Electric Vehicle Scenarios for India

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Electric Vehicle Scenarios for India

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Presentation Agenda

1. Low Carbon National Transport Modeling Assessment
   • Model System
   • Scenarios Architecture

2. National Passenger Transport Demand

3. Sustainable Low Carbon Transport Scenario
   • Energy Demand
   • CO₂ Emission Mitigation
   • Air Quality Co-benefits

4. Electric Vehicle (EV) Scenarios

5. Conclusions
Soft-Linked Integrated Model System (SLIM)

DATABASES
Socio-Economic, Technologies, Energy Resources, Environment

AIM CGE/GCAM-IIM

ANSWER-MARKAL Model

AIM ExSS

Scenario Database

Sustainable Transport Indicators Database

Transport Demand Model

Transport Database

Soft-Linked Integrated Model System (SLIM)
Scenario Paradigm

Transport Scenarios

Baseline Scenario
GDP Growth rate -8% (2007-2032)

Avoid
Coal by wire
Urban Planning
Penetration of ICT technologies

Sustainable Low Carbon Transport
GDP Growth rate -8% (2007-2032)

Shift
Investment in Mass transit Systems
Greater use of Pipelines

Improve
Vehicle Efficiency Improvement
Penetration of Electric Vehicles
Transport Scenarios Architecture

Base (BAU)
- GDP – 8% CAGR
- CO2 – 3.6 deg C

Conventional Low Carbon Scenario
- GDP ~ 8% CAGR
- CO2 – 2 deg C

Sustainable Low Carbon Scenario
- GDP - Pegged to 8% CAGR
- CO2 – 2 deg C

Changes due to targeted strategies + a carbon budget equivalent to conventional scenario

Sustainable Mobility
- i. Public Transport
- ii. NMT
- iii. Urban Design
- iv. High speed rail

Sustainable Technologies
- i. Electric Vehicles
- ii. Fuel Economy
- iii. ICT - Navigation

Sustainable Fuels
- i. Bio-fuels
- ii. CNG
- iii. Clean Electricity

Sustainable Logistics
- i. Dedicated Rail Corridors
- ii. Coal by wire
- iii. Regional Pipelines

Passenger
Passenger & Freight
Freight

Changes due to price of carbon
Sustainable Mobility Storyline

Non-Motorized Transport

Pipe Transport

Coal-by-wire

State Wise Coal Reserves

Total Proven Reserves 99.9
Million tonnes

Fuel Economy (Cars)
(lit gasoline / 100 km)

2010 2015 2020 2025 2030 2035 2040 2045 2050

BAU Sustainable Low Carbon Scenario
National Passenger Transport Demand in Scenarios
Passenger Transport Demand

BAU - Passenger Transport Demand

BAU - Road Passenger Transport Demand
Modal Share of Passenger Transport

BAU Modal Share

Sustainable Low Carbon Scenario Modal Share

Legend:
- Air
- Railways
- Public Transport
- Four Wheeler
- Three wheeler
- Two Wheeler
Share in Road Passanger Transport

BAU Road Transport Share

Sustainable Low Carbon Scenario Road Transport Share

- Two Wheeler
- Three wheeler
- Four Wheeler
- Public Transport
Sustainable Low Carbon Transport Scenario

Results from Modeling Assessment
Low Carbon Electricity Transition

Carbon Price Trajectory

2°C Stabilization Scenario

BAU Scenario

CO2 Intensity of Grid
(tCO2 / Mwh)

<table>
<thead>
<tr>
<th>Year</th>
<th>BAU</th>
<th>Sustainable LCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>0.98</td>
<td>0.64</td>
</tr>
<tr>
<td>2020</td>
<td>0.97</td>
<td>0.64</td>
</tr>
<tr>
<td>2030</td>
<td>0.94</td>
<td>0.64</td>
</tr>
<tr>
<td>2040</td>
<td>0.91</td>
<td>0.64</td>
</tr>
<tr>
<td>2050</td>
<td>0.88</td>
<td>0.64</td>
</tr>
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</table>

US$/ tons

2010 2020 2030 2040 2050
Energy Mix for Transport

[Graph showing energy mix for transport from 2010 to 2050, comparing BAU and 2°C Stabilization scenarios. The graph indicates the usage of different energy sources such as oil, electricity, CNG, hydrogen, jet fuel, and biofuel over the years.]
Transport Fuel Mix in 2050

**Transport Energy: 299 Mtoe**
- Oil: 64%
- Jetfuel: 9%
- Biofuel: 3%
- CNG: 16%
- Electricity: 8%
- Hydrogen: 0%

**BAU Scenario**
- Oil: 30%
- Jetfuel: 8%
- Biofuel: 23%
- CNG: 19%
- Electricity: 19%
- Hydrogen: 1%

**2°C Scenario**
- Oil: 30%
- Biofuel: 23%
- CNG: 19%
- Jetfuel: 8%
- Electricity: 19%
- Hydrogen: 1%
Contribution to CO2 Mitigation in Sustainable Low Carbon Transport Scenario

- Electric Mobility + Electric cleaning
- Fuel Switching
- Fuel Economy
- Shift
- Demand Reduction
- Residual Emissions
CO2 Emissions - Transport

**BAU**

**Sustainable LCT**

CO2 Emissions (Million tCO2)

- **Electricity**
- **CNG**
- **Jet Fuel**
- **Oil**

CO2 Emissions (Million tCO2)

- **Oil**
- **Jet Fuel**
- **CNG**
- **Electricity**
Air Quality Co-benefit

**SO\(_x\)**

- **BASE**
- **2\(^0\)C**

**NO\(_x\)**

- **Ktonnes**
- **Years:** 2010, 2015, 2020, 2025, 2030, 2035, 2040, 2045, 2050
Electric Vehicle Scenarios
Electric Vehicles (EV) Scenarios

- **Business-as Usual (BAU):** Future socio-economic development along the conventional path: mirrors resource intensive path of developed countries.

- **National EV Policies (EV):** Governments recognize multiple co-benefits of EVs (urban air quality; energy security etc.) and push their penetration.

- **EV plus 2°C Target (EV_LCS):** Global 2°C climate stabilization target leads to high carbon price; this lowers carbon content of generated electricity.
Electric Vehicle Scenario (EV): Assumptions

• Domestic policy supports: Direct capital subsidy, improved charging infrastructure, dedicated lanes, incentives for R&D in power train, batteries and smart grid technologies, quotas for EVs in urban public & goods transport
• Battery costs comes down to half of current costs in next 10-15 years: driven by advancements in battery technologies, improvements in battery capacities, declining component costs, and economies of scale in production
• Improved batteries with higher energy density will also help reduce weight of batteries: further pushing down EVs costs
• Limited range per charge put constraints on EVs penetration for urban transportation

Electric Vehicle plus 2°C Scenario (EV_LCS): Assumptions

• Global 450 ppmv CO₂ equivalent concentration stabilization target
• Carbon Price rise: from US$ 46/tonne CO₂ in 2020 to US$ 200/tonne CO₂ in 2050 (based on outputs from IMAGE and MESSAGE models)
EV Share in Personal Motorised Transport

Share of EV 4 Wheelers

- BAU
- EV Scenario
- EV + 2 deg C

<table>
<thead>
<tr>
<th>Year</th>
<th>BAU</th>
<th>EV Scenario</th>
<th>EV + 2 deg C</th>
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<tbody>
<tr>
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<td>0.1%</td>
<td>0.1%</td>
<td>0.1%</td>
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<tr>
<td>2020</td>
<td>0.1%</td>
<td>0.3%</td>
<td>0.3%</td>
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<td>2030</td>
<td>15.4%</td>
<td>29.4%</td>
<td>25.7%</td>
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<td>2040</td>
<td>19.5%</td>
<td>47.0%</td>
<td>52.7%</td>
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<td>2050</td>
<td>23.9%</td>
<td>35.4%</td>
<td>39.8%</td>
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EV Share in Personal Motorised Transport

Share of EV 2 Wheelers

- BAU
- EV Scenario
- EV + 2 deg C

<table>
<thead>
<tr>
<th>Year</th>
<th>BAU</th>
<th>EV Scenario</th>
<th>EV + 2 deg C</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0.2%</td>
<td>0.2%</td>
<td>0.2%</td>
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<tr>
<td>2020</td>
<td>0.5%</td>
<td>34.3%</td>
<td>34.3%</td>
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<tr>
<td>2030</td>
<td>2.1%</td>
<td>41.5%</td>
<td>41.5%</td>
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<tr>
<td>2040</td>
<td>9.2%</td>
<td>40.0%</td>
<td>40.0%</td>
</tr>
<tr>
<td>2050</td>
<td>9.6%</td>
<td>40.0%</td>
<td>40.0%</td>
</tr>
</tbody>
</table>
Share of EV for Public transport

Share of EV in Public Transport*

- BAU
- EV Scenario
- EV + 2 deg C

( * ) Excludes Demand for Passenger Transport met by Railways.
CO2 emissions: BAU, EV, EV_LCS

CO2 Emissions from Transport Sector
(Million tCO2)

- BAU
- EV
- EV LCS

Year: 2010, 2020, 2030, 2040, 2050

Emissions levels:
- BAU: Increasing from 2010 to 2050
- EV: Increasing from 2010 to 2050
- EV LCS: Increasing from 2010 to 2050
Conclusions

• Under global 2°C stabilization policy, in 2050, India’s:
  – Transport sector would mitigate 66% of BAU emissions
  – Transport Emissions will still be 60% above 2010 emissions

• The low carbon transition of transport sector is accompanied by sizable shift in fuels and technologies

• Low carbon transport transition shall deliver Air Quality and Energy Security co-benefits

• Electric Vehicles (EV) by themselves do not contribute to CO₂ mitigation; they may even increase emissions

• Under global 2°C stabilization policy, in India, EV contribute sizable mitigation, nearly 38% to the BAU transport emissions in 2050

• Early penetration of EV in India would come through 2-wheelers; this would create infrastructures that would facilitate larger vehicles.
Thank You

Low Carbon Transport Project Website :

www.unep.org/transport/lowcarbon