

# High Speed Rail along the Ahmedabad- Mumbai corridor

## Impacts on energy and emissions

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High Speed Rail Seminar, Ahmedabad  
February 11, 2013



# Growth in passenger transport sector in India

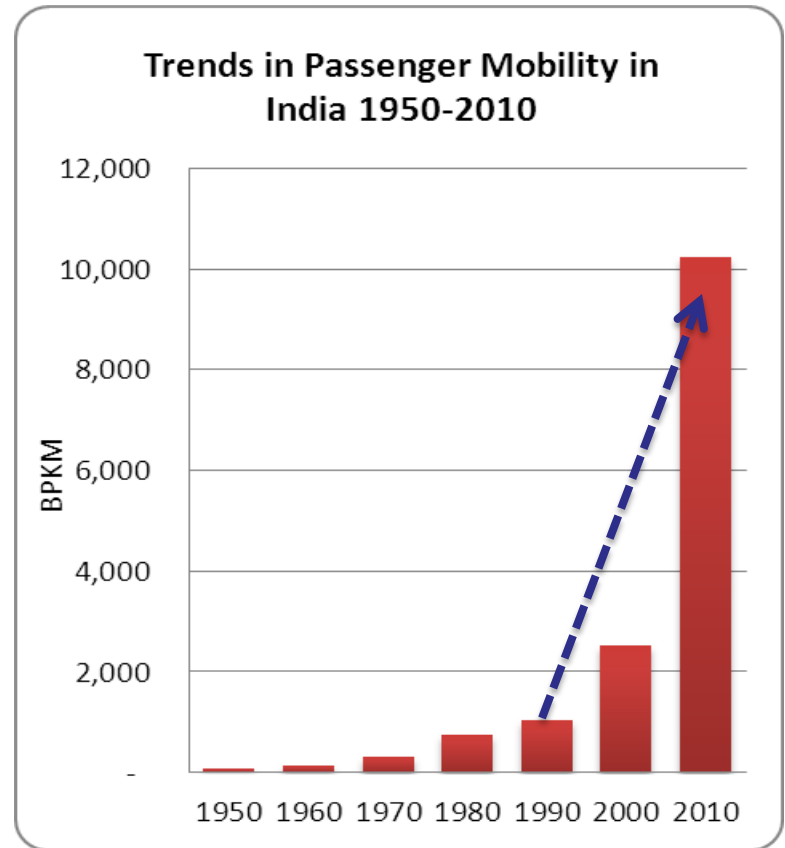


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- Very fast growth in passenger transport activity (PKM)
- 10 times growth observed since 1990

1,060 BPKM (1990) → 10,230 BPKM (2010)

- Growth drivers: population, economy, urbanization, motorization



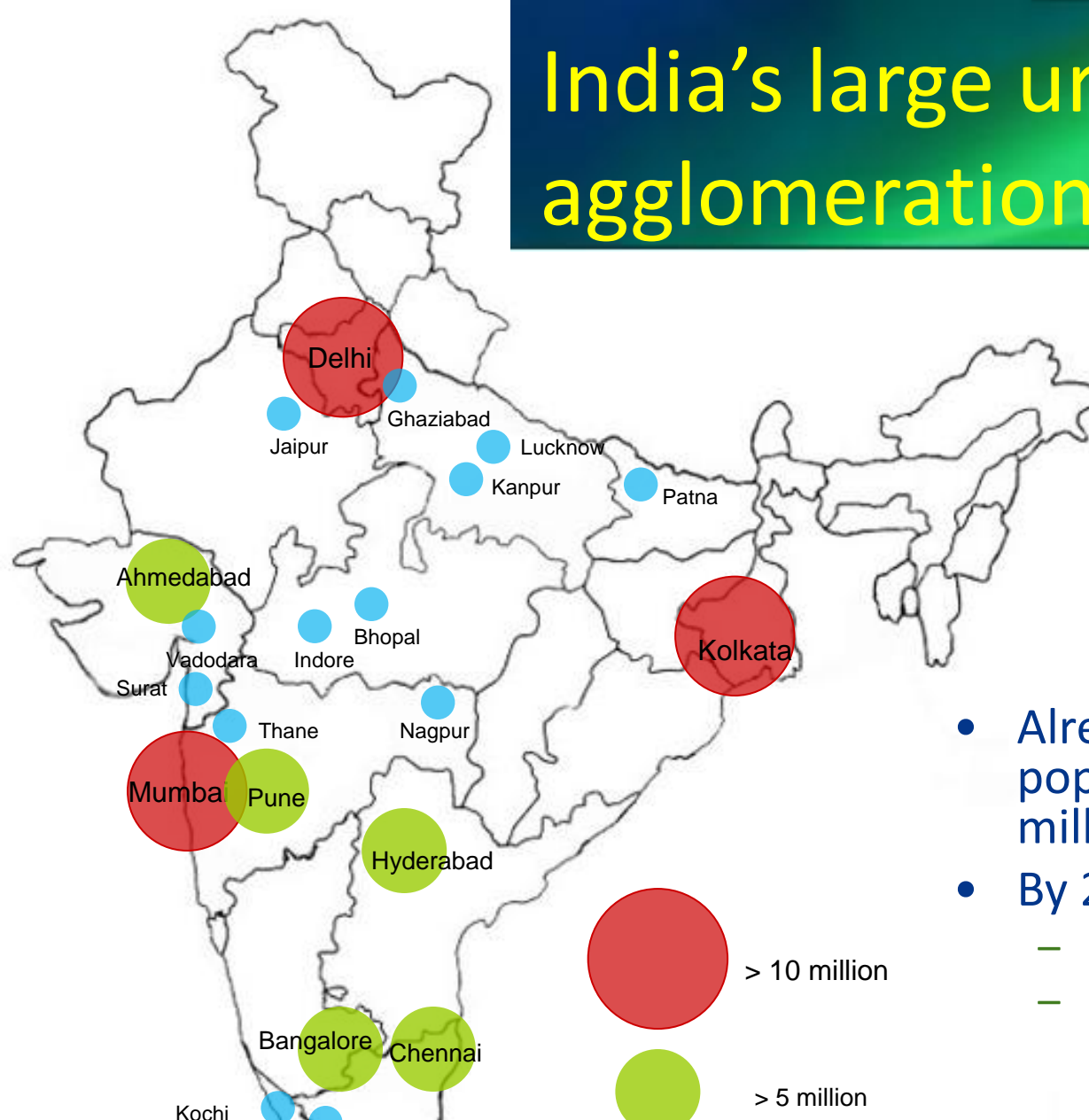
Source: Estimates by different Ministries and Planning Commission  
Estimates are on higher side as compared to many other estimates

A handful of large urban centers are responsible for a major portion of this traffic growth

# India's large urban agglomerations



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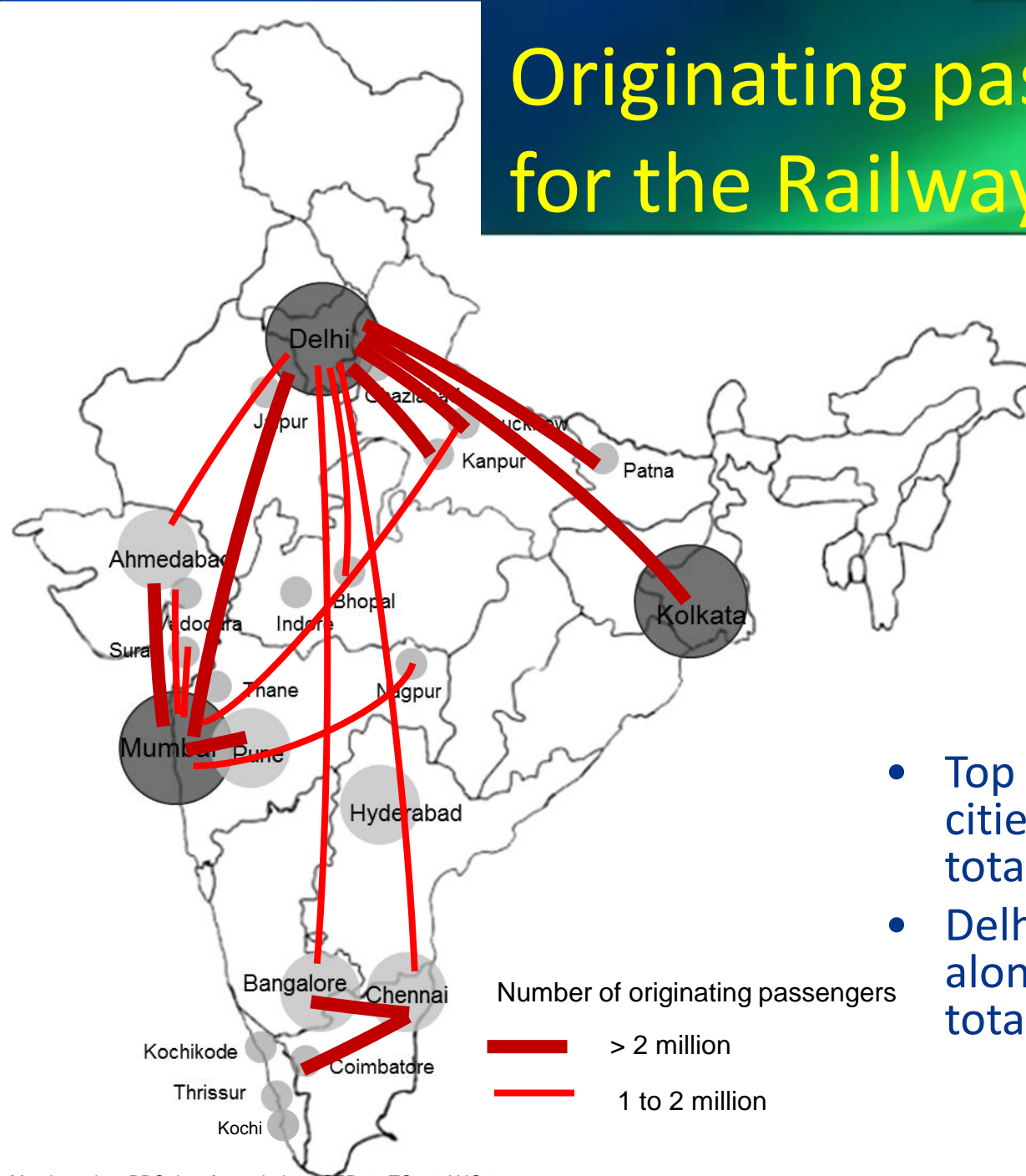
- Already 8 urban centers have populations greater than 5 million people
- By 2030
  - At least 6 ten million plus cities
  - 7 to 13 four million plus cities

Large passenger mobility can be seen between such large cities across the country

# Originating passengers for the Railways



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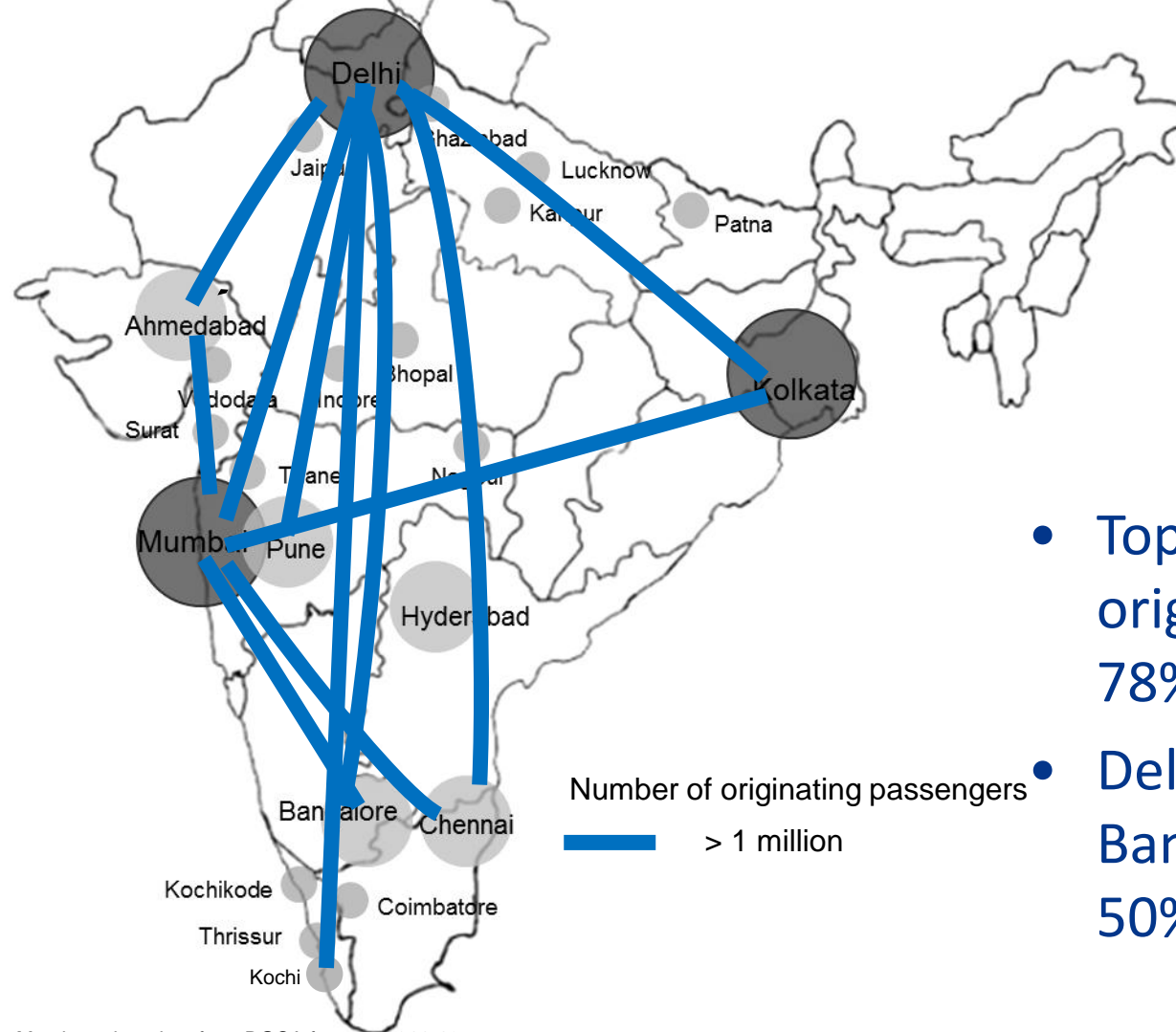


- Top 40 passenger originating cities generate 51% of the total non-suburban traffic
- Delhi, Mumbai and Kolkata alone generate 20% of the total traffic

# Originating passengers for the Airlines

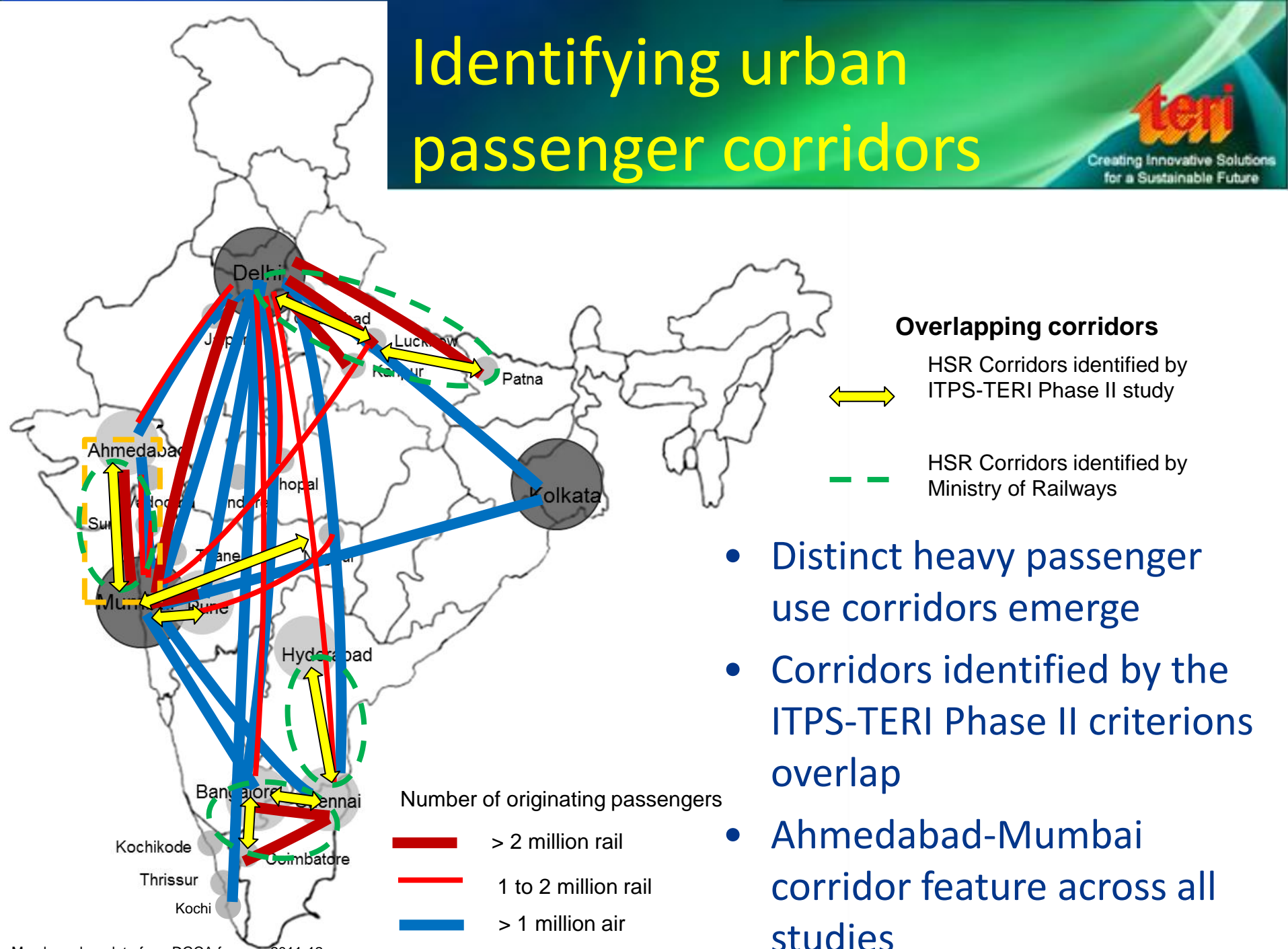


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- Top 10 passenger originating cities generate 78% of the total traffic
- Delhi, Mumbai and Bangalore generate about 50% of the total traffic

# Identifying urban passenger corridors



- Distinct heavy passenger use corridors emerge
- Corridors identified by the ITPS-TERI Phase II criteria overlap
- Ahmedabad-Mumbai corridor feature across all studies

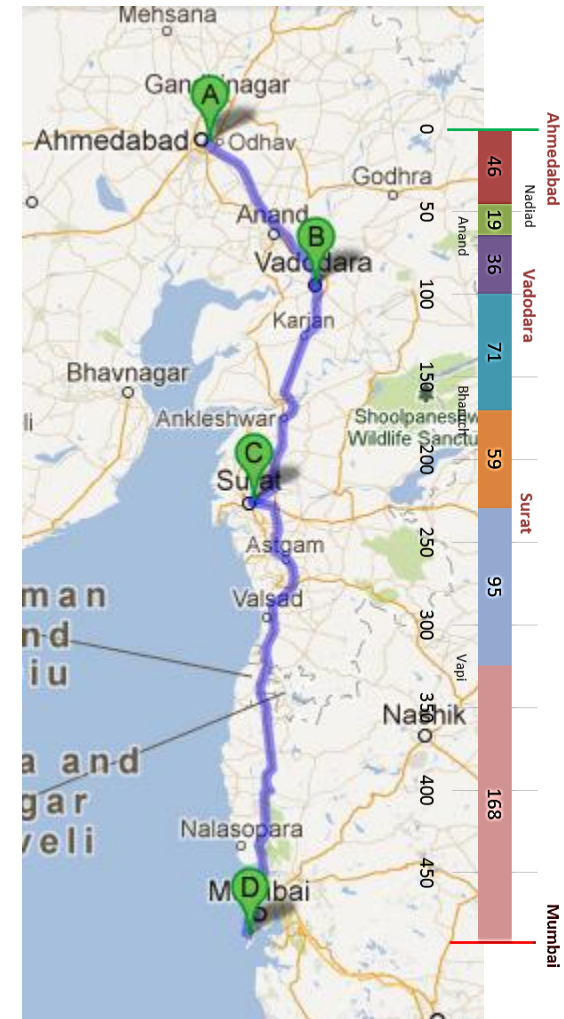
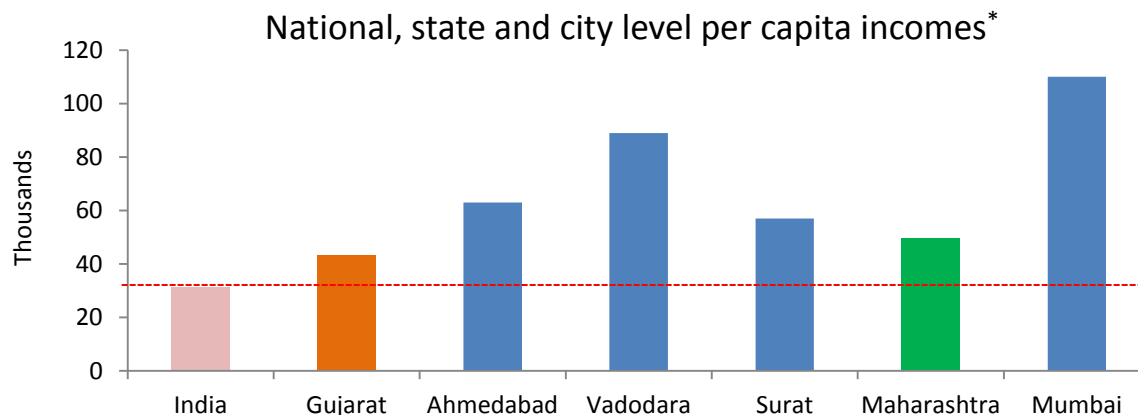
# The Ahmedabad-Mumbai corridor

## MOST DEVELOPED REGION IN INDIA



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- Corridor length: 491 km
- Runs through the most urbanized states in India
- **Ahmedabad, Surat, Vadodara, Mumbai:** most populous metropolitan areas in India
- Some of the highest per capita incomes
- Historically connected through trade, business and culture



\*Source; City Skyline Indicus Report

# The Ahmedabad-Mumbai corridor

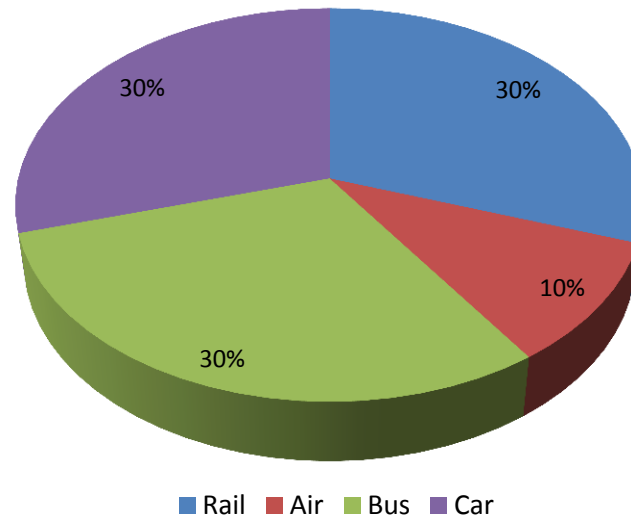
## NATURE OF TRAFFIC



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Corridor generated about 75 bpkm in 2011-12

Share of mobility along the corridor 2011-12



Air registered a 37% growth rate followed by road (6%) and rail (5%) along this corridor

(CAGR: 2008/9-2010/11)



# The Ahmedabad-Mumbai corridor

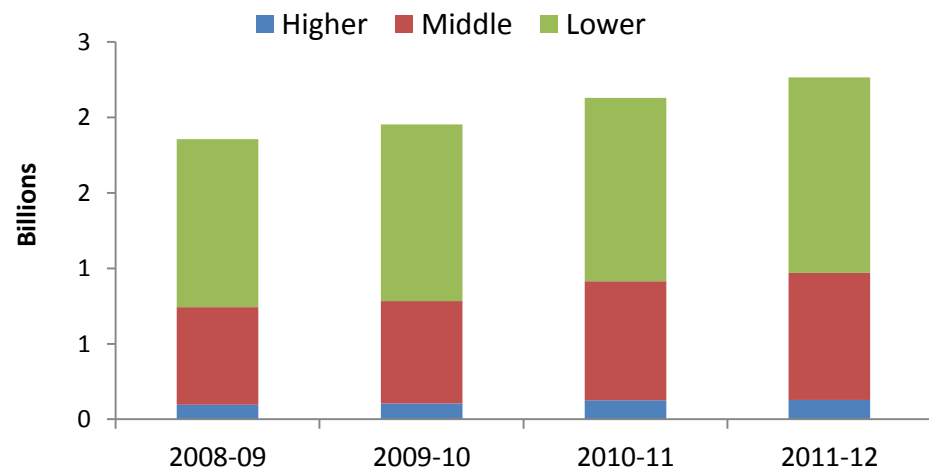
## RAIL TRAFFIC



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- 6.2 million passengers travelled on reserved rail categories in 2011-12
- Growth of passenger kilometers on various classes (CAGR: 2008/9-2010/11)
  - **Higher - 7.62%**
  - **Middle - 6.79%**
  - **Lower - 3.85%**
- Higher journey classes have higher leads (404km-373km-348km)

Traffic on railways (PKM)



Class types combined:

**Higher:** 1A, 2A, EC; **Middle:** 3A, 3E, CC; **Lower:** SL, 2S

Fastest end to end travel time on  
railways: 6h 25min



# The Ahmedabad-Mumbai corridor

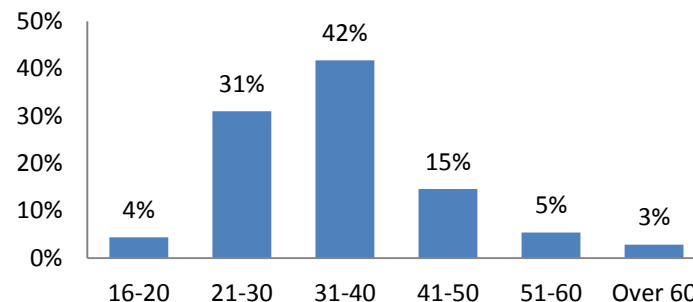
## RAIL – GLIMPSE AT PASSENGER PROFILES



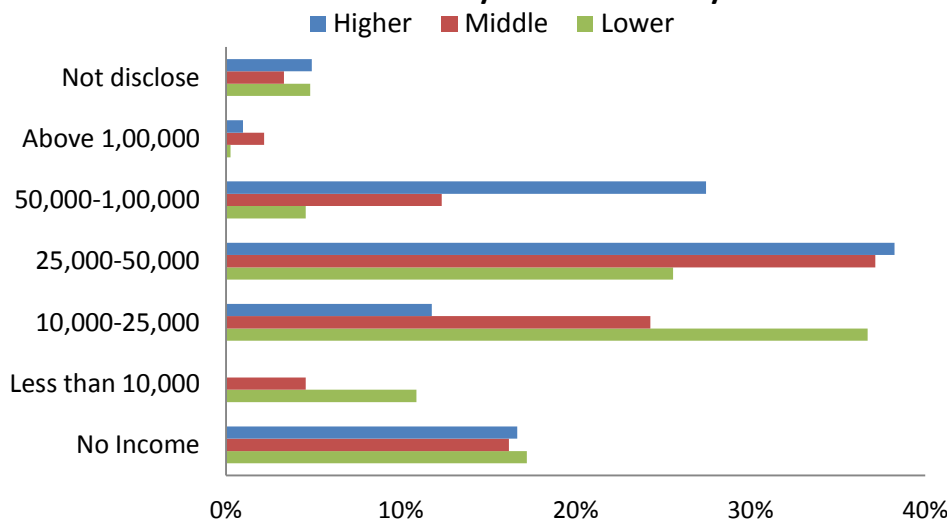
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- Conducted a primary face to face passenger survey on-board trains
- 73% of the respondents were in the ages between 21 and 40 years
- Largely in private services (44%) or self employed (25%)
- Highest share of total respondents in the income band of Rs. 25-50,000

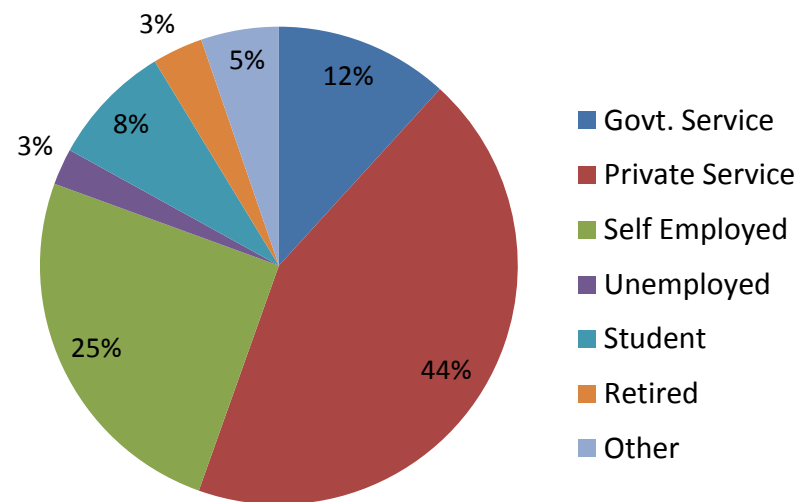
Age of respondents



Shares of monthly incomes by class



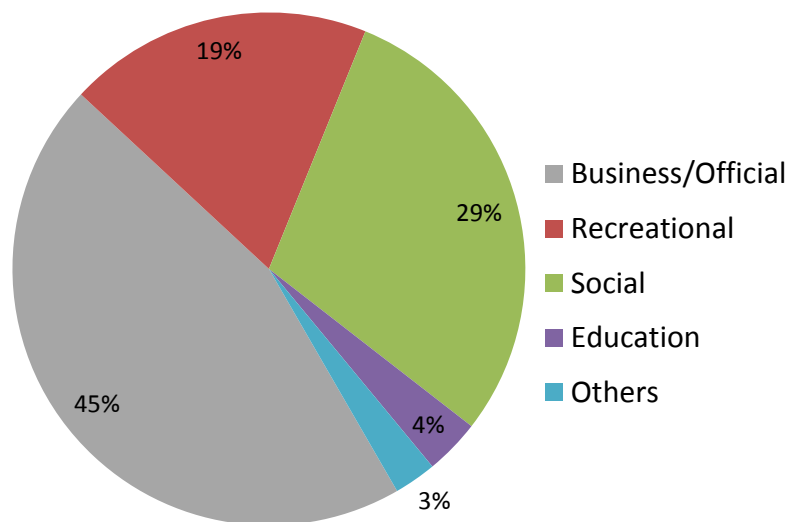
Occupation of respondents



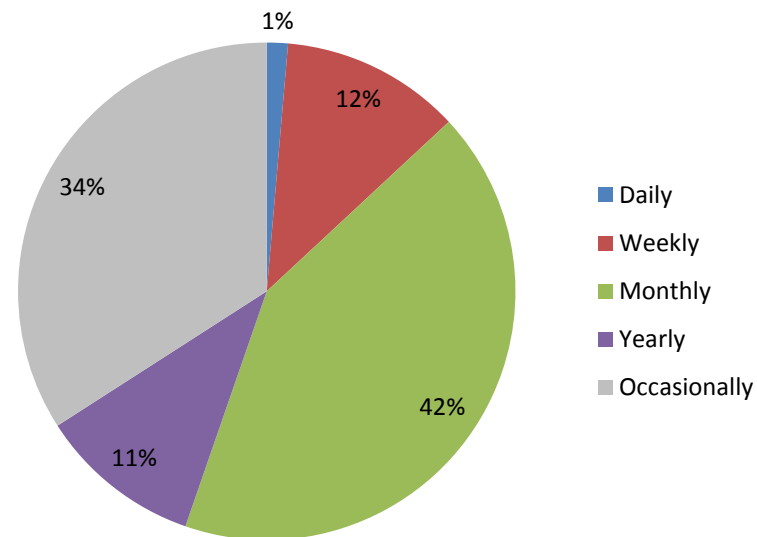
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## RAIL – GLIMPSE AT PASSENGER PROFILES

Purpose of travel by respondents



Frequency of travel



- 45% of the respondents were traveling for business or official purposes
- A large number of people were also traveling for social reasons

Large share of rail passengers surveyed were making this journey on a monthly basis and most of them were traveling on work

# The Ahmedabad-Mumbai corridor

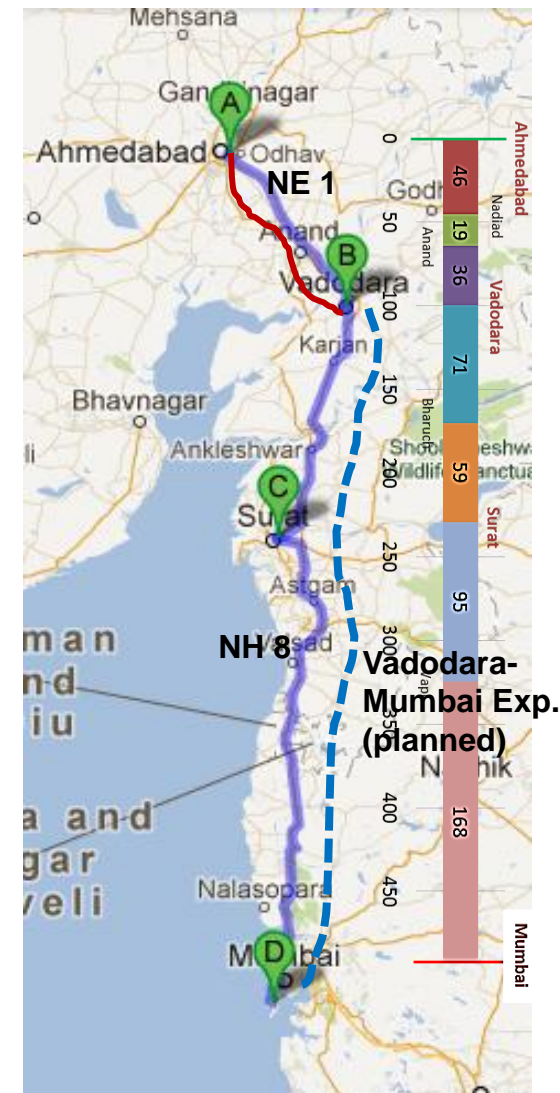
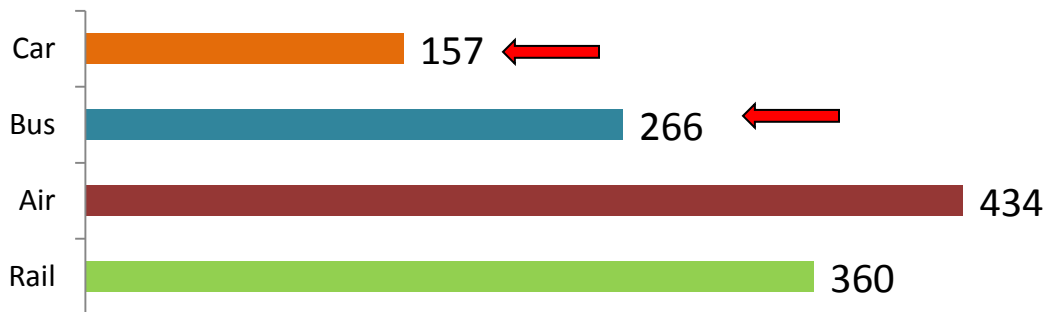
## ROAD TRAFFIC



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- Car traffic (2011-12)
  - An average of 38,419 people traveled on cars/vans/jeeps along the highways and expressways everyday
  - Vehicle occupancy of 3.42 persons\* on the route
- Bus traffic (2011-12)
  - About 8.5 million people traveled on intercity buses

Average leads of different transport modes (km)



\* RITES: Total Transport System Study on Traffic Flows & Modal Costs (Highways, Railways, Airways & Coastal Shipping),

# The Ahmedabad-Mumbai corridor

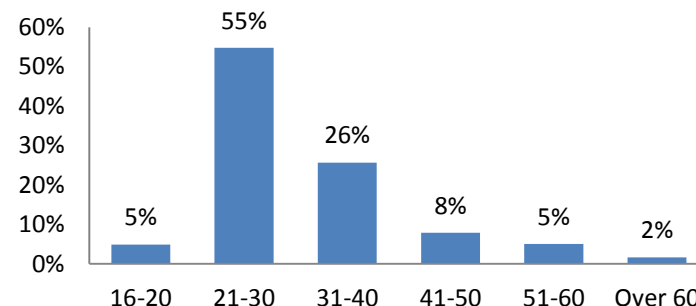
## BUS TRAFFIC – PASSENGER PROFILES



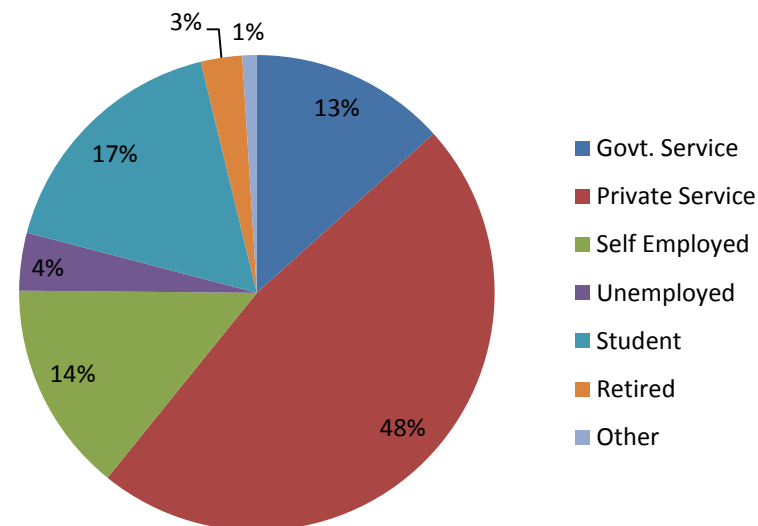
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- Conducted face-to-face surveys at bus terminals across four cities
- Mostly young travelers - 55% respondents between 21 and 30 years
- Greater percentage of respondents were students as compared to the railways
- Respondents had on average, lower incomes than those on the railways

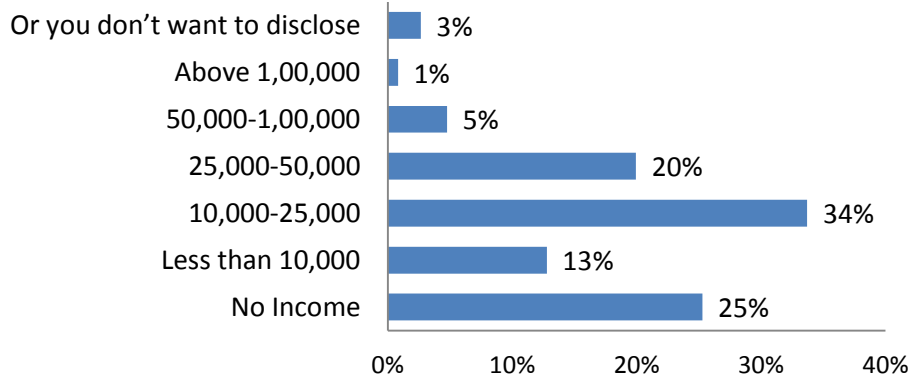
Age of respondents



Occupation of respondents



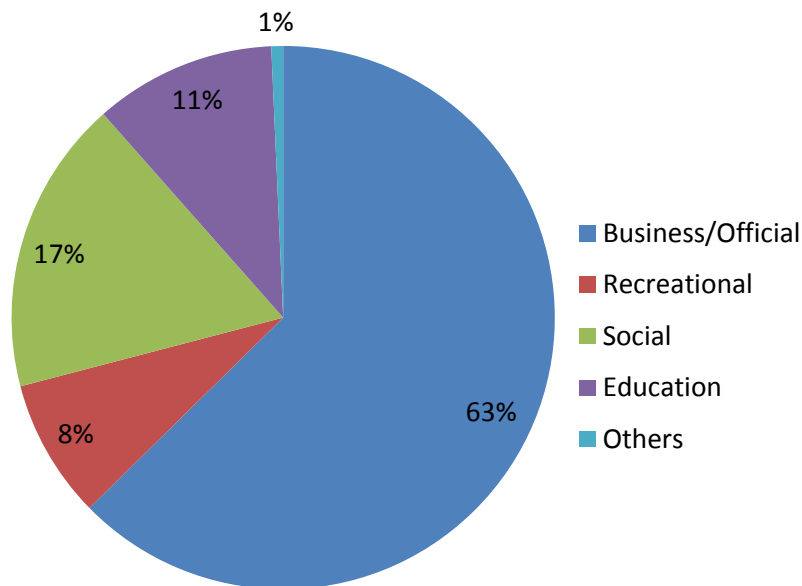
Shares of monthly incomes



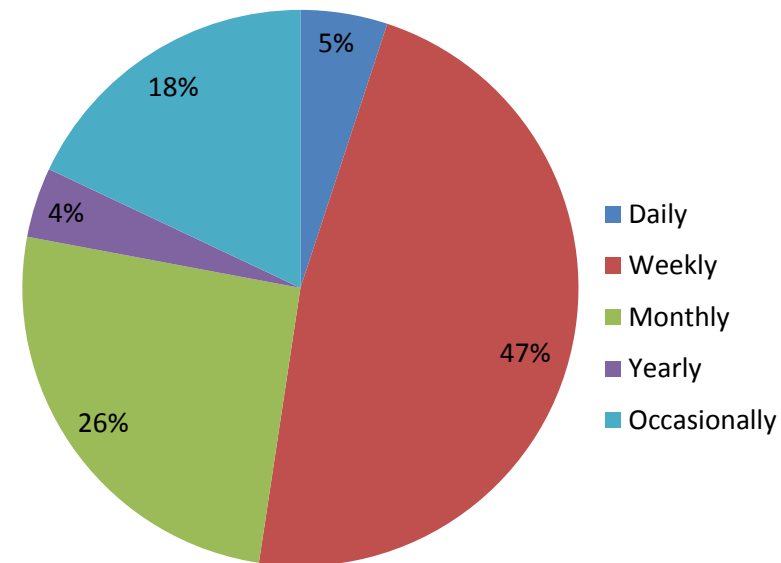
# The Ahmedabad-Mumbai corridor

## BUS TRAFFIC – PASSENGER PROFILES

Purpose of travel by respondents



Frequency of travel



- 63% of the respondents were traveling for business or official purposes
- Most of these respondents made trips along this corridor once a week

High share of bus passengers surveyed along this corridor were young and booked their tickets at the time of journey

# The Ahmedabad-Mumbai corridor

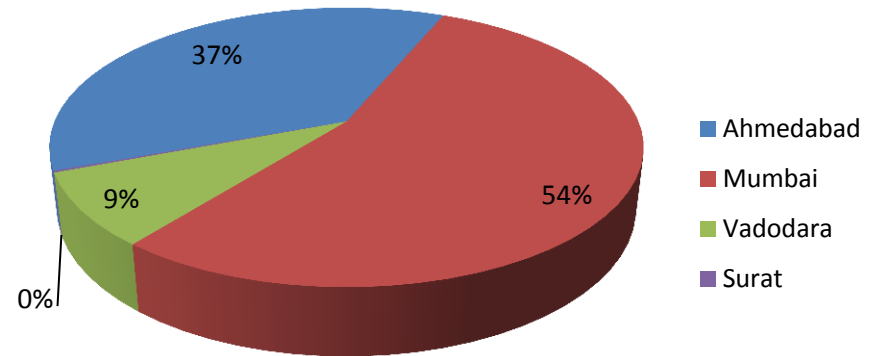
## AIR TRAFFIC



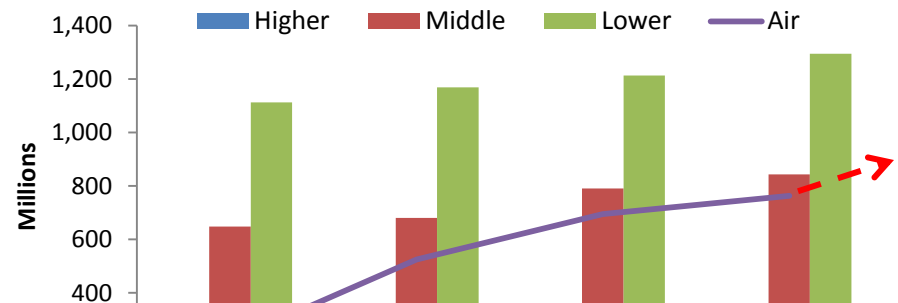
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- 1.76 mn passengers travelled by air in 2011-12
- Mumbai-Ahmedabad accounts for 80% of the traffic
- Rapid growth of aviation passengers
- New airports in the anvil
- **At this rate the mobility on air would exceed the mobility on medium classes of the railways by 2012-13**

Share of originating air traffic  
2011-12



Growth of air and rail traffic



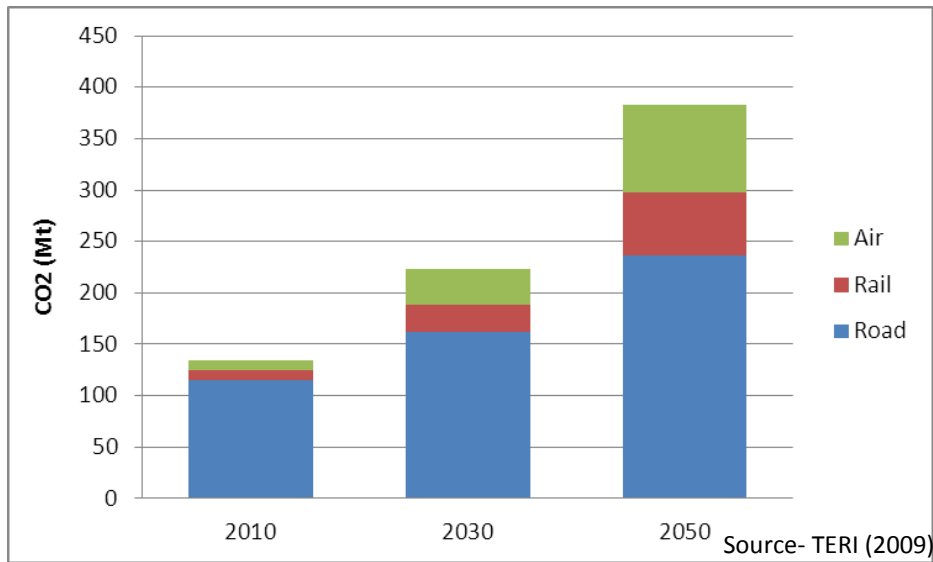
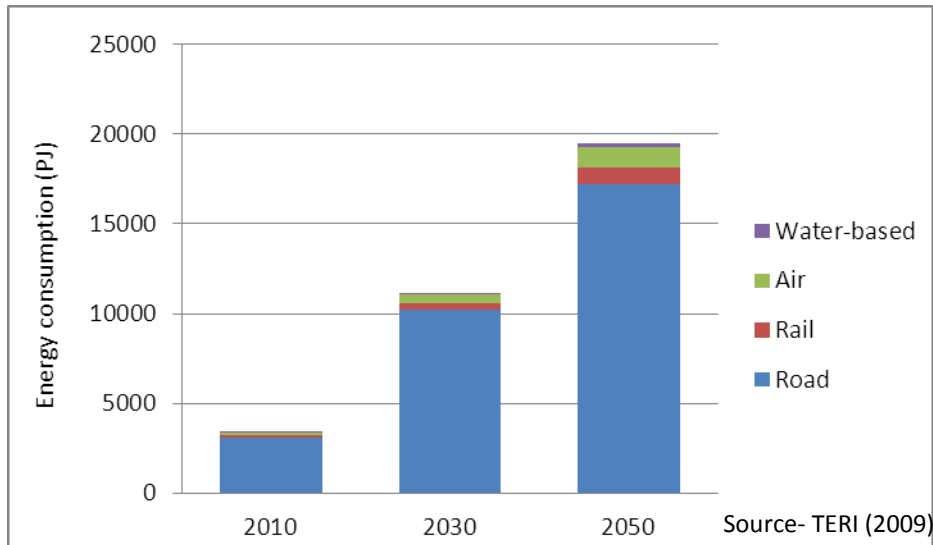
This growth of passenger traffic driven by growth in air and road traffic is unsustainable in the long run

# National energy mix for transport is unsustainable



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- 6 times increase in energy consumption from 2010 to 2050 expected
- 90% energy consumption by road transport sector
- Heavy dependence on petroleum products (95%)
- 80% energy demand will be met by diesel
- 3 times increase in CO<sub>2</sub> emissions from 2010 to 2050 expected
- Road and air transport - key contributors to CO<sub>2</sub> emissions





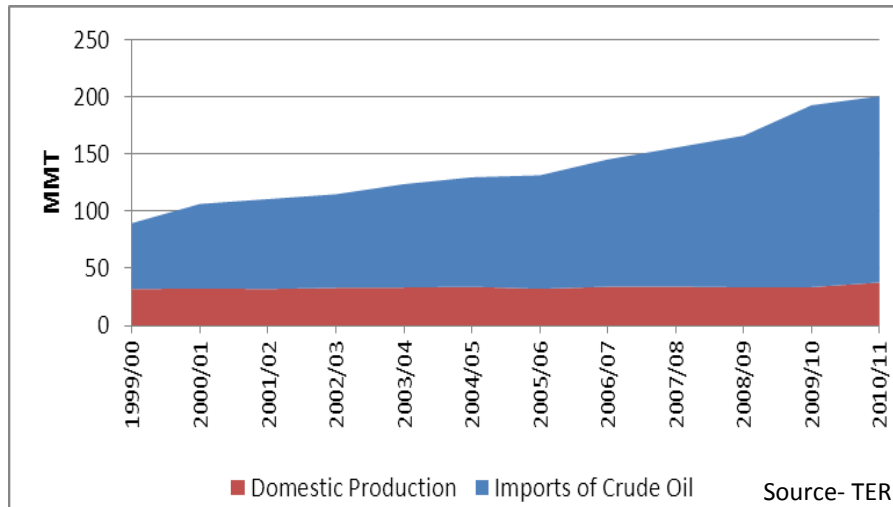
# Trends not sustainable from the perspective of energy security



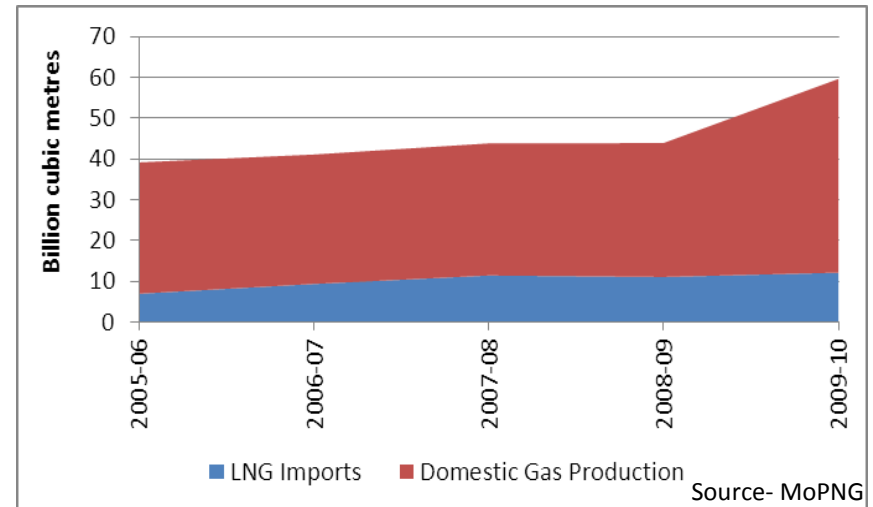
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- India imports almost 80% of its total crude oil requirements
- Import dependence expected to reach almost 90% by 2031-32
- More than 20% of the domestic gas requirements are met through imports

Domestic production and imports of crude oil



Domestic production and imports of natural gas



# The Ahmedabad-Mumbai corridor

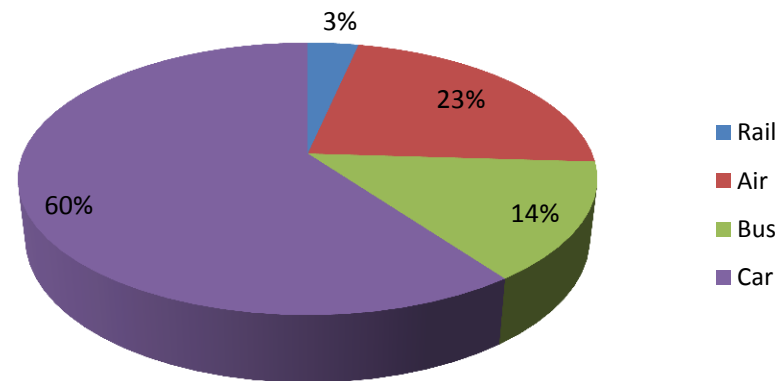
## ENERGY USE IN TRANSPORT



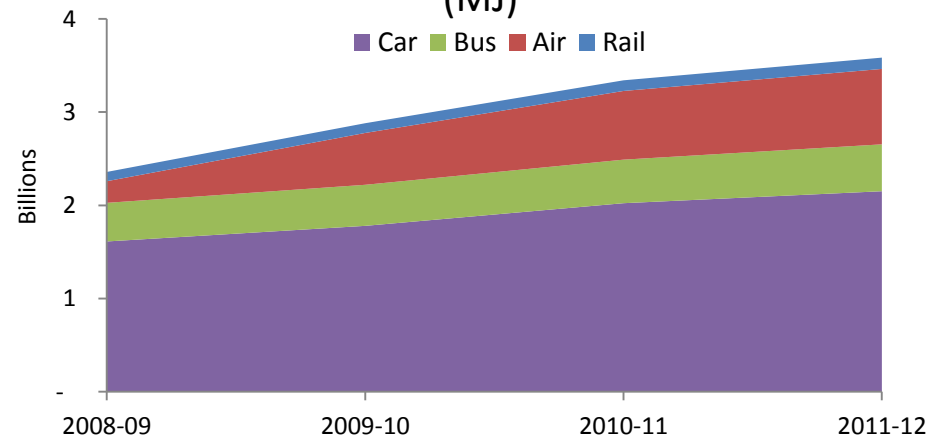
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- Road traffic consumed almost 75% of the energy used
- Cars: 30% traffic -> 60% energy
- Air: 10% traffic -> 23% energy
- Rail, most efficient with 30% traffic and only 3% of the energy used
- Over 90% of the energy needs are being met by petroleum sources

Share of energy use on different modes  
2011-12



Growth of energy use on various modes  
(MJ)



# The Ahmedabad-Mumbai corridor

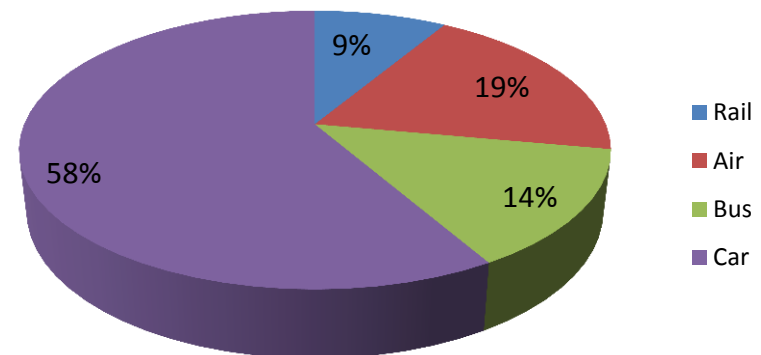
## EMISSIONS FROM TRANSPORT



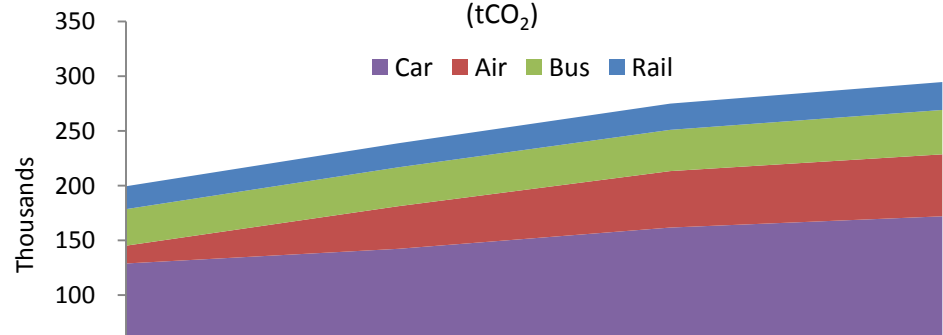
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- Road traffic –72% of the emissions
- Diesel use among cars – causing large amount of emissions
- Air generating a disproportionate amount of the emissions
- Rail - 30% of the passenger traffic with

Share of CO<sub>2</sub> emission from different transport modes  
2011-12



Growth of emissions on different transport modes  
(tCO<sub>2</sub>)



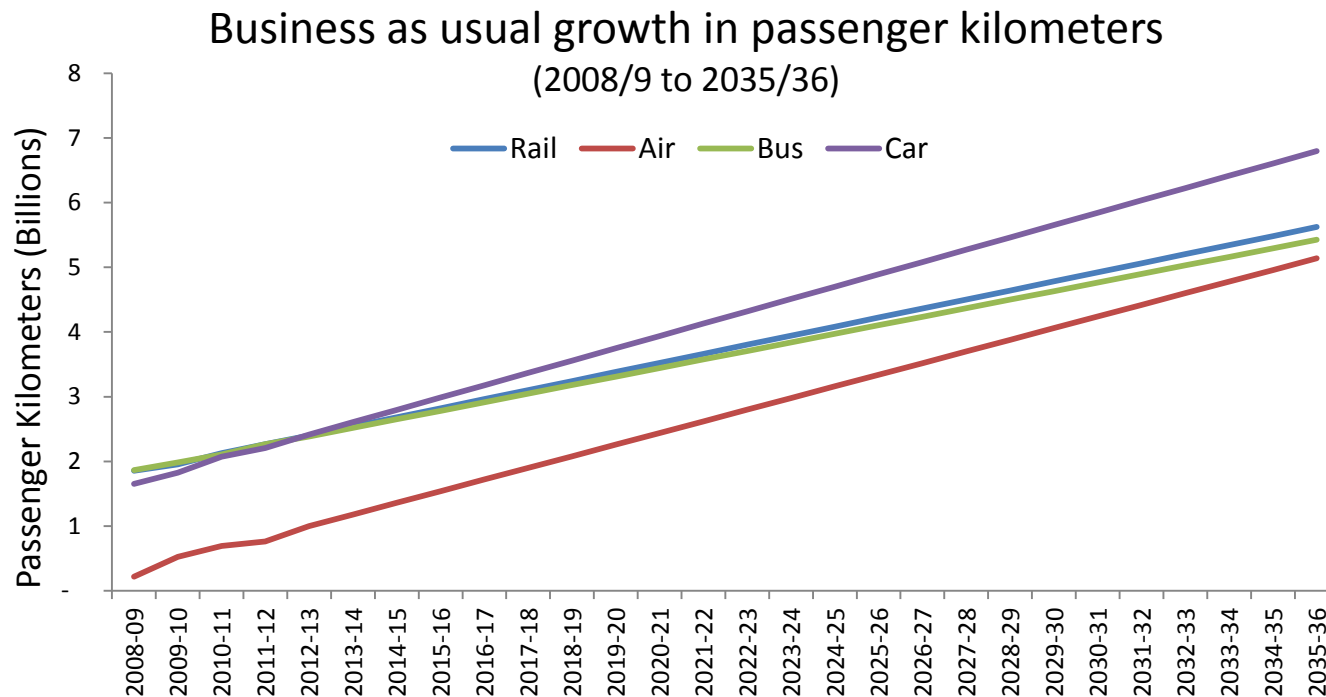
Need to reduce energy consumption from transport sector –  
Need to adopt alternative growth pathways for passenger transport sector

# The Ahmedabad-Mumbai corridor

## BAU TRAFFIC GROWTH TRENDS



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- Modal share of air to reach 23% (2035-36) from just 10% (2011-12)
- Largest share of the traffic would still be carried on roads (53%)
- Traffic share on cars would be retained at 30% of total traffic

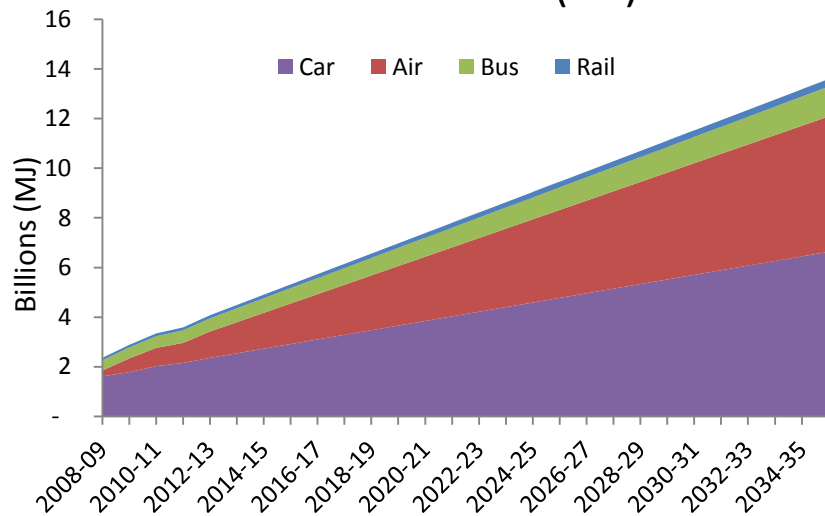
# The Ahmedabad-Mumbai corridor

## BAU ENERGY AND EMISSIONS TRENDS

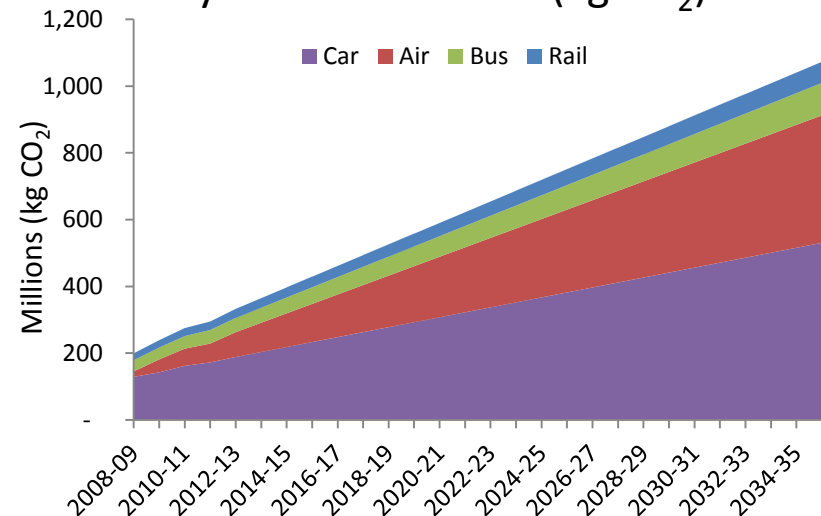


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BAU trends in energy use by  
different modes (MJ)



BAU trends in CO<sub>2</sub> emissions use  
by different modes (kg CO<sub>2</sub>)



- The on-road traffic would be using 58% of the energy for transport along this corridor by 2035-36
- By 2035-36 air would need 40% of the energy with only 23% of the mobility; Rail - 2% energy -> 25% of the mobility

Corridor trends of energy and emissions mirror national trends.  
Need to move more people to rail based mass transport systems.

# A possible solution

## INTRODUCTION OF HSR



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- Reduced energy use due to modal shift

Energy efficiency:

- 8.5 times airplane
- 4 times car
- 3 times bus

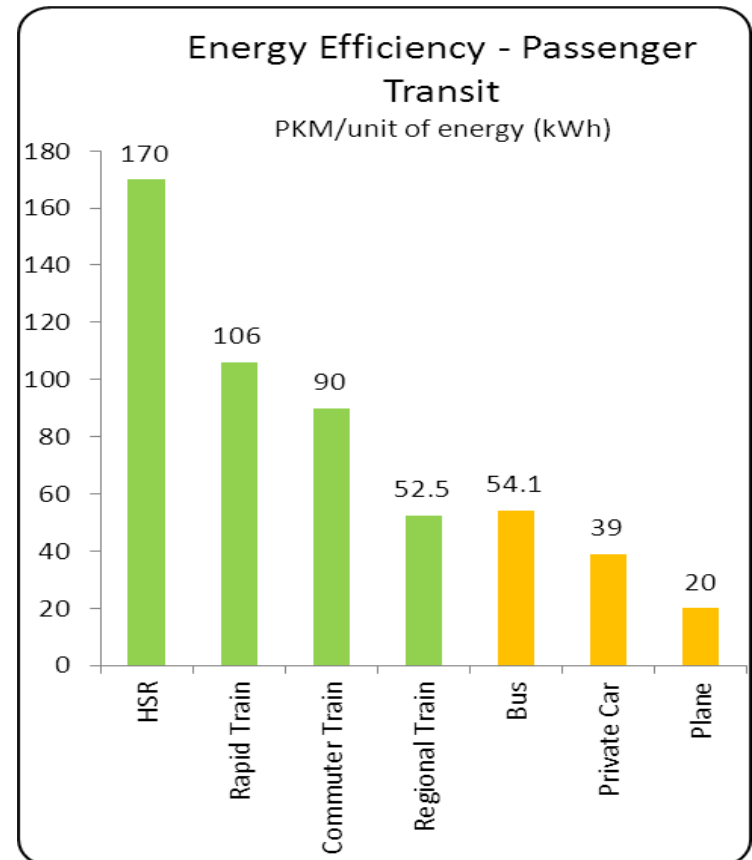
- Reduction in carbon emissions

CO<sub>2</sub> emissions (kg) per 100 PKM

- Airplane: 17
- Car: 14
- HSR: 4

- Time savings

- Could act as catalyst for economic growth, facilitate regional development



Source: UIC HSR Presentation by Jean-Pierre Loubinoux 2009

If introduced, with all its advantages, would people be willing to travel by HSR?

# The Ahmedabad-Mumbai corridor

## MODAL SHIFT TO HSR

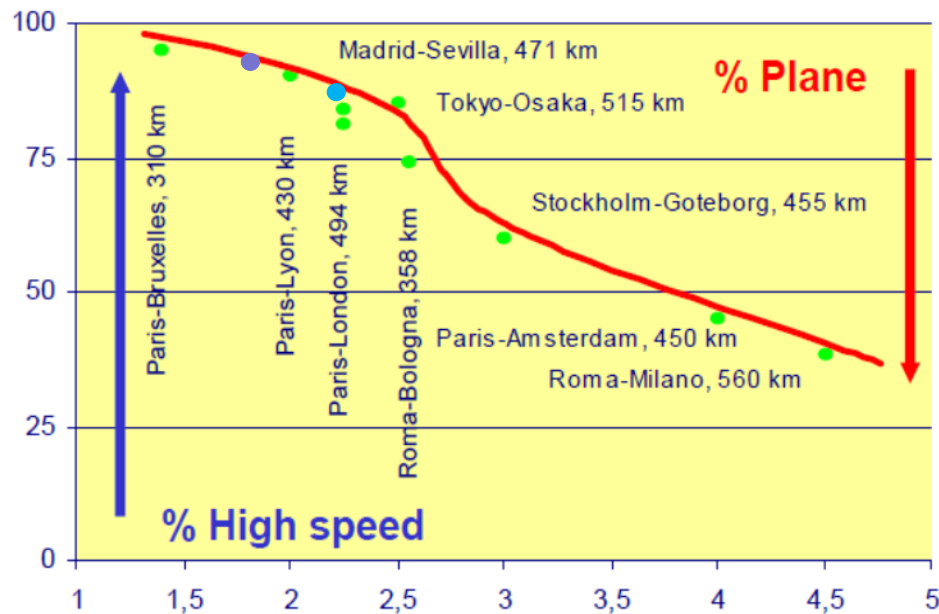


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### Air

- International experience show HSR passengers prefer to travel by HSR for journeys with travel time less than 3 hours

#### Relationship between rail speed and market share



Source: UIC-High Speed Presentation by Jean-Pierre LOUBINOUX 2009

- About 80% of the passengers between Ahmedabad and Mumbai can be expected to shift to HSR

# The Ahmedabad-Mumbai corridor

## MODAL SHIFT TO HSR

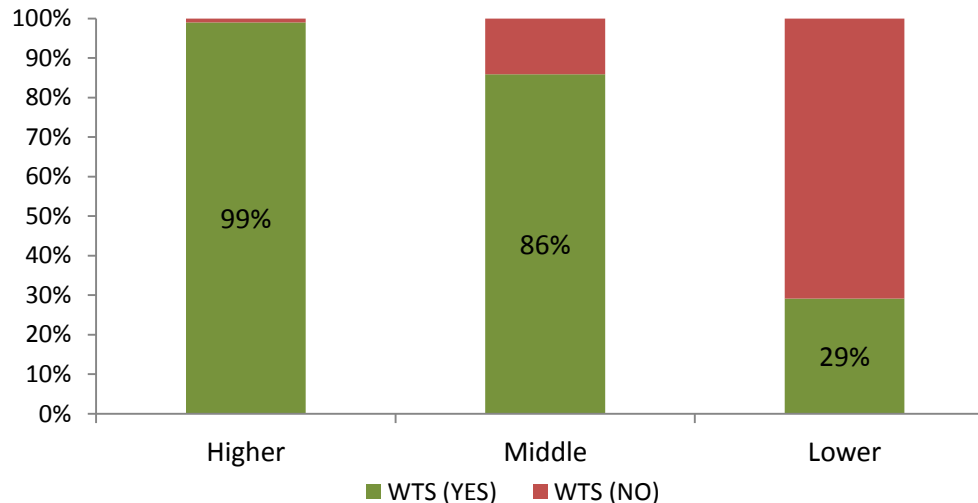


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### Rail

- Conducted primary surveys on board trains and on platforms to understand willingness of current passengers to shift to HSR if introduced
- About 98% passengers said that they would be willing to shift to HSR
- But smaller percentage were willing to pay for HSR services

Willingness to shift and pay for HSR





# The Ahmedabad-Mumbai corridor

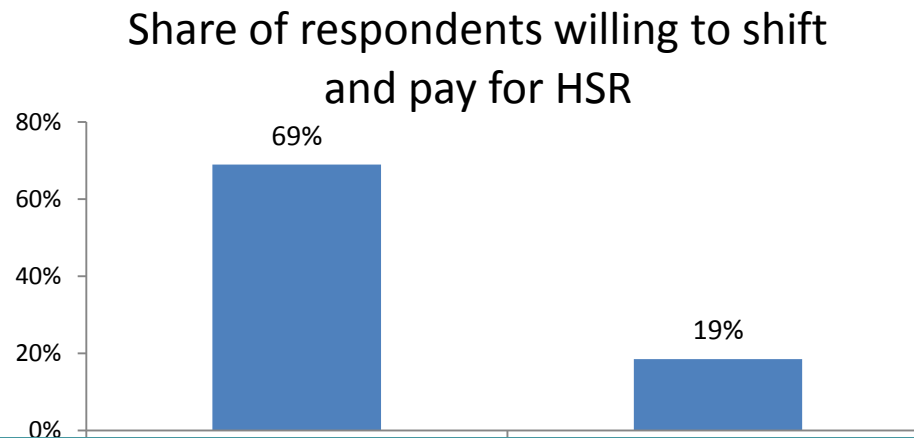
## MODAL SHIFT TO HSR



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### Road

- Conducted primary surveys at bus terminals to understand willingness of current passengers to shift to HSR if introduced
- About 69% passengers traveling on luxury bus classes said they would shift to HSR and pay
- From the Japanese experience of the Shinkansen, about 15% of car users shifted to HSR



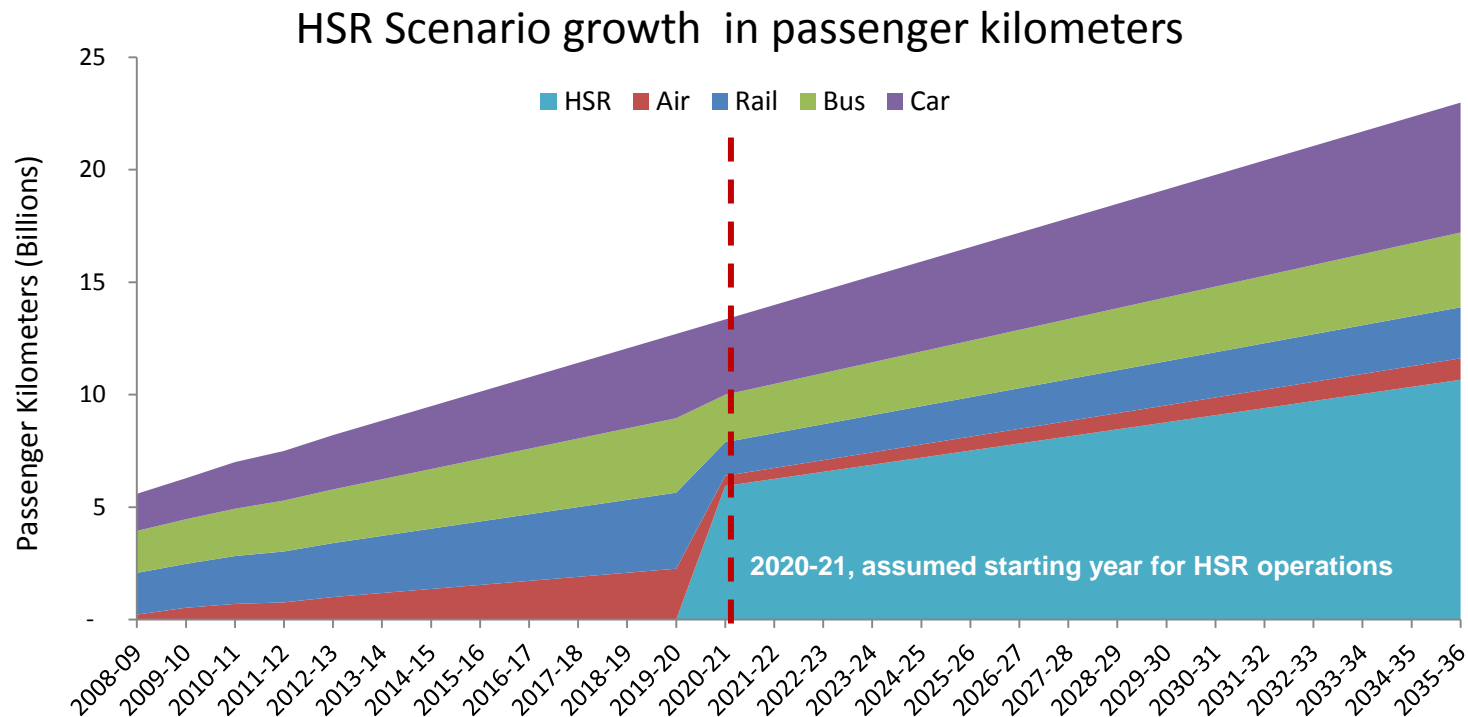
Based on these assumptions an alternate scenario was built to evaluate the impact of HSR along this corridor

# The Ahmedabad-Mumbai corridor

## TRAFFIC TRENDS WITH INTRODUCTION OF HSR



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- Large share of air and conventional rail passengers would shift by 2035-36
- 46% of corridor traffic is seen to move on HSR within 15 years of operation
- About 40% of the passenger traffic would still move on roads (car: 25%, bus: 15%) in 2035-36

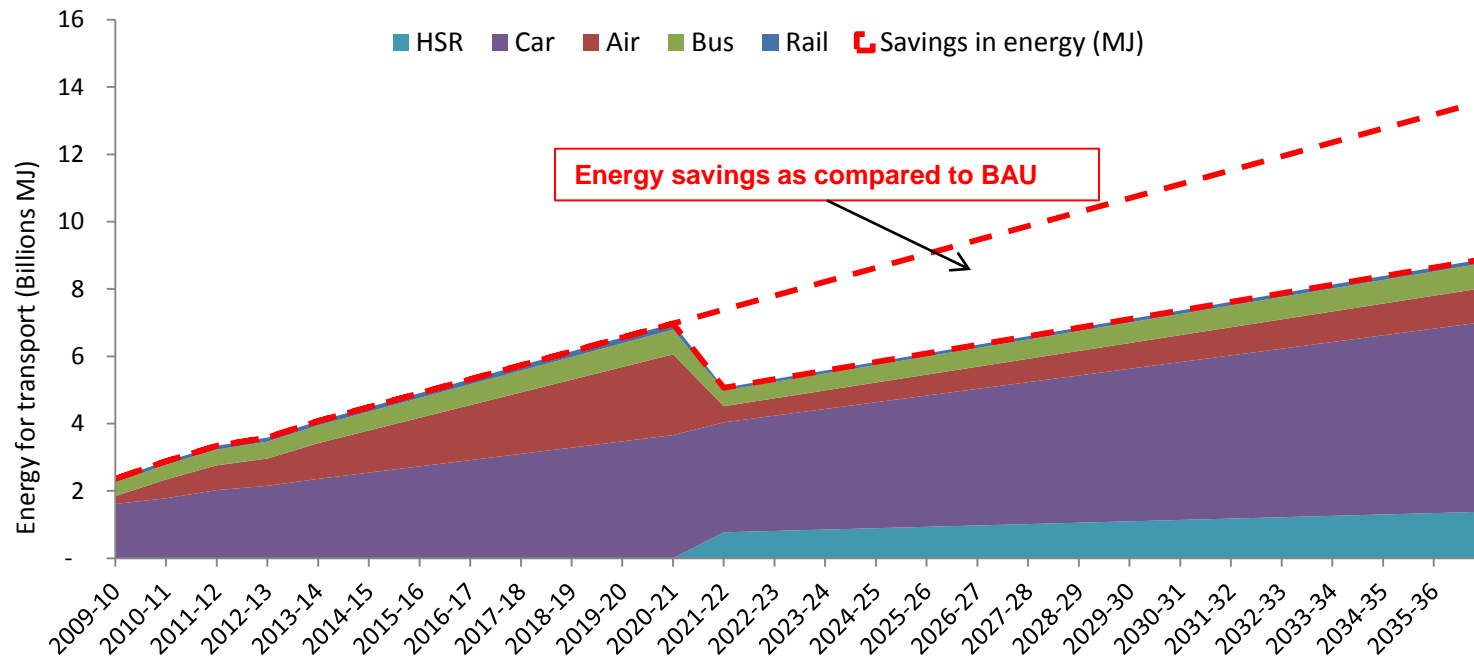
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## ENERGY TRENDS WITH INTRODUCTION OF HSR



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HSR scenario growth in energy use by different modes (MJ)

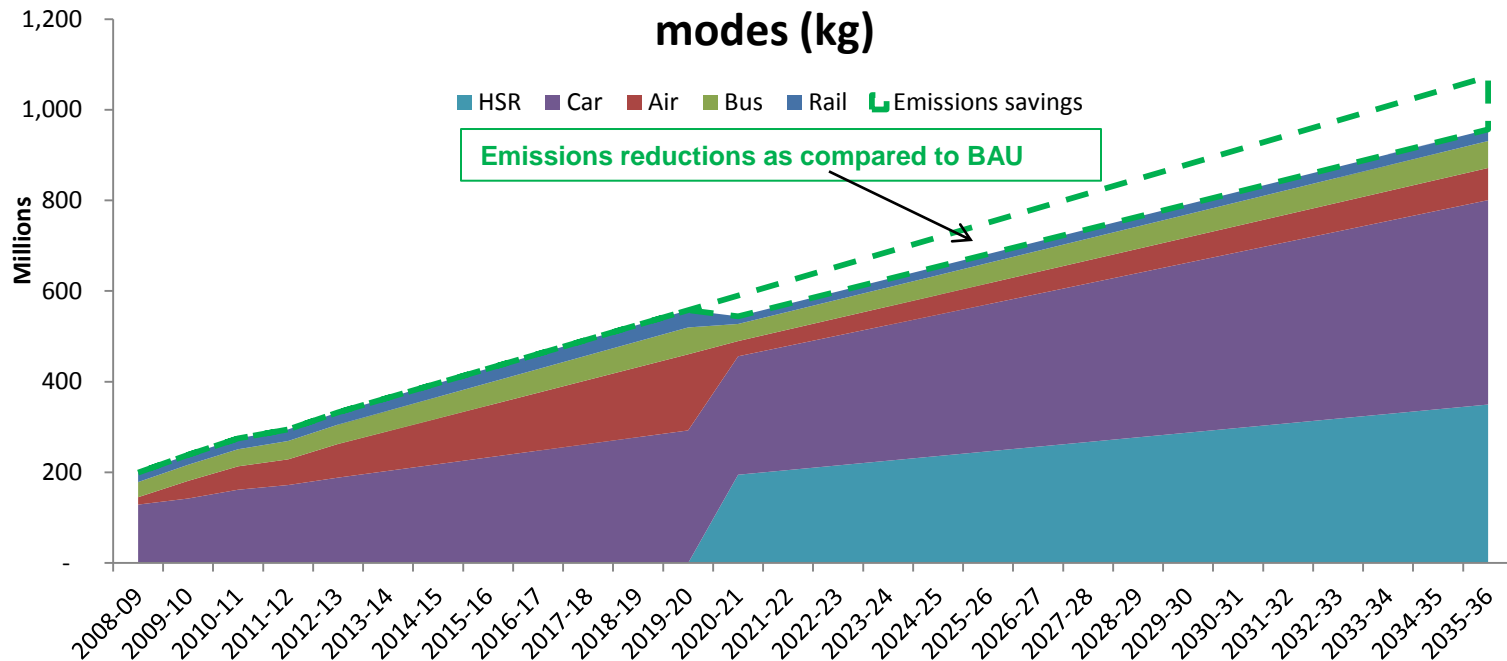


- This scenario results in an annual average savings of about 3.5 PJ over a 15 year period
- By 2035-36, HSR services would carry about 46% of the total traffic by consuming only 16% of the energy
- Road transport would still continue to consume the largest share of energy

# The Ahmedabad-Mumbai corridor

## EMISSIONS TRENDS WITH INTRODUCTION OF HSR

**HSR scenario growth in CO<sub>2</sub> emissions use by different modes (kg)**



- A 10% reduction of emissions per annum over BAU
- Annual average emissions reduction of about 81,040 tCO<sub>2</sub> over a 15 year period
- Impact on emissions due to HSR is dampened due to heavy coal based energy generation – need to move towards non-fossil fuel energy sources

# Summary



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- High Speed Rail is definitely one of the solutions to meet the rapidly increasing demands for mobility along this corridor
  - **Large energy savings**
  - **Man hours savings**
  - **Increased safety**
  - **Reduced total emissions**
- New technologies for electricity generation should be explored to realize the complete benefits of HSR



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THANK YOU