Macro Indicators of Sustainable Low Carbon Transport: Outcome of Public Consultations

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Macro Indicators of Low Carbon Transport

• Aggregate
  – All Sectors
  – All Regions

• National and Global Linkages

• Long-term (period to 2050)
## Economic Indicators

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Description</th>
<th>Measurement</th>
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<tbody>
<tr>
<td>1 Carbon Intensity of Transport</td>
<td>Measures transport sector’s contribution to de-carbonization of Economy</td>
<td>CO2 emissions per Million Rupees of Economic value added by Transport Sector</td>
<td>GoI has committed to reduce by 20 to 25% CO2 emissions intensity of GDP from 2005 to 2020</td>
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<tr>
<td>2 Energy Security</td>
<td>Measures the risk to the country from negative balance of energy trade</td>
<td>Value of negative energy (resources &amp; technologies) trade over the total value of energy consumed (%)</td>
<td>Three-quarters of India’s oil consumption is imported. The oil and gas imports are increasing. Transport is a major consumer of oil.</td>
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<td>3 Transport Infrastructure Investment</td>
<td>Measures investment needs to implement transport plan</td>
<td>Investment in Transport Infrastructure at National level</td>
<td>Important to delineate institutional (e.g. PPP) and financial plans</td>
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<tr>
<td>4 Total Cost of Transport</td>
<td>Measures overall and long-term cost-effectiveness of the national transport plan</td>
<td>Includes infrastructure investments, fuel costs, vehicle &amp; maintenance costs</td>
<td>Useful to assess the long-term marginal and total costs of a transport plan to the economy</td>
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## Social Indicators

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<td><strong>1</strong> Access to transport</td>
<td>Measures the ability of the transport infrastructure to support balanced regional development</td>
<td>Maximum distance of key transport modes accessible from human settlements (e.g. roads, rail stations, electricity transmission network)</td>
<td>India is a large and diverse country. Transport links people across diverse geographies and economic activities. The access to transport network is important for national integration and balanced development.</td>
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<td><strong>2</strong> Transport Subsidies</td>
<td>Measures the affordability of transport (passenger &amp; freight) - a key driver of accessibility for the low-income segments</td>
<td>Value of targeted subsidies for transport sector</td>
<td>Transport expenditure is a significant fraction of income for self-employed and those in the informal sector. Targeted subsidies can enhance their ability to participate in and contribute to the national growth dynamics.</td>
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<td><strong>3</strong> Food Security</td>
<td>Measures food related risk (including imported food inflation)</td>
<td>Value of additional food imports from diversion of land for bio-energy production (%)</td>
<td>For low carbon transitions, the bio-fuels for transport (e.g. bio-ethanol, bio-diesel) can be major substitutes for liquid fossil fuels.</td>
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## Environmental Indicators

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| 1 Air Pollution | Measure of aggregate external air quality related damages from transport use | • Direct and indirect emissions load of different air pollutants from transport.  
• Since there are multiple pollutants, each can be a sub-indicator | Air pollution from transport is a concern in urban spaces. In many cities urban air quality norms are violated. Besides, measurement of some pollutants is missing (e.g. tropospheric ozone, particulate products of incomplete combustion). |
| 2 Water Pollution | Enhancing Inland water transport (passenger and freight) is on the agenda (e.g. River-linking) | • Pollution caused by water transport  
• Pollution at Ports, jetties etc. | Water transport is an efficient mode. Low carbon transition would increase its share. Globalization is increasing shipping and ports. The external cost of pollution from inland water transport and near ports would increase. |
| 3 Water Stress | Measures incremental water demand/stress | Incremental water use due to bio-energy crops replacing other crops | Most energy crops are water intensive (e.g. sugarcane for bio-ethanol). Their extensive farming adds to water stress. |
## Technical / Technological Indicators

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| 1 Vehicle (fleet) Energy & Emissions Efficiency | Important indicator to set emissions targets for the vehicle manufacturers   | • Delivered kilometers per liter  
• Grams of emissions per kilometer travel                                               | This is an extensively used indicator by the Governments (e.g. CAFÉ standards in USA)          |
| 2 Carbon Content of Electricity                | Transport modes use electricity for traction (e.g. rail). CO2 is emitted at electricity generation | Gram of CO2 per Kwh of delivered electricity                                 | Electricity is an energy input for transport. Including electricity emissions closes the emissions accounting loop. An integrated framework is needed to integrate transport & electricity decisions |
| 3 Transport demand substitution                | Internet services (e.g. video-conferencing) can reduce travel demand          | % of transport demand substituted by alternate technology                    | Many organizations use video-conferencing or permitting employees to work from home to eliminate travel |
| 4 Operational Efficiency of Transport Infrastructure | Quality infrastructure and operating systems are the backbones of efficient transport | • Av. speed of a transport network  
• Waiting time per km travel etc.                                              | Overall transport efficiency is delivered by the operational system (e.g. information system, infrastructure maintenance) |
## Meta (Strategic) Indicators

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<td>Sustainable Urban Form and Structure</td>
<td>Urbanization pattern to promote balanced regional and urban structure</td>
<td>• Population density • City-size distribution • Regional linkages of urban centers</td>
<td>Urban form is a determinant of transport demand &amp; supply. Urban &amp; regional linkages are key drivers of sustainable growth &amp; balanced development.</td>
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<td>National Logistics Grid</td>
<td>Modes of transport use electricity for traction. Electric vehicles do not emit CO2 (or other pollutants) at consumption point but at generation.</td>
<td>• Reduce Travel Demand • Optimal locations of production centers • Linkages for domestic and international trade • Optimal multi-modal choices for primary energy &amp; electricity T&amp;D</td>
<td>National level logistics planning is essential to: i) minimize transport demand by substitutions, ii) minimize costs via optimal modal shares, &amp; iii) creating linkages for passenger and goods transport for desired level of access in all regions</td>
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<td>Investment in Transport Sector Innovations</td>
<td>Transition to low carbon transport requires innovation in institutions, management, technology and infrastructures.</td>
<td>R&amp;D budget for low carbon transport in public and private sectors</td>
<td>Technology RD&amp;D are vital to leapfrog the conventional transport infrastructures and technologies and to prevent the lock-in of the transport sector into high energy and carbon intensive path</td>
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## Macro Indicators (17): Summary

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<tr>
<th>Economic (4)</th>
<th>Carbon Intensity of Transport</th>
<th>Energy Security</th>
<th>Transport Infrastructure Investment</th>
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<td>Environmental (3)</td>
<td>Air Pollution</td>
<td>Water Pollution</td>
<td>Water Stress</td>
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<td>Technical (4)</td>
<td>Vehicle (fleet)</td>
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Sustainable Low Carbon Mobility Framework

**Objective**
- Low Carbon Transport
- Space Design
- Technologies
- Behavior

**Options**
- Infrastructures

**Decisions/Indicators**
- Modes (avoid lock-ins)
- Supply-push (public finance)
- Market Integration (PPP)
- Land-use (Zoning, V/H City)
- Inclusion (Access)
- Institutions (Decentralized)
- Efficiency (Standards)
- Taxes/Subsidies (Targeted)
- R&D (Finance, IPR)
- Awareness/Education ()
- Governance (Policies, Rule)
- Incentives (Tariff, Taxes)

**Targets**
- National Socio-economic Objectives and Targets
- Global Climate Change Targets

**Back-casting**
Copenhagen Commitments and Strategy

Copenhagen Commitments
• 20 to 25% Emissions Intensity Reduction from 2005 to 2020 (1.5 to 1.9% decoupling)
• Per Capita Emissions Below OECD Average (for ever)

National Climate Change Action Plan
Implementation Strategy: 8 National Missions

1. Solar Energy (22000 MW PV + Thermal by 2022)
2. Enhanced energy efficiency (Avoided Capacity 19000 MW by 2014-15)
3. Sustainable habitat
4. Water Sector (20% water use efficiency improvement)
5. Sustaining the Himalayan eco-system
6. A “Green India” (20 Mil. Hectare Forestation; Forest cover from 23 to 33%)
7. Sustainable agriculture (Micro irrigation promotion in 40 m ha)
8. Strategic knowledge for climate change
Co-benefits & Technology Choices

Technologies delivers multiple dividends

- In developing countries, significant opportunities exist for gaining co-benefits
- Technology Assessment should consider all costs and benefits

“For developing countries, the ‘good news’ is that their environment and natural resources policies are often so bad that there are reforms which would be both good for the economy and good for the environment.”

Joseph Stiglitz
Energy Security Co-benefits

Energy Mix in 2050

- **Base**: 2825
- **LCS_CT**: 2945
- **LCS_SS**: 2207

Analysis with ANSWER-MARKAL Model
Air Quality Co-benefits

Emissions and Income

Co-benefits: SO2 Emissions

Analysis with ANSWER-MARKAL Model

Indian Institute of Management, Ahmedabad, India
LCS with Lower Carbon Prices

Analysis with ANSWER-MARKAL Model
Conclusions

• Indicators are key to link **Low Carbon Actions** and Development Targets

• ‘Paradigm Shift towards ‘Co-benefits’ and ‘Co-operation’:
  – **Co-benefits** reduces welfare losses
  – Deliver LCS at **Low Carbon Price**

• Transport Policy Assessment Methodologies should link:
  – **MACRO Indicators**: Aggregate, National, Long-term Indicators
  – **MICRO Indicators**: Sectoral, Local, Short-term
Thank you