Transformation of India's Transport Sector under global warming of 2°C and 1.5°C scenario

Subash Dhar, UNEP DTU Partnership
Minal Pathak, Global Centre for Environment and Energy, Ahmedabad University
P R Shukla, Global Centre for Environment and Energy, Ahmedabad University

Annual Chair Conference: Prospective for Energy-Climate Issues
22 November 2017
MINES ParisTech, Paris
1.5°C and Efforts relative of 2°C

India's INDC

**Overall Target : Reduction in CO₂ intensity by 33% - 35% in 2030 from the 2005 level**

### Transport related actions

<table>
<thead>
<tr>
<th>Focus Area</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rail Transport</td>
<td>• Enhancing share of rail from 36 % to 45 %</td>
</tr>
<tr>
<td></td>
<td>• Dedicated Freight Corridors to reduce 457 million tonnes of CO2 over a 30-year period</td>
</tr>
<tr>
<td>Coastal shipping &amp; inland waterways</td>
<td>• implementation of a 1,620-km navigable channel for large commercial ships</td>
</tr>
<tr>
<td></td>
<td>• waterway transportation grid connecting waterways to roads, railways, and ports.</td>
</tr>
<tr>
<td></td>
<td>• to improve and augment capacity in India’s ports, promoting efficient transportation of goods.</td>
</tr>
<tr>
<td></td>
<td>• a 7,000 km road network along the coast to provide further connectivity to the ports.</td>
</tr>
<tr>
<td>Mass transit</td>
<td>• Urban transport to focus on moving people - investments in mass transit</td>
</tr>
<tr>
<td>Vehicle efficiency</td>
<td>• Efficiency targets for new cars</td>
</tr>
<tr>
<td></td>
<td>• Improve fuel standards</td>
</tr>
<tr>
<td>Alternate Fuels and Vehicles</td>
<td>• Incentivizing hybrid and electric vehicles in the country</td>
</tr>
<tr>
<td></td>
<td>• Promoting Biofuels</td>
</tr>
</tbody>
</table>
### Scenarios

<table>
<thead>
<tr>
<th>Strategies</th>
<th>NDC Scenario</th>
<th>2°C Scenario</th>
<th>1.5°C Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate Policies</td>
<td>Implementation of voluntary and supported actions aligned with NDC</td>
<td>Global carbon price consistent with 2 °C stabilisation</td>
<td>CO₂ emissions budget consistent with 1.5 °C scenario</td>
</tr>
<tr>
<td>Strategies that reduce or substitute urban passenger transport demand</td>
<td>Improvement of mass transit in cities, and overall mobility (Smart city and AMRUT missions).</td>
<td>Demand and modal mix changed relative to change in carbon prices.</td>
<td>Demand and modal mix changed relative to change in carbon prices.</td>
</tr>
<tr>
<td>Strategies that reduce or substitute intercity passenger transport demand</td>
<td>• Investments in semi high speed rail corridors and high speed rail corridors.</td>
<td>• Demand and modal mix changed relative to change in carbon prices.</td>
<td>• Demand and modal mix changed relative to change in carbon prices.</td>
</tr>
<tr>
<td></td>
<td>• Modal share of Rail increased to 30% by 2050</td>
<td>• High carbon prices incentivize rail electrification.</td>
<td>• High carbon prices incentivize rail electrification.</td>
</tr>
<tr>
<td>Strategies that reduce or substitute freight transport demand</td>
<td>• Integration of rail with coastal shipping &amp; waterways</td>
<td>Demand and modal mix same as NDC Scenario though high carbon prices create incentive to electrify rail.</td>
<td>Demand and modal mix same as NDC Scenario though high carbon prices create incentive to electrify rail.</td>
</tr>
<tr>
<td></td>
<td>• Implementation of dedicated freight corridors (DFC) shift freight to rail.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Modal share of Rail increased to 48% by 2050</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strategies that increase share of EVs</td>
<td>• Full duty exemption and half sales tax till 2025</td>
<td>Carbon Price facilitates cost competitiveness of EVs.</td>
<td>Carbon Price facilitates cost competitiveness of EVs.</td>
</tr>
<tr>
<td></td>
<td>• Increased investment in charging infrastructures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strategies that improve fuel economy</td>
<td>• Fuel consumption standards + additional constraint</td>
<td>Carbon price facilitates cost competitiveness of fuel efficient vehicles.</td>
<td>Carbon price facilitates cost competitiveness of fuel efficient vehicles.</td>
</tr>
<tr>
<td></td>
<td>• Overall fuel economy for 4 wheelers below 4 lit/100 km</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Methodology

- ANSWER MARKAL MODEL
- CO₂ Price and CO₂ Budget

\[
CO_2 \text{Emissions}_\text{India}_{2°C} = CO_2 \text{Emissions}_\text{Global}_{1.5°C} \times \left( \frac{CO_2 \text{Emissions}_\text{Global}_{1.5°C}}{CO_2 \text{Emissions}_\text{Global}_{2°C}} \right)
\]

- Transport demand in 2°C and 1.5°C scenario

\[
Demand \text{ Travel}_{2°C} = Demand \text{ Travel}_{NDC} \times \left( \frac{Fuel \text{ Price}_{2°C}}{Fuel \text{ Price}_{NDC}} \right)^\mu
\]

\[
Demand \text{ Mode}_{2°C} = \frac{Demand \text{ Mode}_{NDC}}{\left( \frac{CO_2 \text{ Price}_{2°C}}{CO_2 \text{ Price}_{NDC}} \times \frac{CO_2 \text{ Intensity}_{2°C}}{CO_2 \text{ Intensity}_{NDC}} \right)^\mu}
\]

Global CO₂ budgets (GtCO₂) for 2°C and 1.5°C scenario

Implicit carbon price: NDC Scenario

- Explicit Carbon Price
- Social Value of Carbon

**CO₂ Price (US $ per tCO₂)**

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
<th>2040</th>
<th>2045</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
<td>30</td>
<td>50</td>
<td>70</td>
<td>90</td>
<td>110</td>
<td>130</td>
<td>150</td>
</tr>
</tbody>
</table>
Passenger Demand

Overall

Rail

4 Wheeler

2 Wheeler

Overall Rail

Demand Total NDC
Demand Total 2°C
Demand Total BAU
Demand Total 1.5°C

Demand Rail NDC
Demand Rail 2°C
Demand Rail BAU
Demand Rail 1.5°C

Demand 4Wheeler NDC
Demand 4Wheeler 2°C
Demand 4Wheeler BAU
Demand 4Wheeler 1.5°C

Demand 2Wheeler NDC
Demand 2Wheeler 2°C
Demand 2Wheeler BAU
Demand 2Wheeler 1.5°C
Results: Energy Mix

Energy Mix

Energy Demand (x 10^6 toe)

Year

2015  BAU  NDC  2°C  1.5°C  BAU  NDC  2°C  1.5°C

Oil  Gas  Electricity  Bio fuels  Hydrogen
Results: Environment

- NDC scenario itself achieves significant improvement in environment and CO₂ co-benefits
Decarbonisation due to demand reduction

Passenger Transport Demand in 2050

- 2 Wheelers
- 3 Wheelers
- 4 Wheelers
- Buses
- Metro / Rail
- Air

CO₂ Emissions in 2050*

* without any fuel/tech change

- 2°C
- 1.5°C

- Overall demand reduction is around 8.3% however reduction in CO₂ emissions is 12.6%
- Demand reduction and shift to sustainable modes would require integrated planning, and redirecting of investments
• Deep decarbonisation would need a strong push towards electrification
<table>
<thead>
<tr>
<th></th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
<th>2040</th>
<th>2045</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>2°C</td>
<td>0.80</td>
<td>0.64</td>
<td>0.44</td>
<td>0.31</td>
<td>0.22</td>
<td>0.13</td>
<td>0.09</td>
</tr>
<tr>
<td>1.5°C</td>
<td>0.51</td>
<td>0.22</td>
<td>0.17</td>
<td>0.02</td>
<td>0.01</td>
<td>0.01</td>
<td>0.00</td>
</tr>
</tbody>
</table>
Conclusions

• India’s NDC measures will improve sustainable development indicators and decoupling of CO₂ emissions compared to BAU.
• NDC alone however not sufficient to achieve Paris ambition.
• The transitions to global 2°C scenario will require policy support for clean transport technologies, electrification of transport and increased shift towards public transport.
• Transition to low CO₂ intensity of electricity supply essential for decarbonisation of transport.
• The 1.5°C scenario is transformative and differentiates from other scenarios in the urgency and intensity of implementation.
• Deep decarbonisation would require additional financing and redirecting of financing.