High Speed Rail in India

Selection of corridors and Impacts on energy and emissions*

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iCED, Jaipur
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*Emissions throughout this presentation refer to CO₂ emissions from operations only
• Very fast growth in passenger transport activity


• Growth drivers: population, economy, urbanization, motorization

286 Rail BPKM (1990) → 1,147 Rail BPKM (2015) **

* Total number of registered cars and jeeps in India; source: Basic Road Statistics, MoRTH; ** Data from the IR

The absolute growth in mobility has been very rapid specifically in the last decade
Reducing energy intensity of transport (recap)

• Inter-city/long distance passenger transport – Shift from roads/air to railways
• Intra-city/short distance transport – Shift from private modes to public modes
• Improvements in vehicle fleets – vehicle efficiency and emission reduction
• Phasing out old vehicular fleet
• Establishing strict inspection and maintenance regime for in-use vehicles
• Promoting use of alternative/clean fuels and technologies
• Measures for urban areas like TDM, ITS, etc.
Impact of energy efficient options

- 40% reduction in energy consumption can be achieved by implementing energy efficient options

- Reductions mainly a result of:
  - Inter-modal shift from roads to rail
  - Shift from private modes to public modes within road sector

Inter-modal share of Railways in the alternate growth scenario envisaged at 50%

Source: TERI (2009)
India’s large urban agglomerations

- Already 8 urban centers have populations greater than 5 million people
- By 2030
  - At least 6 ten million plus cities
  - 6 to 11 five million plus cities

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

Map based on Census 2011 data
Originating passengers for the Railways

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

Map based on PRS data for period: 01-SEP-09 TO 31-AUG-10
Originating passengers for the Airlines

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

Map based on data from DGCA for year 2011-12 – Data does not include information for Indian
Air data does not include data from Indian

- Distinct heavy passenger use corridors emerge
- Capacity constraint of rail would mean traffic will move to air and road
Increasing Railways’ share -
Need increased rail capacity at fast pace

Two key solutions

• Improve the existing rail network in terms of commercial speeds and quality of services - create more capacity for passenger services

• Introduce new high-speed passenger rail network
Identification of potential HSR corridors in India

- TERI-ITPS study tried to determine the potential corridors for HSR in India
- There were several overlapping corridors with the Govt. links
- Detailed study on two corridors:
  - **Western Corridor**
    - Ahmedabad – Mumbai – Pune
  - **Southern Corridor**
    - Chennai – Bangalore - Coimbatore

<table>
<thead>
<tr>
<th>Economic &amp; social parameters</th>
<th>Corridor specific</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per capita GDP</td>
<td>Corridor length/time</td>
</tr>
<tr>
<td>Population densities</td>
<td>Number of cities on corridor</td>
</tr>
<tr>
<td>Population growth rates</td>
<td>Intercity OD traffic volume</td>
</tr>
<tr>
<td>Historic connectedness</td>
<td>Capacity along the corridor</td>
</tr>
</tbody>
</table>

Map sourced from TERI-ITPS study titled "A Study on the Mid/Long-Term Railway Networks in India Phase II".
The western corridor - a quick snapshot

The Western Corridor
Ahmedabad – Vadodara – Surat – Mumbai – Pune

Road
- 95 km Ahmedabad-Vadodara Expressway (1.5 hours)
- 93 km Mumbai-Pune Expressway (2 hrs)
- Ahmedabad - Pune corridor coming up connecting Vadodara, Surat and Mumbai

Rail
- Ahmedabad, Vadodara, Surat, Bharuch, Valsad, Borivali, Dadar, Mumbai Central & Pune
- 30 trains runs along the Ahm to Mum, 15 - superfast, 11 - Express, 4 Rajdhani, Shatabdi & Duronto

Air
- All the cities along the corridor are connected by air with center at Mumbai

Section 1: Ahmedabad to Mumbai
Section 2: Mumbai to Pune
The southern corridor - a quick snapshot

The Southern Corridor
Chennai – Bangalore - Coimbatore

Road
- High density passenger network on roads – SRTUs and private operators
- NHAI is expanding the road from 4 to 6 lanes between Chennai and Bangalore – DPR is ready
- Expressway being planned independently between Chennai – Bangalore and Chennai – Coimbatore

Air
- There are about 9 flights daily between Chennai-Bangalore and 3 between Bangalore and Coimbatore
- Since Bangalore airport is 40 km away from the city center it takes approximately the same time between the cities on air as it takes on the road

Rail
- 17 trains between Chennai and Bangalore and 13 trains between Bangalore – Coimbatore (no Shatabdi)

Section 3: Chennai-Bangalore
Section 4: Bangalore-Coimbatore
Section 5: Coimbatore-Chennai

Chennai – Bangalore 327.6 km
Bangalore – Coimbatore 372.0 km
Chennai – Coimbatore 530.0 km
THE AHMEDABAD-MUMBAI CORRIDOR
Ahmedabad-Mumbai
7.94 BPKM in 2011-12

- 58% of the traffic moves on the roads
- Aviation grew at almost 37% (CAGR) between 2008/09 and 2011/12
- Traffic on cars and jeeps have almost caught up with that on the railways
The Ahmedabad-Mumbai corridor

RAIL TRAFFIC

- 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)

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

Primary surveys were conducted on day passenger superfast trains that started and terminated between Ahmedabad and Mumbai Central. Sample size: 1461
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
About 12 million people travel on intercity buses along this corridor (2011-12)

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

Primary surveys were conducted at bus terminals in Ahmedabad, Vadodara, Surat and Mumbai. Sample size: 712
The Ahmedabad-Mumbai corridor
BUS TRAFFIC – PASSENGER PROFILES

- 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

- 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
- Mobility on air at par with the mobility on medium classes of the railways

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

Primary surveys were conducted on day passenger superfast trains that started and terminated between Ahmedabad and Mumbai Central. Sample size: 1461
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 was assumed to shift to HSR

Primary surveys were conducted at intercity bus terminals in Ahmedabad, Vadodara, Surat and Mumbai. Sample size: 712
The Ahmedabad-Mumbai corridor
MODAL SHIFT TO HSR

Air

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

![Graph showing the relationship between rail speed and market share.](image)

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

Based on these assumptions an alternate scenario was built to evaluate the impact of HSR along this corridor
After 15 year of operations likely shares of traffic on this corridor would be

- 46% on HSR
- 40% on roads (car: 24%, bus: 16%)
- 4% on air and 10% on conventional rail
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

- A 10% reduction of emissions per annum over BAU
- Annual average emissions reduction of about 81,040 tCO₂ 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
HOW DO THESE IMPACTS VARY ACROSS OTHER SECTIONS?
Traffic shares
VARIOUS SECTIONS in 2011-12

Mumbai-Pune: 6.41 BPKM

Chennai-Bangalore: 3.99 BPKM

Bangalore-Coimbatore: 1.35 BPKM

Coimbatore-Chennai: 4.57 BPKM
Changing shares of traffic
COMPARING DIFFERENT SECTIONS

Not many car users are expected to shift, mostly bus users.

Bus shares could go down from the present 72 per cent to as low as 10 per cent.

Large shift from bus and conventional rail.

HSR shares could grow to as high as 52 per cent on account of conventional railways.
Energy use patterns
COMPARING DIFFERENT SECTIONS

Energy requirements by different modes with HSR Mumbai-Pune (MJ)

Trend of energy use on different modes Bangalore-Chennai (HSR) (MJ)

Trend of energy use on different modes Bangalore-Coimbatore (HSR) (MJ)

Trend of energy use on different modes Chennai-Coimbatore (HSR) (MJ)
Where large shifts are expected from conventional rail and buses, there is a decline in the emissions benefits of HSR.
Key takeaways

1. High Speed Rail is one of the solutions to meet the rapidly increasing demands for mobility along these corridors.
2. It will also help in achieving energy savings - however the level of savings would depend on the nature of modal shifts.
3. Introduction of HSR may not result in decreased emissions in all cases.
4. Electricity generation from dirty fuels like coal could reduce the overall benefits of HSR - need to move to renewables.
5. The selection of HSR corridors should be done on a case by case basis after thoroughly understanding the traffic patterns along each section.
THANK YOU

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Transport and its link with energy and emissions

*Energy Management and the Transport Sector*

**Sarbojit Pal**
Fellow
The Energy and Resources Institute (TERI)
Energy consumption in all end use sectors projected to reach a level of about 740 quadrillion Btu by 2035, a 1.5 times increase as compared to 2007 level.

Transport will continue being the second largest energy consuming sector after industry.

95% of the total energy used in transport sector globally comes from petroleum.

Sector was responsible for 23% of the world’s energy-related GHG emissions (6.3 Gt) in 2004, about three quarters of which came from on-road vehicles.

Transport sector’s GHG emissions have increased at a faster rate than any other energy using sector during the last one decade.

1 Quadrillion BTU = 23.57 × 10^6 mtoe

Transport sector will be responsible for 60% of the world’s liquid fuel consumption in 2035.

Source – EIA (2010); Photo credit – Lohia (2009)
ROAD TRANSPORT
Main consumer of energy within transport sector

- Road transport sector responsible for \( \frac{3}{4} \)th of transport sector’s energy consumption and emissions

Source – IPCC (2007)
Global energy-related CO₂ emissions expected to increase to about 40Gt by 2030

Emissions from transport sector would be around 9Gt (23%) despite significant mitigation policies built into the reference scenario.

Share of non-OECD countries in the total global CO₂ emissions from transport sector in 2004 was 36%. This is expected to increase to 46% by 2030 if the current trends of transport growth in these countries continue.

Source – IPCC (2007); Photo credit – IRF (2009)
Future growth of motor vehicles:

- Globally, an average annual increase of about 3% expected

- Europe to experience slowest rate of car growth (less than 1% per year)

- Rate of growth in United States expected around 1-2% per year

- China and India to experience much faster annual growth rates of more than 7 or 8% per year

Source – Sperling and Gordon (2008)
RISE OF PERSONAL VEHICLES
Linked to economic growth

> Personal vehicles per thousand population in developing countries increases with economic growth

Largest growth in energy demand in transport sector would be in developing countries
TRANSPORT AND ENVIRONMENT

Other Impacts

- Emissions
- Congestion
- Air pollution
- Health
- Accidents
- Parking

Largest impacts of these effects are felt in developing countries

Photo credits – Lohia (2009); www.hindu.com
INDIAN SCENARIO
TRANSPORT SECTOR IN INDIA
Challenges magnified due to its scale and needs

- About 182 million registered vehicles (3rd highest in the world)
- Second highest road network (5.23 mil. kilometers in 2012/13)
- Highest railway passenger traffic (23 million passengers per day!)
- Fourth largest freight carrying railway system in the world
- Almost 8000 cities with over 55 million plus
- Public bus and rail based services available in only 68 cities

Largest volume of both passenger and freight traffic moves on road

Over 2 million road vehicles are sold every year

In 2012-13 motorized freight transport moved on:
- Roads (50%)
- Railways (36%)
- Pipelines (7.5%)
- Coastal shipping (6.4%)

Passenger traffic mostly moved on:
- Road (84%)
- Rail (15%)
- Air (1%)

Energy efficient railways consistently losing its share in both passenger and freight traffic

*TERI Estimates; #RITES Total Transport System Study on Traffic Flows & Modal Costs (Highways, Railways, Airways & Coastal Shipping)
Exact volumes of road transport traffic is difficult to determine in the absence of accurate road data.

Most studies however point to a declining share of Railways in both freight and passenger traffic.

Source: Planning Commission and TERI Estimates
Rail losing share even in core commodities

- Rail losing its share to road across a large number of commodities
- Coal, Iron Ore, Food-grain shares are flat or are increasing
- Cement and POL are major commodities where shares are declining
RAILWAYS
Efficient passenger transport mode

Operational CO$_2$ emission (g/PKM)

CO$_2$ emissions (g/PKM)


- The most environmentally benign mode of land transport
- Need to retain, and increase the share of railways
### RAILWAYS LOSING SHARE
Some key factors for share decline

<table>
<thead>
<tr>
<th>Sector</th>
<th>Year</th>
<th>Infrastructure supply (km)</th>
<th>Avg. annual growth rate of infrastructure supply</th>
<th>Demand in BAU (BPKM)</th>
<th>Avg. annual growth rate of demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rail</td>
<td>2010-11</td>
<td>Route kms - 64,015 28% double/multiple lines</td>
<td>3.9%</td>
<td>868</td>
<td>13.5%</td>
</tr>
<tr>
<td></td>
<td>2020-21</td>
<td>Route kms - 89,015 33% double/multiple lines</td>
<td></td>
<td>2,360</td>
<td></td>
</tr>
</tbody>
</table>

- Demand growth has outpaced infrastructure growth
- Investments in railways have remained low
  - Current suggestion is injection of Rs. 8.5L Cr. over next 5 years
- Non-competitive freight rates cross subsidizing passenger
- Passenger business getting stiff competition from airlines

Source: IR Vision 2020 for infrastructure supply and TERI Estimates for demand
LARGE CONSUMER OF ENERGY
Second only to industry sector

> Transport consumes 22% of the India’s commercial energy
> Most of the energy is consumed in the form of petroleum fuels

Source: TEDDY 2015
Disproportionate use of energy by roads

> Road transport meets ~50% of the freight and ~84% of the passenger mobility but consumes over 90% of the energy

Source: TERI Transport Model Estimates
ROAD TRANSPORT
Heavily reliant on petroleum products

- Single largest petroleum consuming sector in India
- Consumption in 2012-13*
  - ~100% of gasoline/petrol (15.7 MT)
  - ~70% of the diesel (48.42 MT)
  - Traces of LPG and CNG

*source: PETSTAT 2012-13 and PPAC; #MOEF (INCCA 2010 Study – India: GHG Emissions 2007)

- Inadequate energy supply to this sector can destabilize economic growth
- And increasing petroleum consumption by this sector can jeopardize national energy security

Source: All India Study on Sectoral Demand of Diesel & Petrol, PPAC 2013
ENERGY DEMANDS
Increasing demand for petroleum products

> India imports about 84% of its crude resources
> Rapidly increasing demand for petrol and diesel
> Leads to linked concerns of energy security and emissions

Source: MoPNG, 2013; PPAC, 2013; PPAC: 07-Feb-14
R O A D  T R A N S P O R T
Rapid growth in road vehicles in India

> Passenger vehicles have been growing at exponential rates
> Almost 30 per cent of registered vehicles are concentrated in 35 million plus cities
TRENDS OF CAR OWNERSHIP
Car ownership levels will continue to rise

With continued economic growth and urbanization similar situation will arise in other cities and rural centers

Source: Ghate and Sundar (2013)
LONG TERM IMPLICATIONS
A scenario of high energy and emissions

If current trends were to continue:
> 5 times growth in energy consumption
> 7 times growth in emissions generated
INDIA’s STEPS SO FAR FOR REDUCING ENERGY DEMAND AND EMISSIONS FROM THE SECTOR
For a developing and low income country like India, growth of transport sector is critical for meeting its development objectives.

Access and availability is still limited in many parts of the country – need to develop all modes.

Government’s current strategy include development of rail, road, air and water transport driven by the objective of providing choice for both passenger and freight mobility.

The sector has large scope to reduce energy intensities and GHG emissions and an energy efficient, low carbon transport path has large number of co-benefits.

Focus gradually shifting to make the sector more energy efficient and sustainable.
TRANSPORT POLICIES recognize the need for low carbon transport

- National Urban Transport Policy
- National Action Plan on Climate Change
- 12th Five Year Plan
- National Electric Mobility Mission
- Inland Water Transport policy
- Smart cities and new National Urban Renewal Mission
- INDCs

Need for having a holistic and integrated view of the sector to reap the largest benefits
Measures being pursued in India to reduce energy demand from road transport

- Improvement in vehicle efficiencies
- Aggressive implementation of emission norms
- Increasing public transport services

- Moving to energy efficient Hybrid and Electric Vehicles
- Removal of fuel subsidies
- Improvement in road quality
Efforts to reduce energy intensities of the road transport sector

> The fuel efficiency of new cars in India is 20-30% more than the global average, owing to its high share of small cars (UNEP, 2014)

> India has announced its first-ever automobile fuel efficiency norms for LMVs (below 3500 kg) in 2014 - corporate average fuel economy (CAFE) standards

> CAFE standards for cars are based on the corporate average kerb weight (CAKW) of the vehicles sold by the manufacturers applicable from 2017

> Fuel efficiency improvements in HDVs can result in substantial savings of the fuel (in the order of 65 MT annually by the year 2030)

> Fuel Economy Standards for HDVs are in the process of being formulated
Emissions norms and cleaner fuels

> Emissions norms critical for the health and well being of citizens through better air quality

> India introduced emission norms through the Auto Fuel Policy, 2002

> Better fuel qualities require better engine standards – thereby increasing vehicle efficiencies

> Auto Fuel Policy for India charts out a path till 2025

<table>
<thead>
<tr>
<th>Category</th>
<th>Bharat Stage II</th>
<th>Bharat Stage III</th>
<th>Bharat Stage IV</th>
<th>Bharat Stage V</th>
<th>Bharat Stage VI</th>
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</thead>
<tbody>
<tr>
<td>2 &amp; 3 wheelers</td>
<td>Entire country April 2005</td>
<td>Entire country April 2010</td>
<td>13 cities* April 2010</td>
<td>To be skipped</td>
<td>Entire country 2020</td>
</tr>
<tr>
<td>All other new vehicles</td>
<td>Entire country April 2005 13 cities* April 2003</td>
<td>Entire country April 2010 13 cities* April 2003</td>
<td>Entire country to be decided</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*NCR, Mumbai, Kolkata, Chennai, Bengaluru, Hyderabad, Ahmedabad, Pune, Surat, Kanpur, Lucknow, Sholapur, Jamshedpur and Agra
Hybrid and electric vehicles

- Pure electric vehicles are almost 6-7 times more energy efficient than ICT vehicles

- National Electric Mobility Mission Plan 2020 (NEMMP 2020)

- Ambitious vision for 5-7 million xEVs in India

- Including electric, hybrid and plug-in hybrid

- FAME India, an incentive scheme to extend subsidy for xEVs have also been launched

- Could completely revolutionize the nature of road transport in India

- This has to be complemented by also moving passenger traffic to rail based transport and freight traffic to rail, water and pipelines

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<table>
<thead>
<tr>
<th>Vehicle / Technology Segment</th>
<th>Potential for xEVs (M Units)</th>
</tr>
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<tbody>
<tr>
<td>BEV 2W</td>
<td>3.5 – 5</td>
</tr>
<tr>
<td>HEV Vehicles (4W, Bus, LCV)</td>
<td>1.3 – 1.4</td>
</tr>
<tr>
<td>Other BEV Vehicles (3W, 4W, Bus, LCV)</td>
<td>0.2 – 0.4</td>
</tr>
<tr>
<td>Total</td>
<td>5 - 7</td>
</tr>
</tbody>
</table>

Source: NEMMP 2020
Shift and Retain Public transport

- Share of bus and non-motorized passenger traffic had been on the decline

- Aggressive push to introduction/increasing penetration of public transport in cities

- Three key focus areas-
  - Introduce/increase penetration of city buses
  - Implement high capacity public transport systems i.e. BRTS and MRTS
  - Capacity building of stakeholders working in the area of public transport
  - Need to develop innovative financial models to finance public transport
Increasing the share of public transport

- National Urban Transport Plan 2006
  - Increase and improvement of public and non-motorized transport infrastructure

- National Urban Renewable Mission (2005-12)
  - Number of buses have almost doubled
  - 21 BRTS projects in 10 cities
  - Intelligent Transport System infrastructure, Traffic infrastructure, Transit Management Centers, etc.

- Increase in the number of urban metro and suburban services
  - 8 cities have suburban rail services
  - 5 cities already have metro rail services
  - 22 more metro services are being planned

*Source: TEDDY 2011-12; Picture sourced from: Wikimedia Commons
Key policies & schemes promote the concept of sustainable and low carbon mobility

Policy shifted focus in urban transport from transport to “mobility”

Made it compulsory for cities to develop CMPs consistent with NUTP to secure funding

Need for integrated land use planning for Urban Development

Delivery standards for public infrastructure projects

Integrate TOD in development of such cities

Capacity building programs & sustainable transport demo projects

Upgrade of urban transport infrastructure and technology

URBAN TRANSPORT
Large gamut of policies
RAILWAYS
Constant efforts to increase efficiencies

> Railways are about 18-20 times more energy efficient in operations than personal road transport

> In 2013-14 Indian Railways carried
  > 8.397 billion passengers
  > 1.051 billion tonnes

> By consuming
  > 2.78 billion litres of diesel (2.76 MTOE)
    > ~4.0% of total for HSD for transport sector
  > 14.41 billion KWH electricity (1.45 MTOE)
    > ~2% of National Consumption

> Several measures being taken to make the railways more efficient and improve its services to retain traffic

Source: TERI-NTDPC Life Cycle Analysis of Transport Modes, 2012; IR Annual Statistical Statements 2011-12;
Need to taken an integrated view of transport and fit rail

Freight tariff rates need to be moderated for commodities where IR has lost the market share to Roadways.

Commodity specific wagons and wagons with higher tare to weight ratio & increased axle load are strategies for improved operational efficiency.

Quick transit for both freight and passenger services could be a game changer for the Railways.

Increase average freight speed to 60 kmph and passenger to 100 kmph.

Increase bandwidth and capacity of both freight and passenger services.
Increase the share of both freight and passenger movement on Railways

- **DFCs for freight transport**
  - Two already underway, more to follow

- **High Speed Rail** for passenger transport
  - Increase the bandwidth of rail based passenger transport

**Key benefits of DFC**
- 100% electrified traction
- 2.25 times less GHG emissions over a 30 year period compared to BAU
- Efficient, reliable and cost-effective means of freight transportation

**Two step approach to move towards HSR**
- Use conventional rail technology to increase speeds upto 160-200 kmph
- Identify and build HSR links with speeds upto 350kmph
MAKING RAILWAYS MORE EFFICIENT

Measures being taken and suggested

> Targeted efficiency improvements in both diesel and electric locomotives
> Initiatives of Bio-diesel and CNG/LNG in Rail traction can be supported by National Clean Energy fund
> Targeting environmental funds of Government of India to support the energy efficient Railways
> Supplementing market borrowings through Environmental funds for financing railway projects
### Electrification and promoting alternate/clean fuels in Railways

- Electrification of the railway network is a priority for the Railways

- Energy saving measures being adopted in both traction and non-traction activities

- Introduction of high HP, high efficiency electric locomotives

- Couple the drive towards efficient electric traction with the use of renewable power sources

- Railway efforts are already underway in this regard
### Target for Emission Intensity reduction for Railways in India

<table>
<thead>
<tr>
<th>Year</th>
<th>tCO$_2$/million GTKM</th>
<th>% reduction</th>
<th>Annual savings in million tCO$_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>12.40</td>
<td>Base year</td>
<td>Base year</td>
</tr>
<tr>
<td>2014</td>
<td>10.82</td>
<td>12.7</td>
<td>3</td>
</tr>
<tr>
<td>2020</td>
<td>9.44</td>
<td>23</td>
<td>9</td>
</tr>
<tr>
<td>2030</td>
<td>8.35</td>
<td>31</td>
<td>23</td>
</tr>
</tbody>
</table>
RAILWAYS AND INDIA’s INDC
Sustainable green transportation system

- Increase of Rail mode share in land freight transport from 36% to 45%
- Dedicated Freight Corridors
- Improvement in technical energy efficiency factors
- Increase Mass Rapid Transit Systems
- Solar power in Railways – Land & Roof top
MOVING TOWARDS A LOW CARBON TRANSPORT TRAJECTORY - STRATEGIES -
1. Developing an integrated view of transport
   - Large number of ministries presently dealing with transport
   - Need to establish an unified agency with a holistic view for transport coordination and planning

2. Encourage an optimal mix of rail, water and road transport for inter-city movement
   - Develop strategies that specifically target improvement in shares of rail and water modes in inter-regional movement
   - Strategies can focus on investments on rail and water transport infrastructure and incentives to encourage shift to these modes
Moving India
towards a low carbon transport path

3. Diversify the fuel basket of transport sector
   - Encourage use of fuels other than petrol and diesel Large number of ministries presently dealing with transport
   - Establish the necessary infrastructure to promote the use of alternative fuels
   - Promote electricity as a transport fuel of future, keeping in view move towards renewables

4. Arrest the fast pace of motorization (ownership and utilization of vehicles)
   - Policies should target altering the current patterns of motorization in terms of vehicle ownership and utilization
   - Possible policy options - vehicle quota system, high parking fees, high vehicle registration charges, fuel taxes, congestion pricing, etc.
5. Increase the share of public transport and non motorized modes in urban areas

- Need to arrest the growing dependence on private modes in cities - encourage a shift from personal to mass modes of transport
- Introduce comprehensive policies and programs to outline a roadmap for the improvement/development of public transport in all cities –
  - Improve public transport systems, in terms of their capacity, coverage and quality
  - Promote inter-modal integration
- Develop comprehensive strategies to develop infrastructure for non motorized transport users
6. Promote integrated land use and transport planning in urban areas
   > Transit oriented development in cities, high density along transit corridors, inter-modal integration, promote cycling and walking, reduce need for motorized travel, etc.

7. Encourage energy efficient road-based movement
   > Mandate fuel efficiency standards
   > Tighten emission norms
   > Improve vehicle technologies and fuel quality
   > Establish modern inspection and maintenance regimes

8. Increased use of Information Technology
   > Encourage virtual commuting
   > Improved freight delivery and logistics

9. Capacity building at all levels
   > Institutional capacity building for practicing sustainable transport policies
   > Creating awareness among policy makers and transport users on issues of sustainable mobility
Thank you.

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