

# **Annex 1**

## **Macro Indicators for Low Carbon Transport in India**

### **Low Carbon Transport Project**

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## **Macro Indicators for Low Carbon Transport in India**

These indicators have macro-economic, national (i.e. limited to national boundaries) and long-term contexts. The description of the indicators includes both passenger and freight transport. The assessment of transport plans though should consider passenger and freight transport separately to the extent feasible (due to the conjoint use of some infrastructures).

<b>Economic Indicators</b>			
Indicator Name	Description	Measurement	Relevance
Carbon Intensity of Transport	Measures transport sector's contribution to de-carbonization of Economy	CO2 emissions per Million Rupees of Economic value added by Transport Sector	Government of India (GoI) has made voluntary commitment to reduce 20 to 25% CO2 emissions intensity of GDP
Energy Security	Measures the risk to the country from negative balance of energy trade	Value of negative energy (resources & technologies) trade over the total value of energy consumed (%)	Nearly three-quarters of oil consumed is imported by India. The imports of oil and gas are increasing. Transport is a major consumer of oil.
Transport Infrastructure Investment	Measures investment needs to implement transport plan	Investment in Transport Infrastructure at National level	Important to delineate institutional (e.g. PPP) and financial plans
Total Cost of Transport	Measures overall and long-term cost-effectiveness of the national transport plan	Includes infrastructure investments, fuel costs, vehicle & maintenance costs	Useful to assess the long-term marginal and total costs of a transport plan to the economy

<b>Social Indicators</b>			
Indicator Name	Description	Measurement	Relevance
Access to transport	Measures the ability of the transport infrastructure to support balanced regional development	Maximum distance of key transport modes accessible from human settlements (e.g. roads, rail stations, electricity transmission network)	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.
Transport Subsidies	Measures affordability of transport (passenger and freight) which is a major driver of accessibility for the low-income segments	Value of targeted subsidies for transport sector	Transport expenditure is a significant fraction of income for self-employed and those in the informal sector (including small vendor who ferry their goods or provide services like 'dabbavallahs'). Targeted subsidies for these groups enhance their ability to participate in and contribute to the national growth dynamics.
Food Security	Measures food related risk (including imported food inflation)	Value of additional food imports due diversion of land for bio-energy production (%)	Bio-energy is considered as alternate to fossil fuels, especially in transport sector. In the case of low carbon transitions, the bio-fuels for transport (e.g. bio-ethanol, bio-diesel) are considered as major substitutes for liquid fossil fuels.

<b>Environmental Indicators</b>			
Indicator Name	Description	Measurement	Relevance
Air Pollution	Measure of aggregate external air quality related damages from transport use	<ul style="list-style-type: none"> <li>• Direct and indirect emissions load of different air pollutants from transport.</li> <li>• Since there are multiple pollutants, each can be a sub-indicator due to different external effects (on health, eco-systems etc.)</li> </ul>	Air pollution from transport is a major concern in urban spaces. In many cities in the country urban air quality norms are violated. Besides, measurement of many pollutants is missing (like tropospheric ozone, particulate products of incomplete combustion).
Water Pollution	Inland water transport is not prominent in the country, but enhancing it (for passenger and freight) is on the agenda (e.g. the oft discussed River-linking scheme)	<ul style="list-style-type: none"> <li>• Pollution caused by water transport</li> <li>• Pollution at Ports, jetties etc.</li> </ul>	Since water transport is an efficient mode, the low carbon transition would propose its enhanced use. Globalization is increasing the shipping and construction of ports. The external cost of pollution from inland water transport and near ports is expected to increase.
Water Stress	Measures incremental water demand/stress	<ul style="list-style-type: none"> <li>• Incremental water use due to bio-energy crops replacing other crops, e.g. in Billion cubic meter per year</li> </ul>	The energy crops can be water intensive (e.g. sugarcane for bio-ethanol) and therefore their extensive farming can add to water stresses.

<b>Technical/ Technological Indicators</b>			
Indicator Name	Description	Measurement	Relevance
Motor Vehicle (fleet) Energy and Emissions Efficiency	Important indicator to set emissions targets for the vehicle manufacturers	<ul style="list-style-type: none"> <li>Delivered kilometers per liter</li> <li>Grams of emissions per kilometer travel</li> </ul>	This is an extensively used indicator by the Governments (e.g. CAFÉ standards in USA)
Carbon Content of Electricity	Some modes of transport (e.g., rail use) electricity for traction. At the consumption point, electric vehicles do not emit CO <sub>2</sub> (or other pollutants), but these are emitted during electricity generation.	<ul style="list-style-type: none"> <li>Gram of CO<sub>2</sub> per Kwh of delivered electricity</li> </ul>	Including electricity emissions is important to close the emissions accounting loop. Electric cars would further tie transport and electricity. Clean electricity would be essential to low carbon transport. Since transport policymakers do not make electricity decisions, managing carbon content of electricity emphasizes the need for an integrated framework for low carbon transition.
Transport demand substitution	Internet services (e.g. video-conferencing) can reduce travel demand	<ul style="list-style-type: none"> <li>% of transport demand substituted by alternate technology</li> </ul>	Many organizations are using the video-conferencing or permitting employees to work from home to eliminate travel.
Operational Efficiency of Transport Infrastructure	The supply of quality infrastructure and operating systems are vital for sustained efficiency of transport system.	<ul style="list-style-type: none"> <li>Av. speed of a transport network</li> <li>Waiting time per km travel etc.</li> </ul>	Overall transport efficiency is delivered by the operational system (e.g. information system, infrastructure maintenance)

Meta (Strategic) Indicators			
Indicator Name	Description	Measurement	Relevance
Sustainable Urban Form and Structure	Urbanization pattern (e.g. compact cities) to promote balanced regional and urban structure	<ul style="list-style-type: none"> <li>• Population density</li> <li>• City-size distribution</li> <li>• Regional linkages of urban centers</li> </ul>	Design of urban form is a determinant of transport demand and supply architecture. Urban and regional linkages are key drivers of sustainable growth and balanced development.
National Logistics Grid	Modes of transport, e.g. trains, use electricity for traction. At the consumption point, electric vehicles do not emit CO2 (or emissions of other pollutants), but these are emitted during electricity generation.	<ul style="list-style-type: none"> <li>• Reductions in per capita travel demand</li> <li>• Optimal locations of production centers</li> <li>• Linkages for domestic and international trade</li> <li>• Optimal multi-modal choices for primary energy &amp; electricity transmission and distribution</li> </ul>	National level logistics planning is essential to: i) minimize transport demand by substitutions (e.g. locating power plants at mines and transmitting electricity to consuming centers instead of moving coal to power plants), ii) minimize costs through optimal investment into multiple modes, and iii) creating linkages for passenger and goods transport for desired level of access in all regions
Investment in Innovations, R&D and New Technologies in Transport Sector	Transition to low carbon transport requires innovation in institutions, management, technology (hard-wares and soft-wares) and infrastructures.	R&D budget for low carbon transport in public and private sectors	Scientific breakthroughs and technology development and deployment are vital to <i>leapfrog</i> the conventional transport infrastructures and technologies and to prevent the <i>lock-in</i> of the transport sector into high energy and carbon intensive path