delhi UA 16.3 million
  - Kolkata UA 14.1 million

Age/Gender Profile

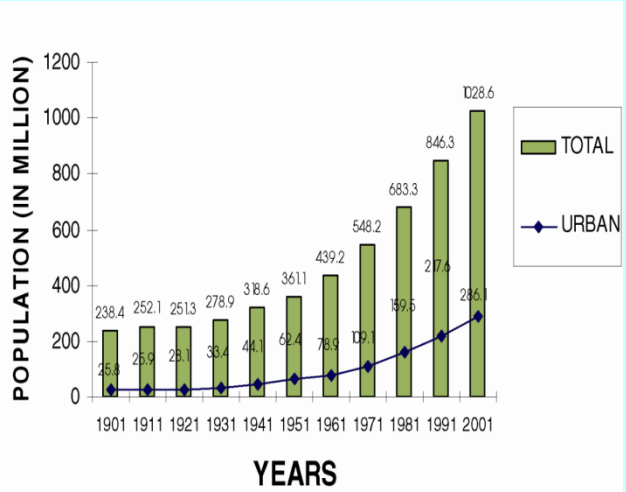






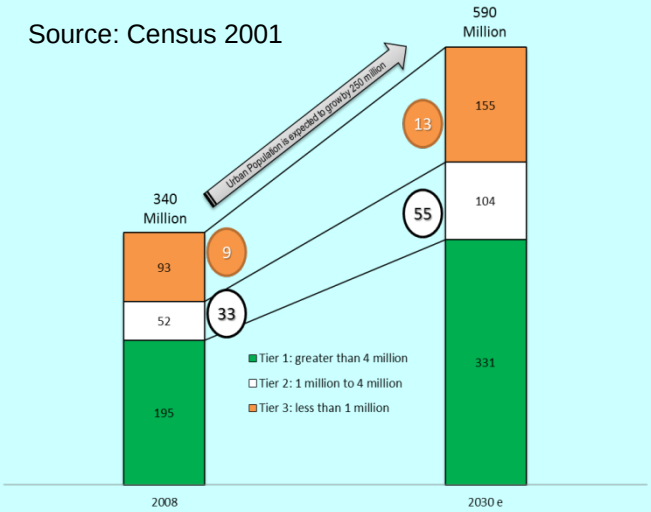


Demographic trends and projections



Share of Urban population

Source: Census 2001

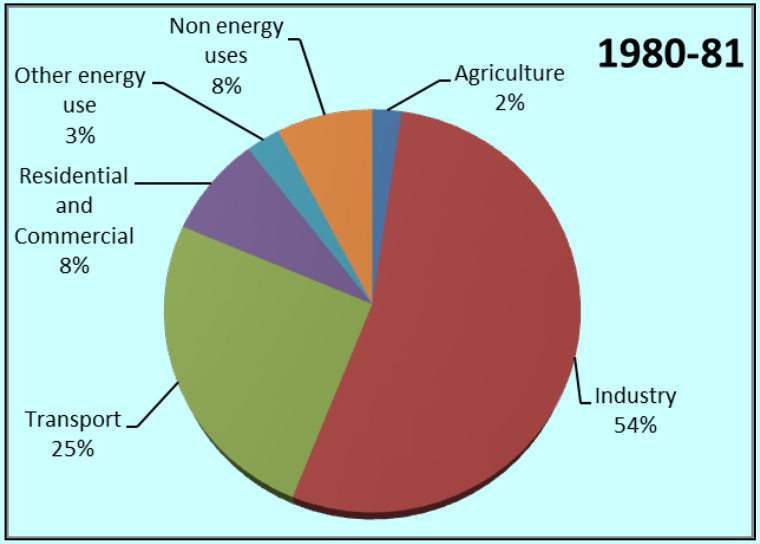


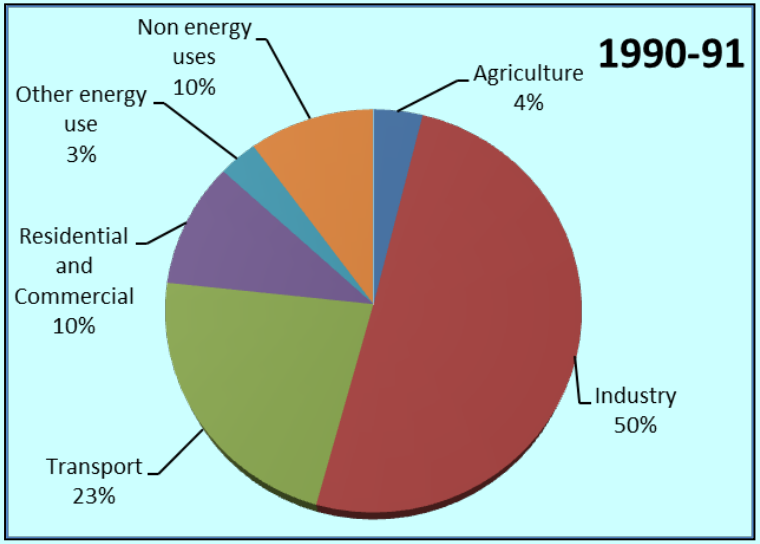
Growth of large cities in India

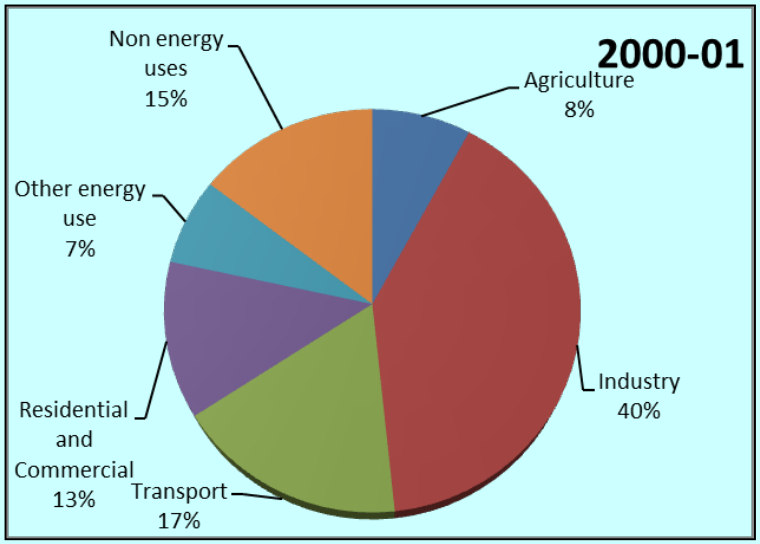
Source: Mckinsey 2010

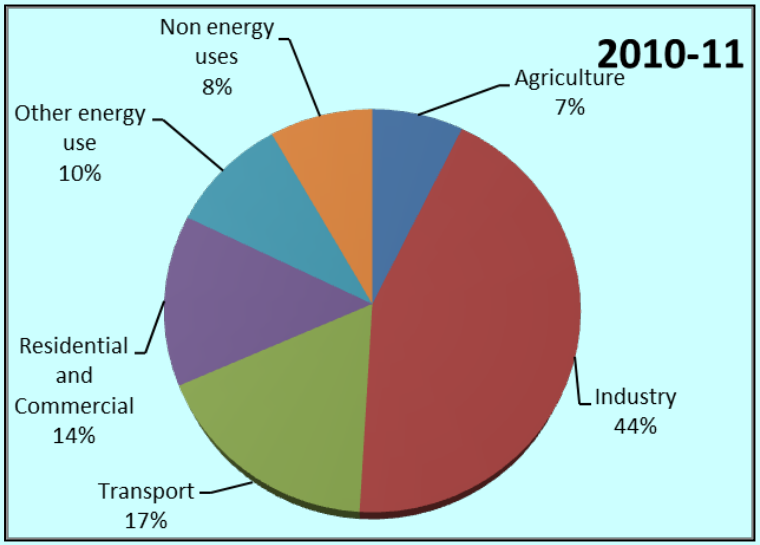
Million-plus Cities and Urban Agglomerations

India’s commercial energy consumption



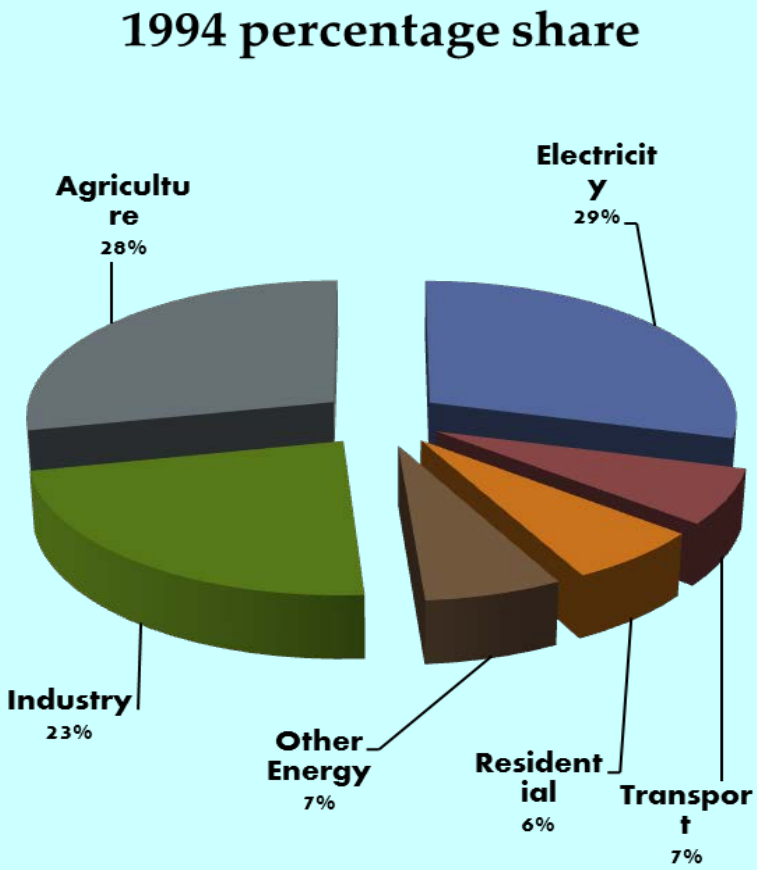


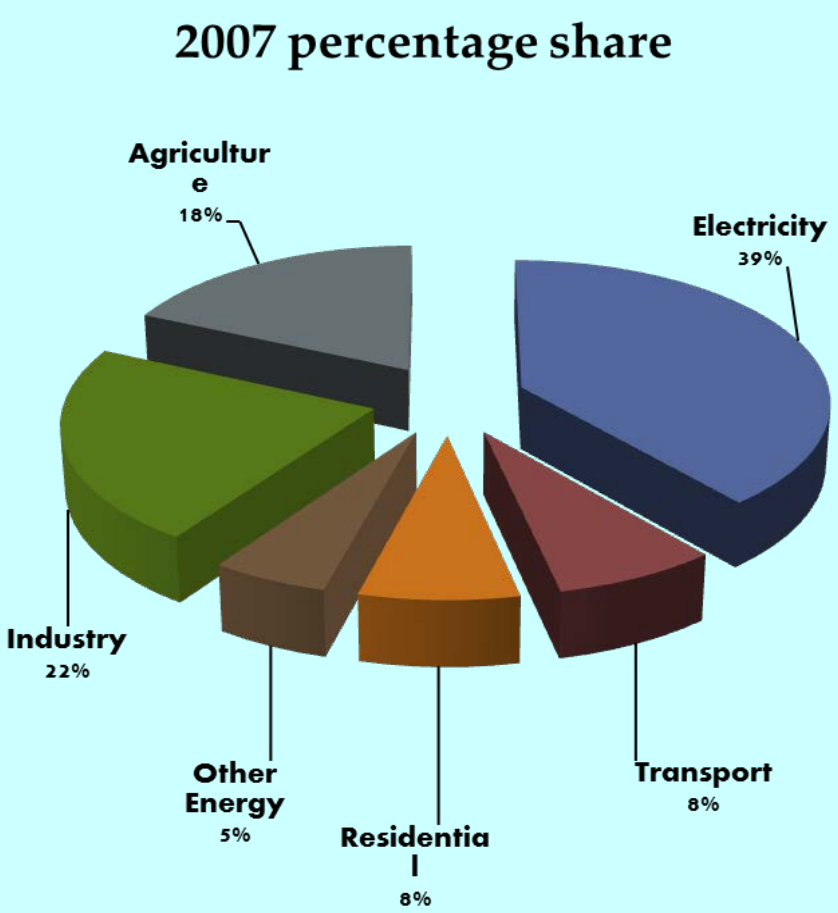




Source: 1. IEA Statistics 2. Energy statistics 2013

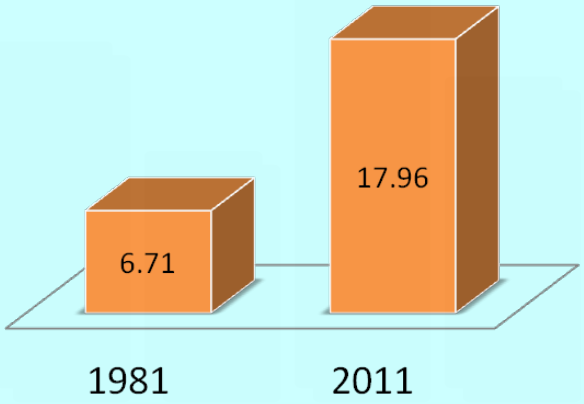
GHG Emissions





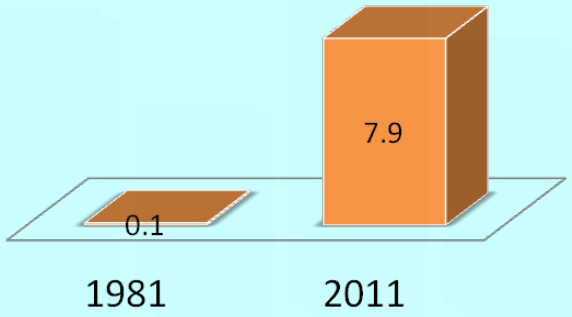
Source: MoEF 2010

Population v/s Vehicle Growth

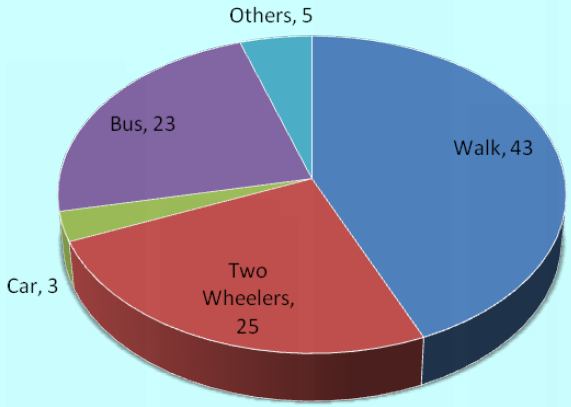


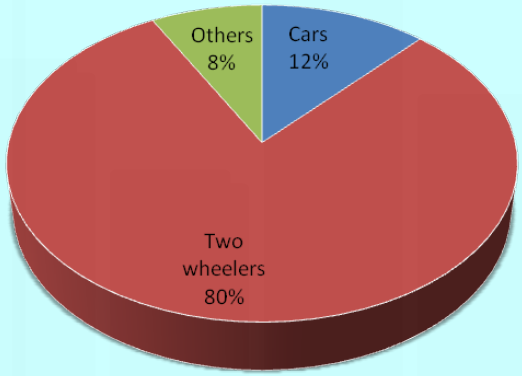
Population growth (lakh nos)

Since 1981, the population of Bhopal has multiplied about 2.5 times and number of registered vehicles has increased 85 times. Of the 0.79 million registered vehicles in 2011, 92% are cars and two wheelers which accounts for 28% of modal share.



Vehicular growth(lakh nos)





Transport Sector Issues

1. **Rapid Growth of Travel Demand**
2. **Insufficient Transport Infrastructure**

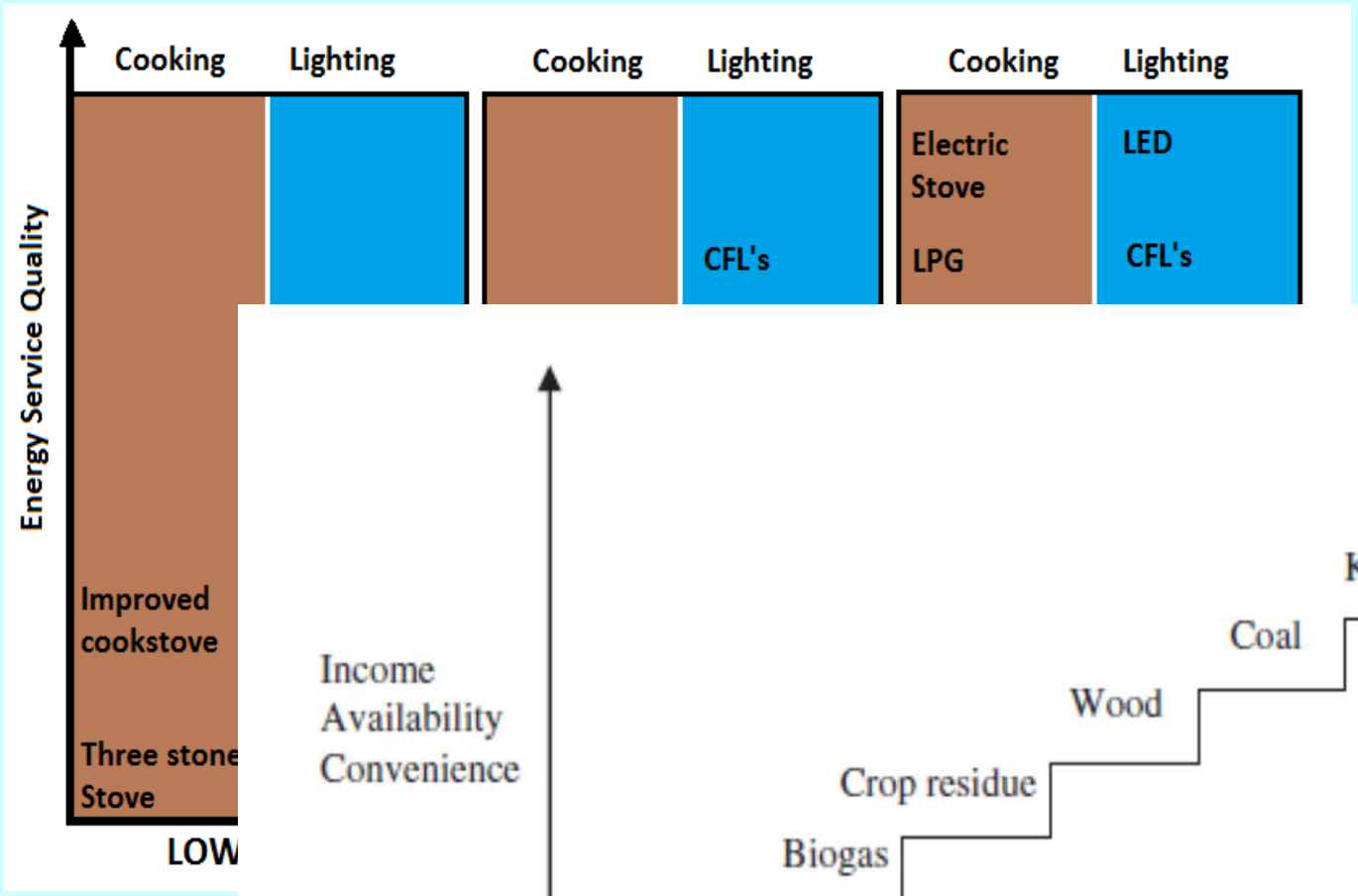
Travel Demand

- Trip rate (per capita trip)
- Size of the population
- Per capita income
- Trip length
- City size and urban sprawl

Consequences……

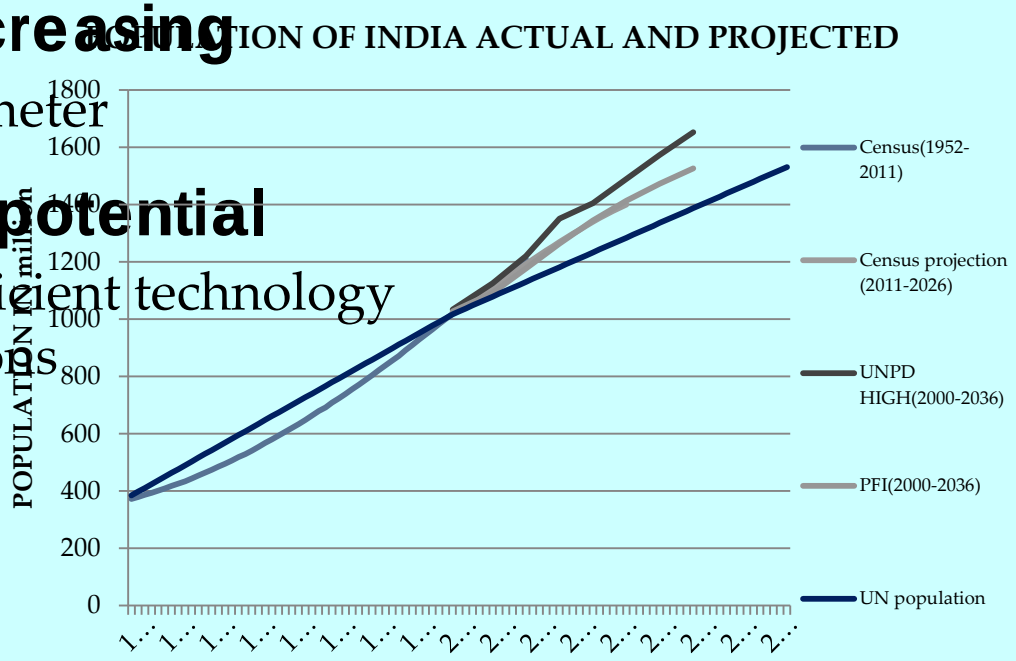
- Congestion
- Growth in number of vehicles
- Limitation to road expansion
- Pollution
- Accidents
- Public Transport Deterioration
- Declining reliance on NMT

Income and energy in Residential Sector



Residential and Transport Characteristics

1. **Technology shift is swift**
   - Short Life span of technology
   - Rapid advancement of new technology
2. **Population increase**
3. **Energy demand increasing**
   - Passenger and freight kilometer
   - Household
     - Family size
     - Income level
     - Household Appliance
     - …..
4. **Emission reduction potential**
   - Introduction of efficient technology
   - Multiple fuel options
5. **Co benefits**



UNPD: United nations population Division
PFI: Population foundation of India

Some Important Questions

1. What drives energy demand and technology choices in Indian residential and transport sector?

2. What has been the technology profile and resulting energy and emission in these sectors?

3. How energy and emission trajectory is likely to change in future under different scenarios?

4. What is the role of clean/renewable energy technology in bringing out this change?

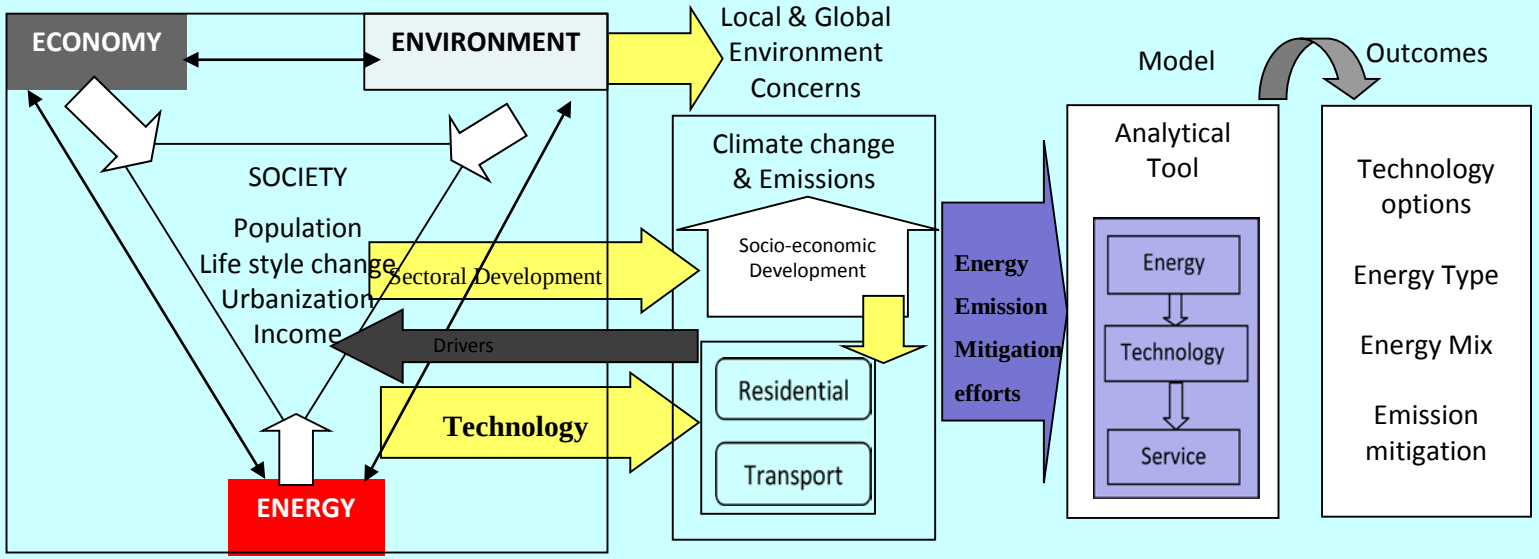
Residential and Transport Energy Scenario

- India has experienced many changes in energy consumption pattern in both residential and transport sector. This is because of following factors:
  - Population growth
  - Increase in economy and development
- Electricity demand in the Indian household sector has also been growing at a very rapid rate over the last decades
- There is a large variation in energy consumption across different sections of households like urban/rural, low/high income group
- As the income of the people increases demand for personalized modes of transport is expected to increase more rapidly

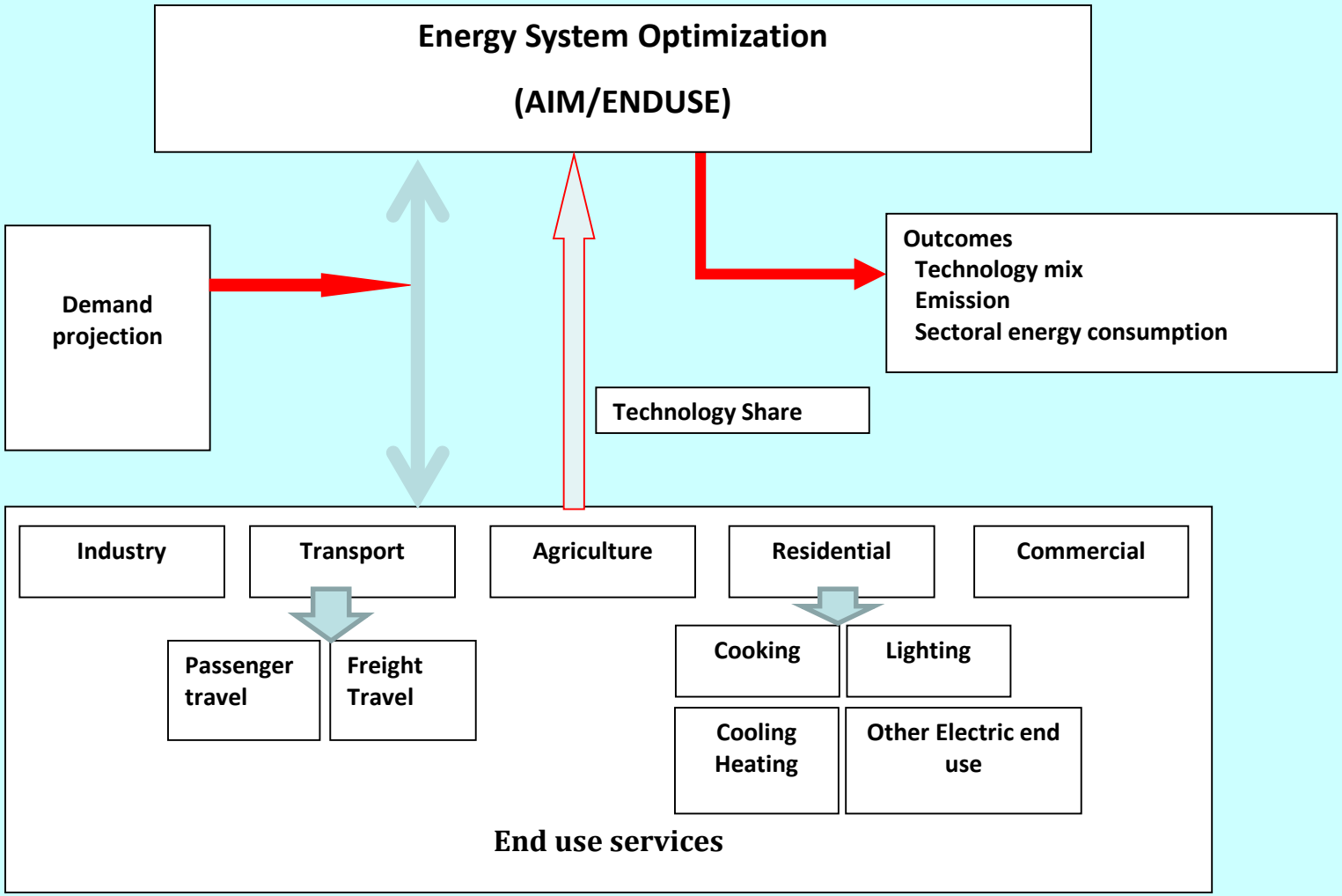
Associated Problems and Co-benefits

- Local pollution is one of the serious problems faced by the people in the country.
- Rapid population growth, industrialization and urbanization in country are adversely affecting the environment as
- India’s two third of the population resides in rural areas and fuelwood and kerosene is the main fuel for cooking and lighting, both cause harm to the women cooking food in houses.
- Due to increase in the number of vehicle, traffic congestion is a serious problem in most of the cities in India.

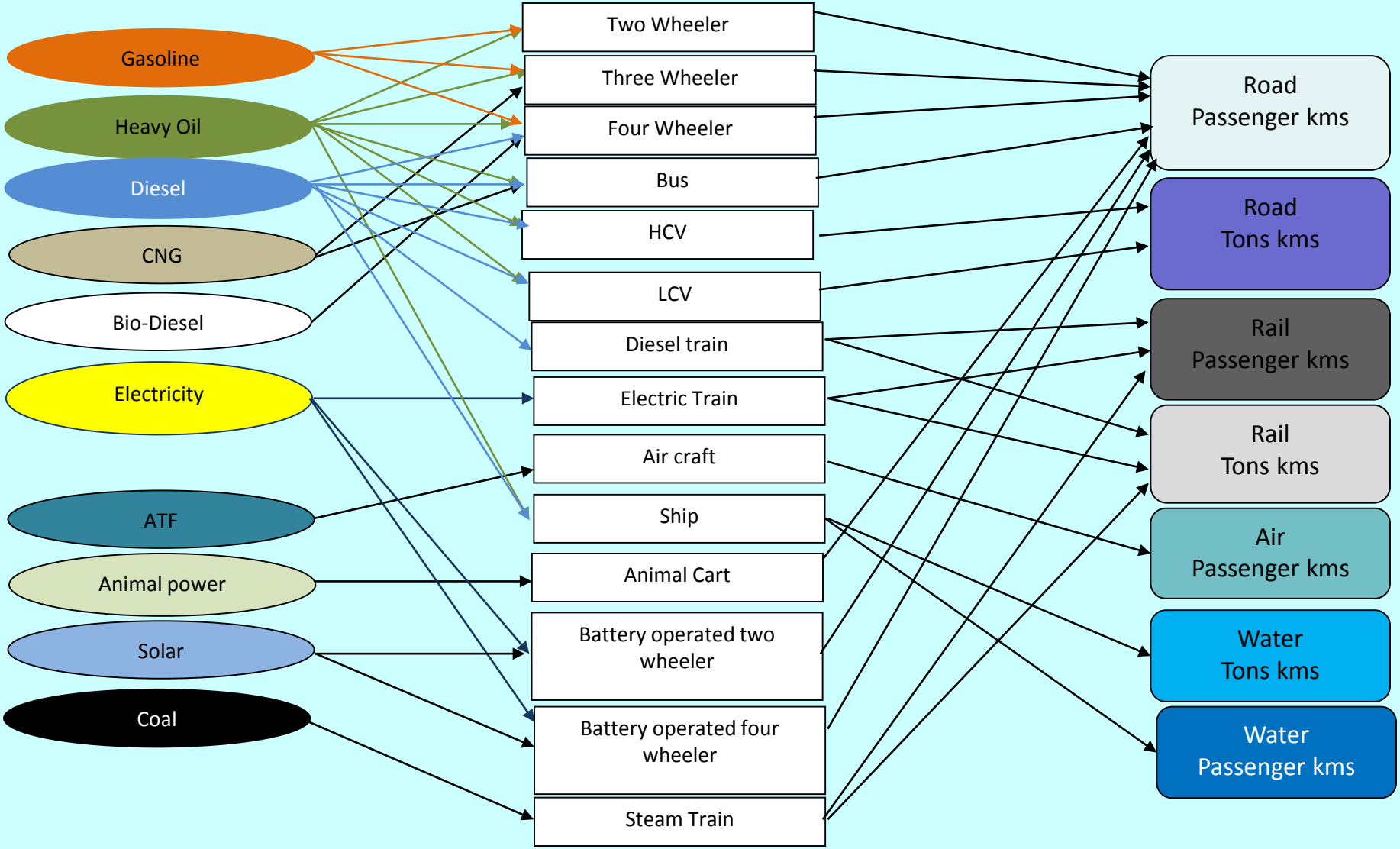
Analysis Framework

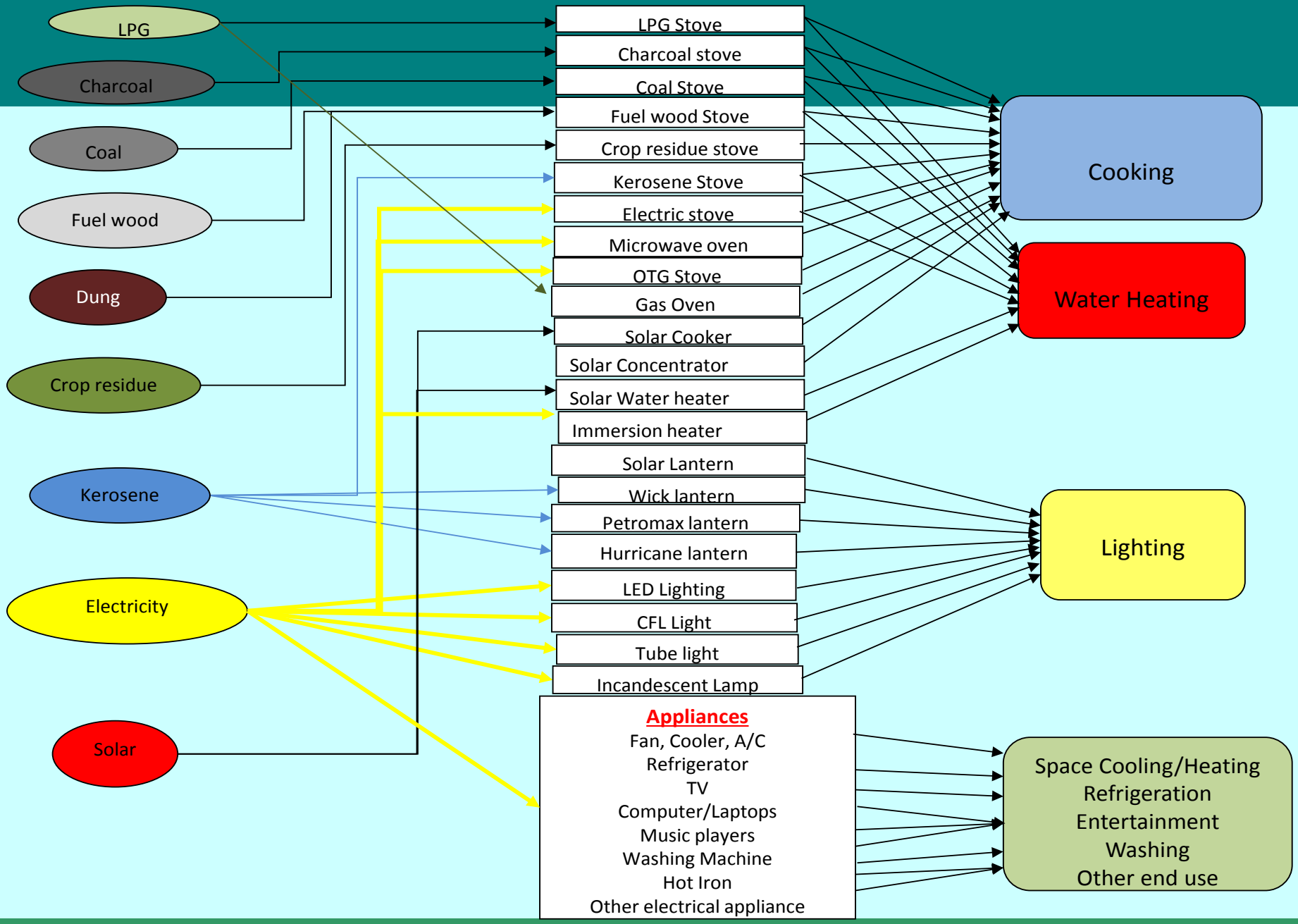


Modeling Framework



Reference Energy Systems

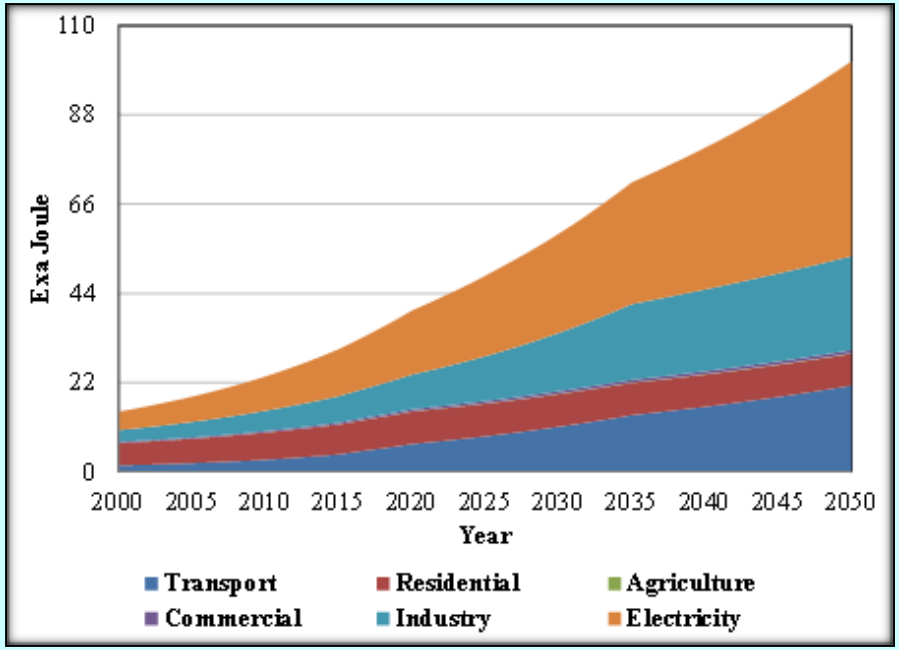


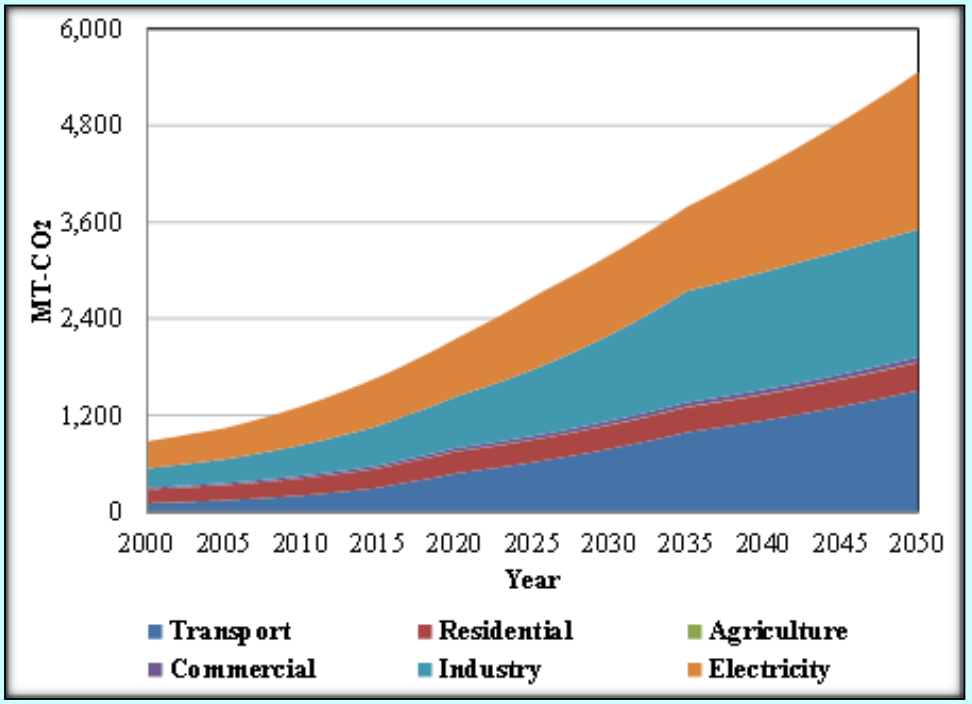

LPG
Charcoal
Coal
Fuel wood
Dung
Crop residue
Kerosene
Electricity
Solar
LPG Stove
Charcoal stove
Coal Stove
Fuel wood Stove
Crop residue stove
Kerosene Stove
Electric stove
Microwave oven
OTG Stove
Gas Oven
Solar Cooker
Solar Concentrator
Solar Water heater
Immersion heater
Solar Lantern
Wick lantern
Petromax lantern
Hurricane lantern
LED Lighting
CFL Light
Tube light
Incandescent Lamp
Appliances
Fan, Cooler, A/C
Refrigerator
TV
Computer/Laptops
Music players
Washing Machine
Hot Iron
Other electrical appliance
Cooking
Water Heating
Lighting
Space Cooling/Heating
Refrigeration
Entertainment
Washing
Other end use

Scenario Description

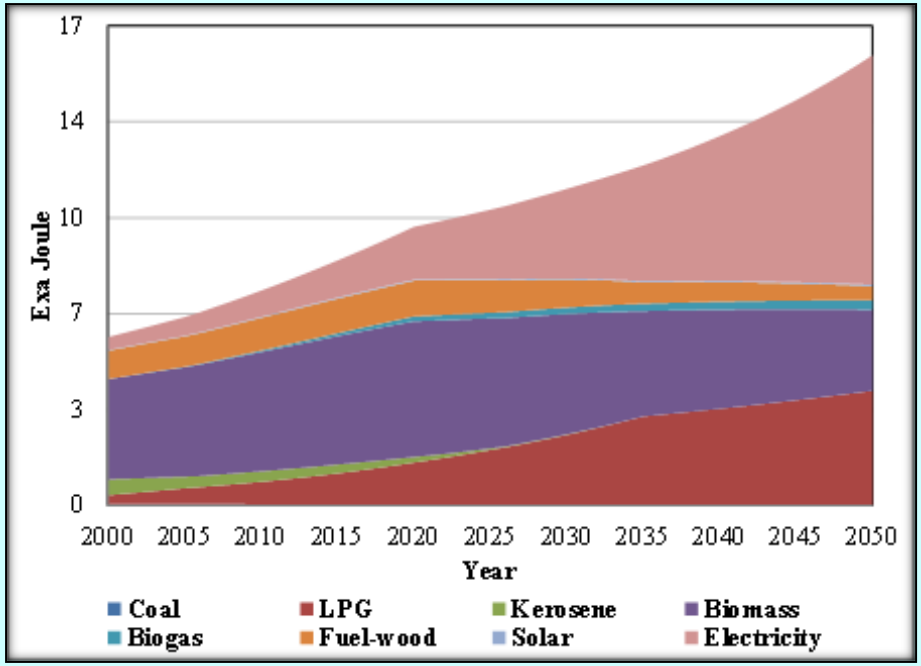
- Business as Usual:
  - BaU scenario for future emission projections assumes continuation with present trend.
- Constraint on Carbon:
  - Different level of CO_2 emission reduction.
- Taxes on Carbon:
  - Energy and emission taxes are applied with assumption to shift towards efficient and cleaner technology
- Renewable Energy Technology:
  - Energy and emission taxes along with subsidy on renewable energy technology.

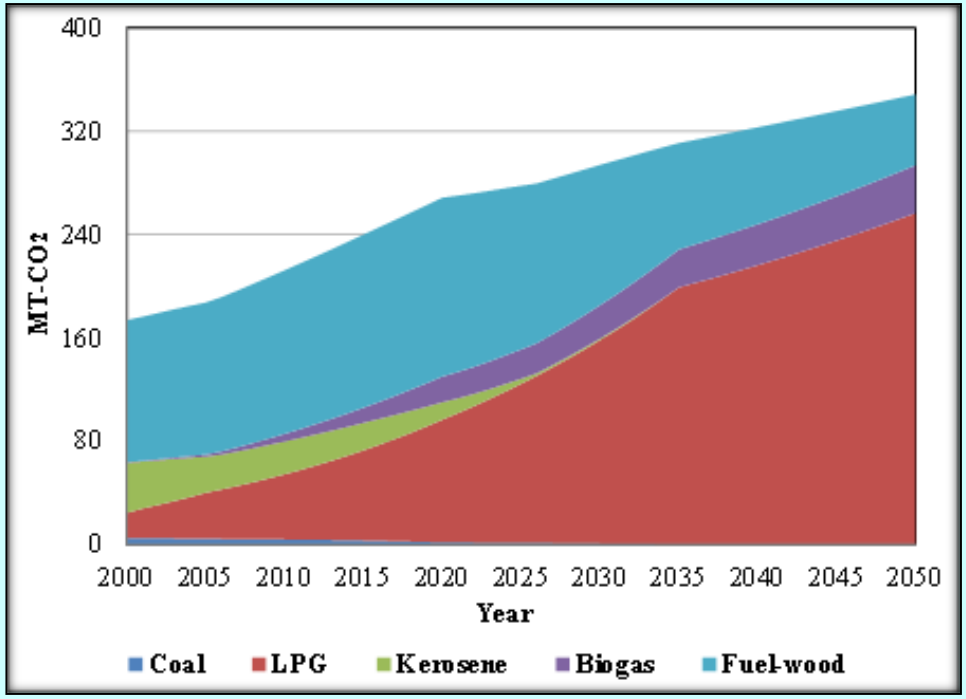
Primary Energy and CO_2 Emission



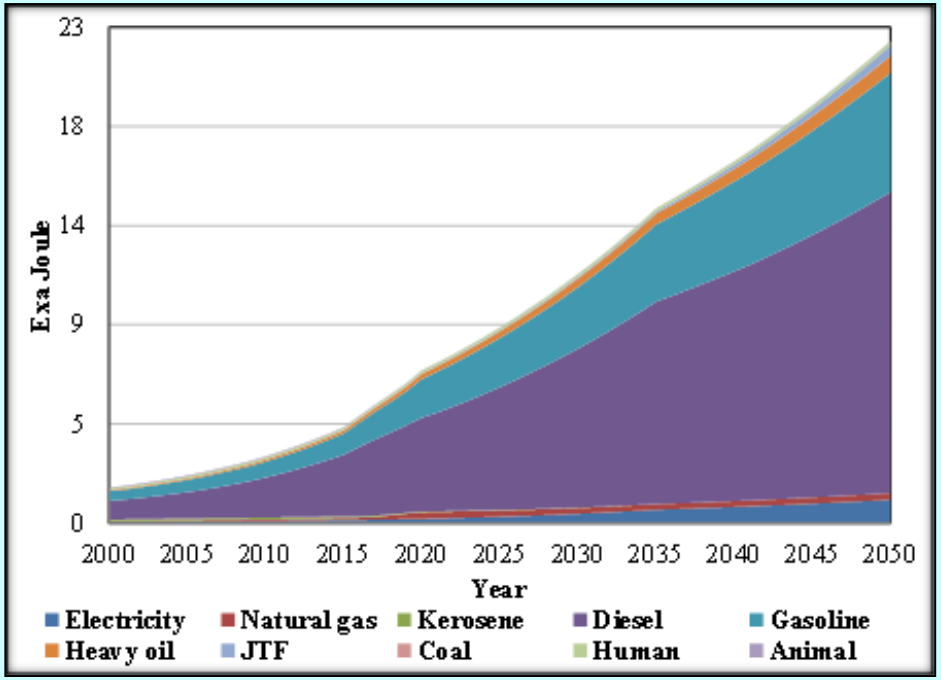


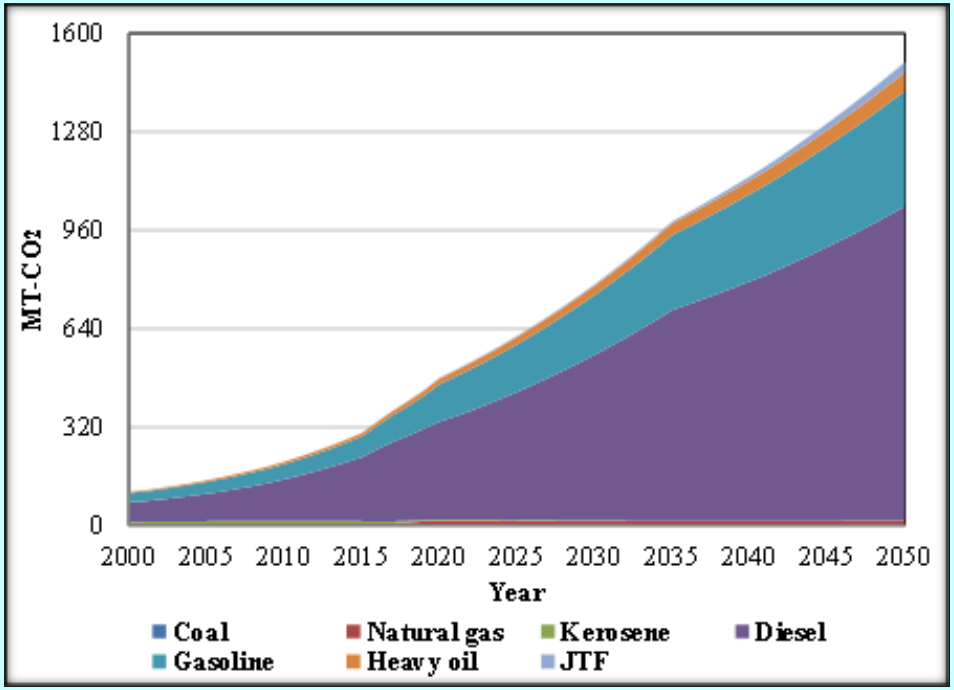
Energy and Emission Residential Sector



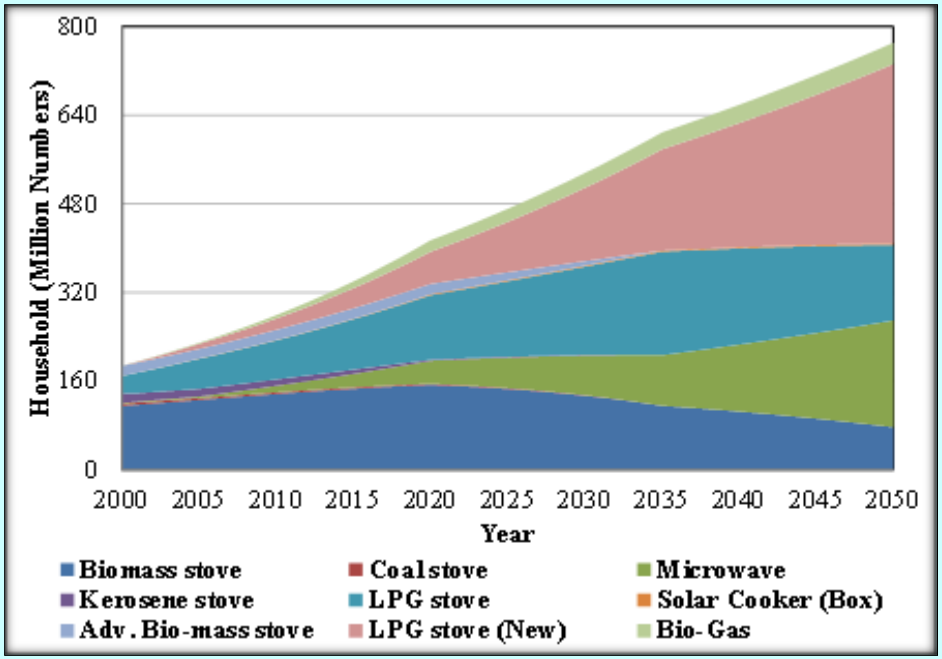


Energy and Emission in Transport Sector

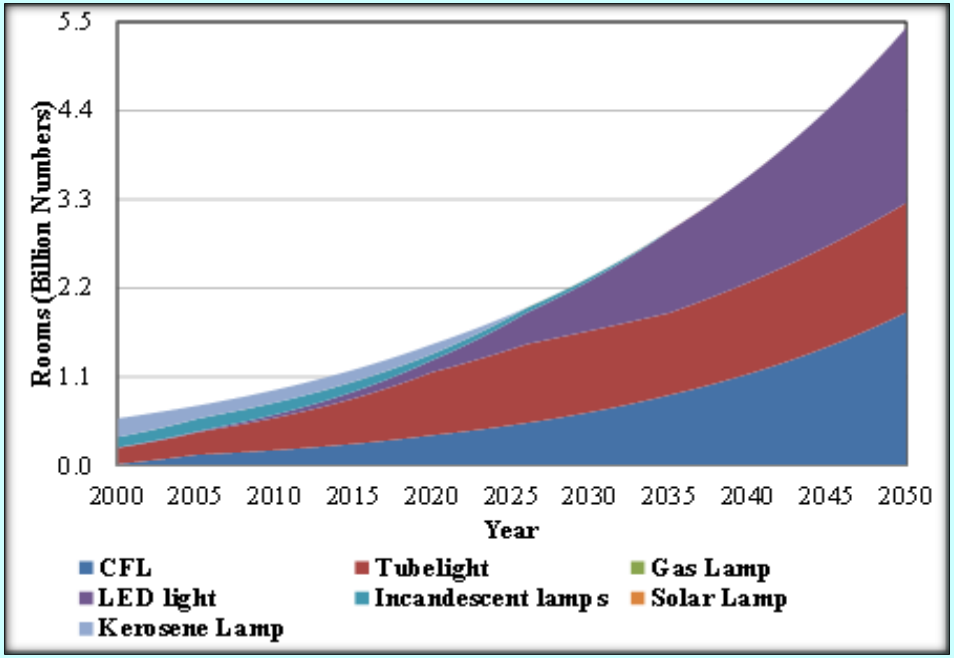


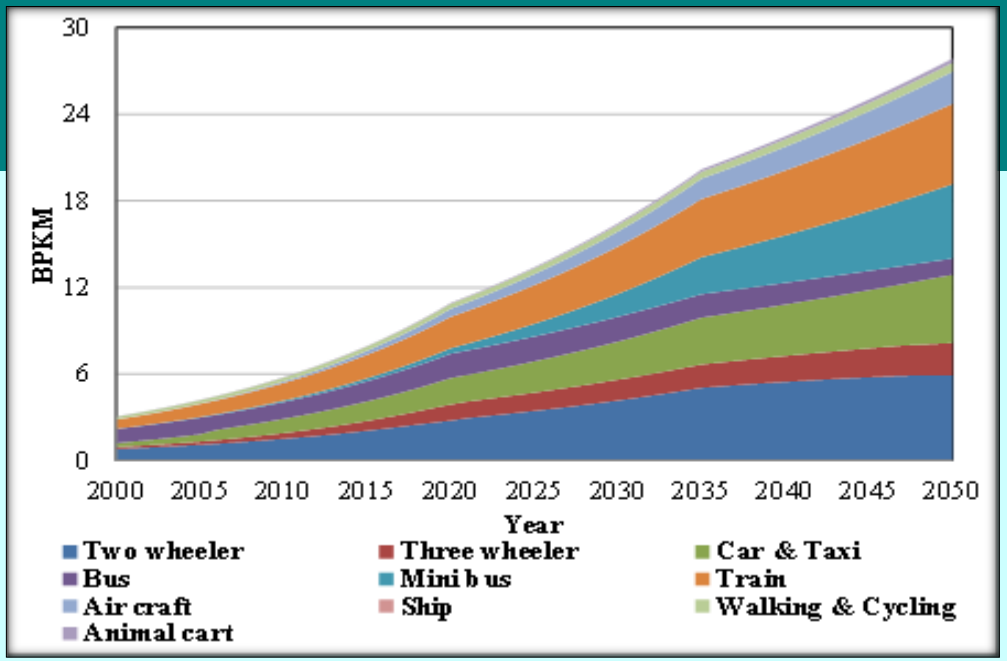


Technology options in Residential Cooking

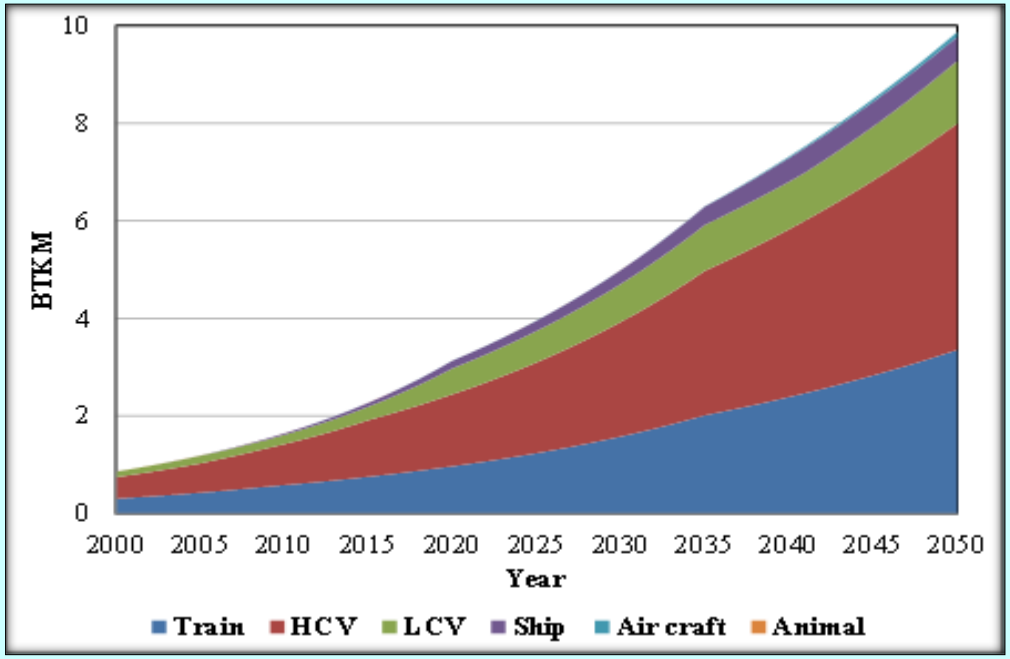


Technology options in Residential Lighting



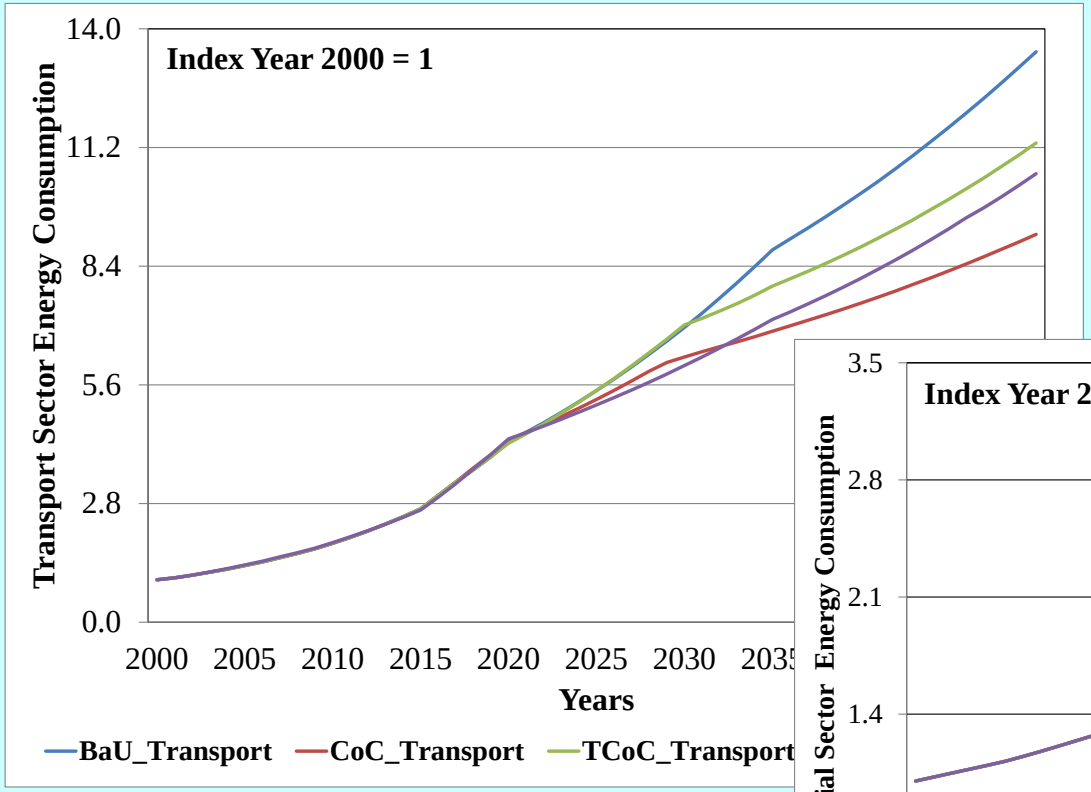


Technology options in Passenger Transportation



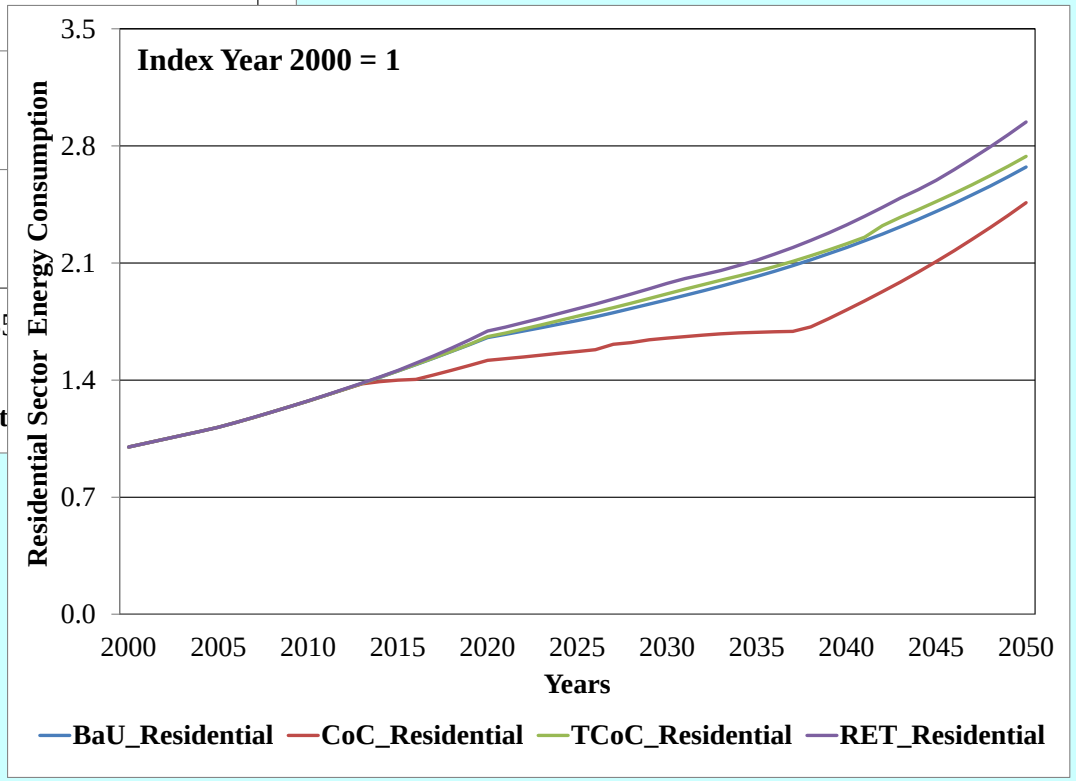
Technology options in Freight Transportation

Scenario wise Energy Consumption



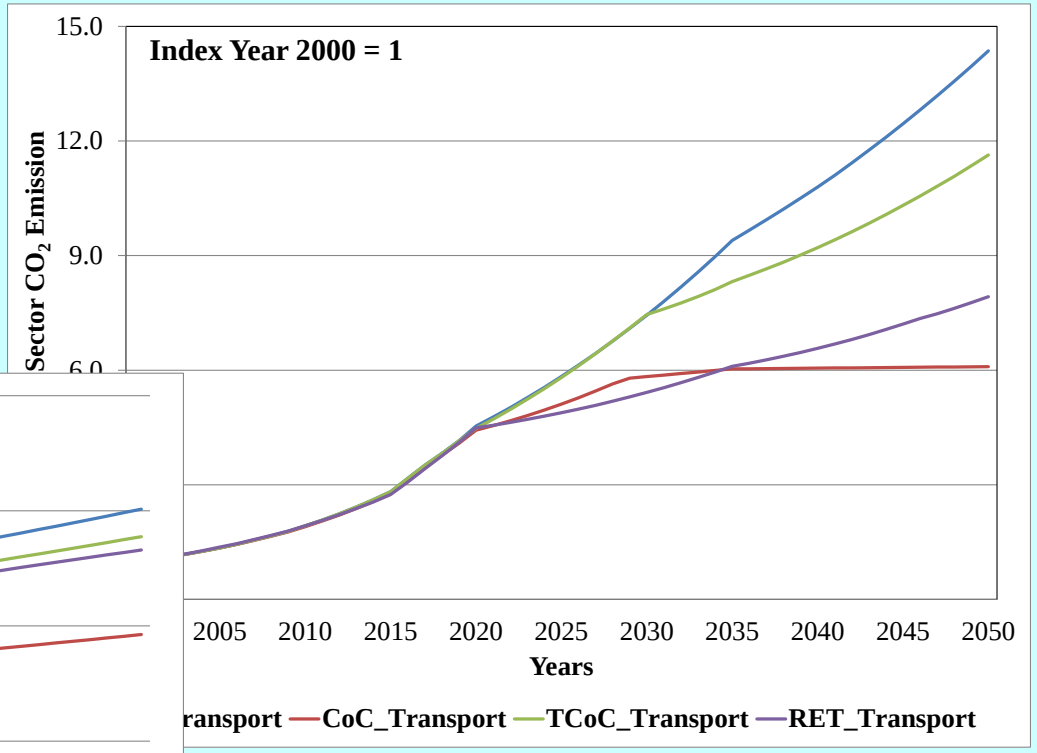
Future Energy Consumption in Transport Sector

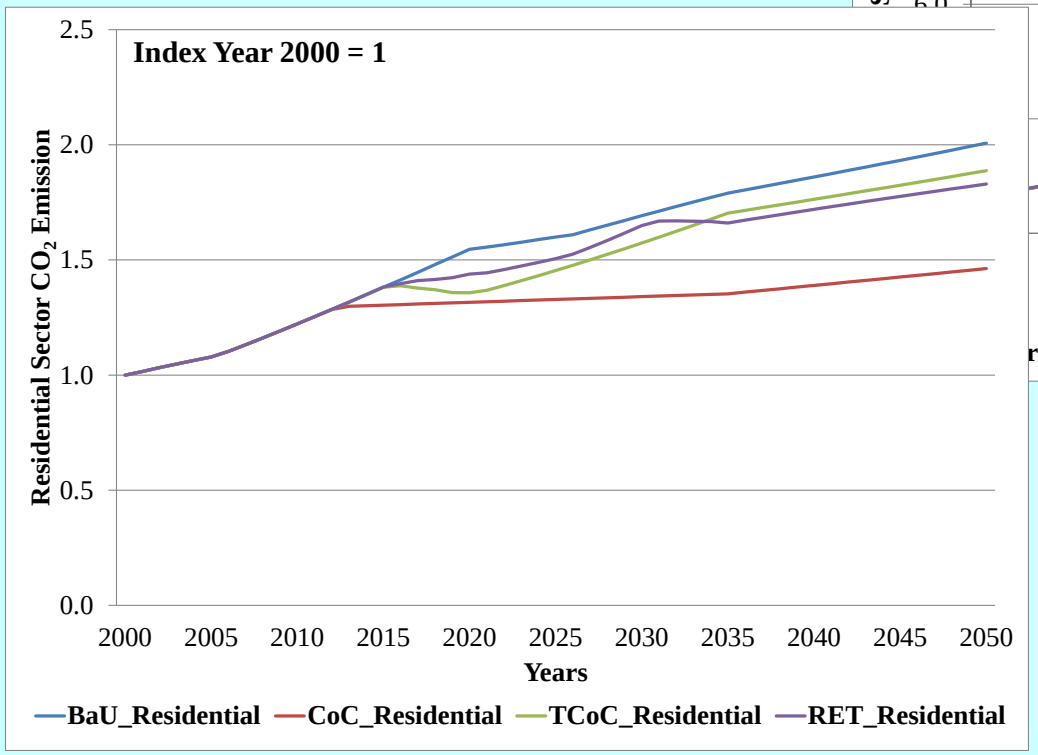
Future Energy Consumption in Residential sector



Scenario wise CO_2 Emission

Future Emission
in Transport Sector





Future Emission
in Residential Sector

Major Findings

Energy:

- Conventional fuels: bio-mass, wood, charcoal, cow dung reduce
- Commercial fuels : electricity, natural gas, renewables, etc. increase
- Residential Sector: LPG and Electricity - Main source of energy, Kerosene & Coal - Decline its share by 2030 & 2020. Solar Energy - increases with subsidy
- Transport Sector: Diesel and gasoline - increase in BaU, Decline slightly in RET. Decrease in these fuels is possible with the use of bio-diesel and promotion of cycling and walking.

Emission:

- Over the analysis period the CO_2 emission from residential and transport sector of India increases by 2.5 fold and 8 fold respectively in BaU..
- Advances in technologies and upcoming renewable options can bring down the CO_2 emission by 40% in year 2050.
- In constraint scenarios, transport sector has higher potential to mitigate emission whereas in RET scenario, residential sector takes the prominent position.

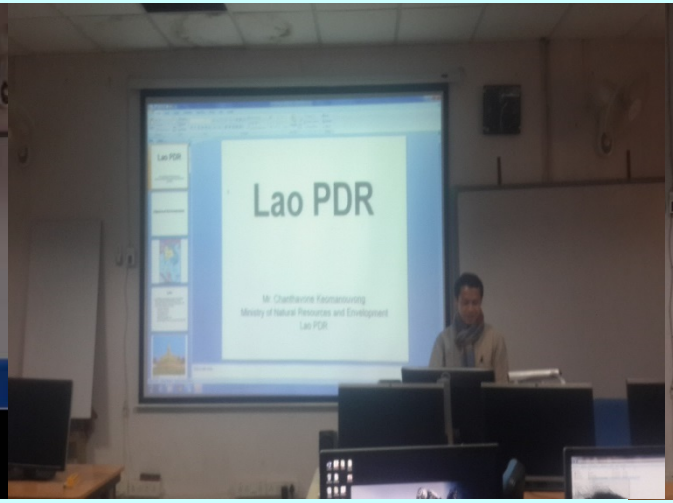
Technology choices:

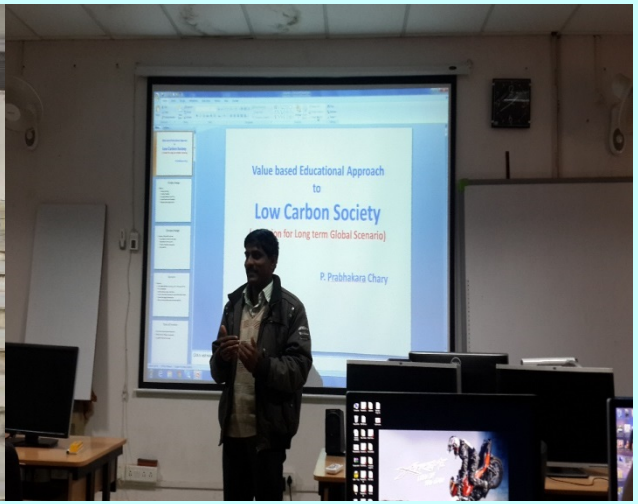
Residential Sector: CFL, LED, Solar water heater, 3-5 star rating appliances

Transport sector: Walking, cycling, bio-diesel, public transport

Workshop on “Climate Change Scenario Development for Policy Analysis” Under TCS Colombo Plan, Ministry of External Affairs, Government of India at NITTTR, Bhopal

Participants from Myanmar, Lao PDR, Sri Lanka presenting regional analysis.





Forthcoming Training Workshops on Climate Change Issues and Challenges

December 06-18, 2015	**Climate Change, Scenario Development for Policy Analysis (Using AIM ExSS for LCS)**
January 04-08, 2016	**Modeling for Energy & Emission Policy Design (Using AIM EndUse & ExSS)**
February 15-19, 2016	**Sustainable Development Practices for Technical Institutions (LCS Concepts)**

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Thank You….

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