Future of Electric Vehicles in Road Passenger Mobility of India

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Presentation Agenda

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

2. National Passenger Transport Demand

3. Electric Vehicle (EV) Scenarios

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

Databases:
- Socio-Economic
- Technologies
- Energy Resources
- Environment

Models:
- AIM CGE/GCAM-IIM
- ANSWER-MARKAL Model
- AIM ExSS
- Scenario Database
- Sustainable Transport Indicators Database

Transport Models:
- Transport Demand Model
- Transport Database
**Transport Scenarios Architecture**

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

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

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

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

**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
National Passenger Transport Demand in Scenarios
Passenger Demand Estimation

Overall (BPKMs)

Urban & Rest

Intercity (BPKMs) = Residual

Modal Split

Private (BPKMs) (VO, TR & TL)

Public Transit* (BPKMs) = Residual

NMT (BPKMs) (TR, TL)

Private (BPKMs) (VO, Mileage, Private Urban)

Public (BPKMs) = Residual

\[ TD_{urban} = \sum_{i=1}^{4} TR_i \times TL_i \times Pop_i \times 365 \]

\[ TD_{overall} = Population \times Per \ Capita \ Mobility \]
Passenger Transport Demand

Passenger Transport Demand - Urban
BAU (Bpkm)

Passenger Transport Demand - Inter-city
BAU (Bpkm)
Mode Share of Passenger Transport

Modal Share: Urban Transport
BAU Scenario

Modal Share: Inter City Transport
BAU Scenario
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
Scenarios Description: EV & EV_LCS

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 penetration of cheaper EVs 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$ 14/tonne CO₂ in 2020 to US$ 200/tonne CO₂ in 2045 (based on outputs from Lucas et. al., 2013)
EV Share in Personal Motorised Transport

- **Share of EV & Hybrid 2 Wheelers**
  - **Share of EV, Hybrid and Fuel Cells: 4 Wheelers**
Electricity Demand and Supply

**Electricity Demand (Mtoe)**

- **2010**: BAU, EV Scenario, EV + 2 deg C
- **2015**: BAU, EV Scenario, EV + 2 deg C
- **2020**: BAU, EV Scenario, EV + 2 deg C
- **2025**: BAU, EV Scenario, EV + 2 deg C
- **2035**: BAU, EV Scenario, EV + 2 deg C

**Electricity Output 2035 (Twh)**

- **BAU**: Coal, Gas, Renewables, Nuclear, Other
- **EV Scenario**: Coal, Gas, Renewables, Nuclear, Other
- **EV + 2 deg C**: Coal, Gas, Renewables, Nuclear, Other
Energy Demand: Transport

![Energy Demand: BAU (Mtoe)](chart1.png)

![Energy Demand (Mtoe)](chart2.png)
PM 2.5 Emissions

![Annual Emissions of PM 2.5 (tons) BAU Scenario](chart1)

![PM 2.5 Emissions (tons)](chart2)
CO$_2$ Emissions

![Graph showing CO$_2$ Emissions (tCO$_2$) from 2010 to 2035 with different scenarios: BAU, EV Scenario, EV + 2 deg C.]
Conclusions

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

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

• Electric Vehicles (EV) by themselves do not contribute to CO$_2$ mitigation; they may even increase emissions

• Under global 2$^\circ$C stabilization policy, in India, EV contribute sizable mitigation however emissions would be much higher than in 2010
Thank You

Low Carbon Transport Project Website:

[www.unep.org/transport/lowcarbon](http://www.unep.org/transport/lowcarbon)