



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

P.R. Shukla and Prem Pangotra
Indian Institute of Management, Ahmedabad

Presented at Workshop on:

Developing Low-Carbon Mobility Plans for Indian Cities

New Delhi, October 19, 2011

Indian Institute of Management, Ahmedabad, India



Macro Indicators of Low Carbon Transport

- **Aggregate**
 - **All Sectors**
 - **All Regions**
- **National and Global Linkages**
- **Long-term (period to 2050)**

Economic Indicators

	Indicator	Description	Measurement	Relevance
1	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	Govt has committed to reduce by 20 to 25% CO2 emissions intensity of GDP from 2005 to 2020
2	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 (%)	Three-quarters of India's oil consumption is imported. The oil and gas imports are increasing. Transport is a major consumer of oil.
3	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
4	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

Social Indicators

	Indicator	Description	Measurement	Relevance
1	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.
2	Transport Subsidies	Measures the affordability of transport (passenger & freight) - a key 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. Targeted subsidies can enhance their ability to participate in and contribute to the national growth dynamics.
3	Food Security	Measures food related risk (including imported food inflation)	Value of additional food imports from diversion of land for bio-energy production (%)	For low carbon transitions, the bio-fuels for transport (e.g. bio-ethanol, bio-diesel) can be major substitutes for liquid fossil fuels.

Environmental Indicators

	Indicator	Description	Measurement	Relevance
1	Air Pollution	Measure of aggregate external air quality related damages from transport use	<ul style="list-style-type: none"> • 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)	<ul style="list-style-type: none"> • 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

	Indicator	Description	Measurement	Relevance
1	Vehicle (fleet) Energy & Emissions Efficiency	Important indicator to set emissions targets for the vehicle manufacturers	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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)

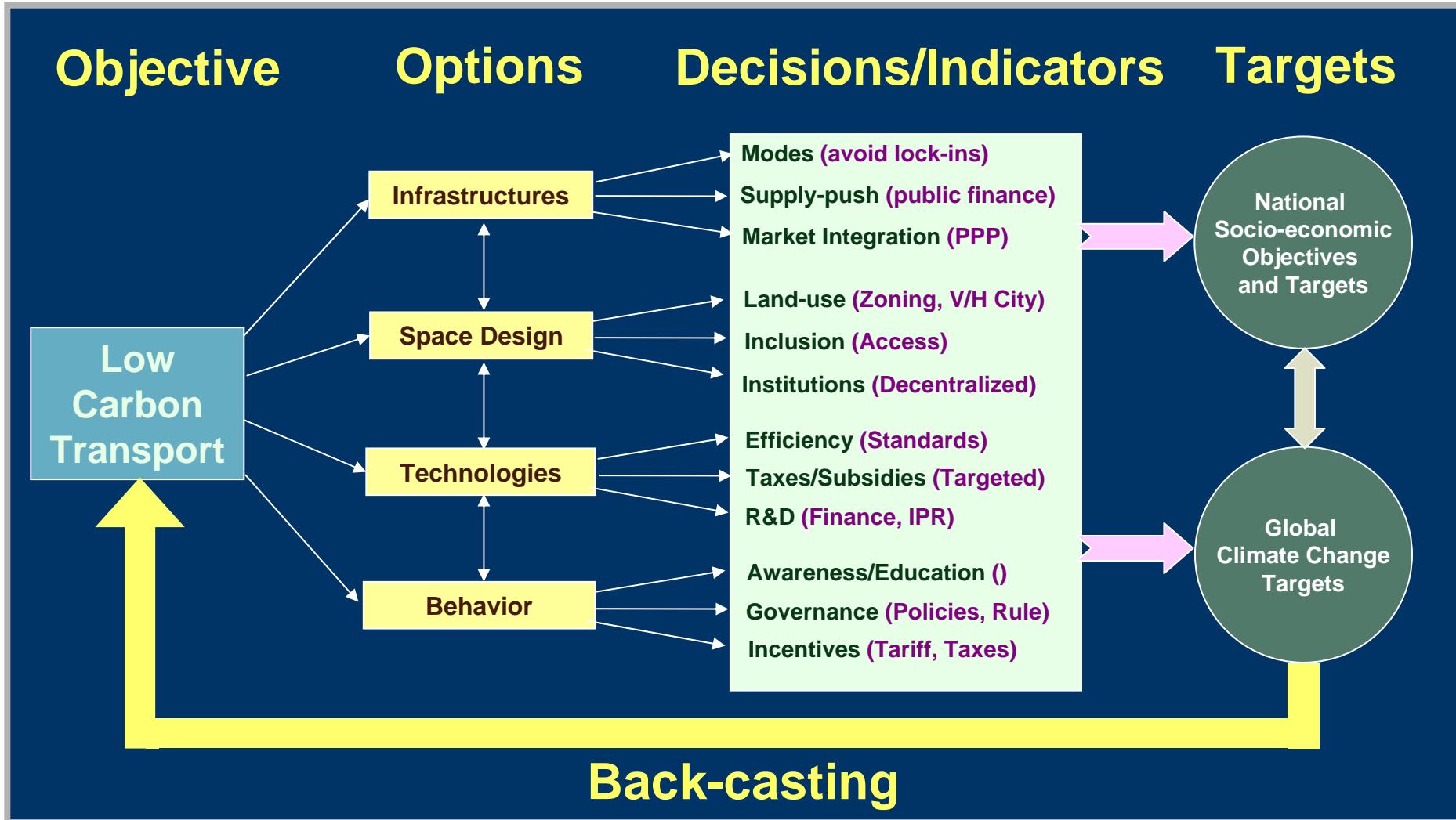
Meta (Strategic) Indicators

Indicator	Description	Measurement	Relevance
Sustainable Urban Form and Structure	Urbanization pattern to promote balanced regional and urban structure	<ul style="list-style-type: none"> • Population density • City-size distribution • Regional linkages of urban centers 	Urban form is a determinant of transport demand & supply. Urban & regional linkages are key drivers of sustainable growth & balanced development.
National Logistics Grid	Modes of transport use electricity for traction. Electric vehicles do not emit CO2 (or other pollutants) at consumption point but at generation.	<ul style="list-style-type: none"> • Reduce Travel Demand • Optimal locations of production centers • Linkages for domestic and international trade • Optimal multi-modal choices for primary energy & electricity T&D 	National level logistics planning is essential to: i) minimize transport demand by substitutions, ii) minimize costs via optimal modal shares, & iii) creating linkages for passenger and goods transport for desired level of access in all regions
Investment in Transport Sector Innovations	Transition to low carbon transport requires innovation in institutions, management, technology and infrastructures.	R&D budget for low carbon transport in public and private sectors	Technology RD&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

Macro Indicators (17): Summary

Economic (4)	Carbon Intensity of Transport	Energy Security	Transport Infrastructure Investment	Total Cost of Transport
Social (3)	Access to transport	Transport Subsidies	Food Security	
Environmental (3)	Air Pollution	Water Pollution	Water Stress	
Technical (4)	Vehicle (fleet) Energy & Emissions Efficiency	Carbon Content of Electricity	Transport demand substitution	Operational Efficiency of Transport Infrastructure
Meta (3)	Sustainable Urban Form and Structure	National Logistics Grid	Investment in Transport Sector Innovations	

Sustainable Low Carbon Mobility Framework



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

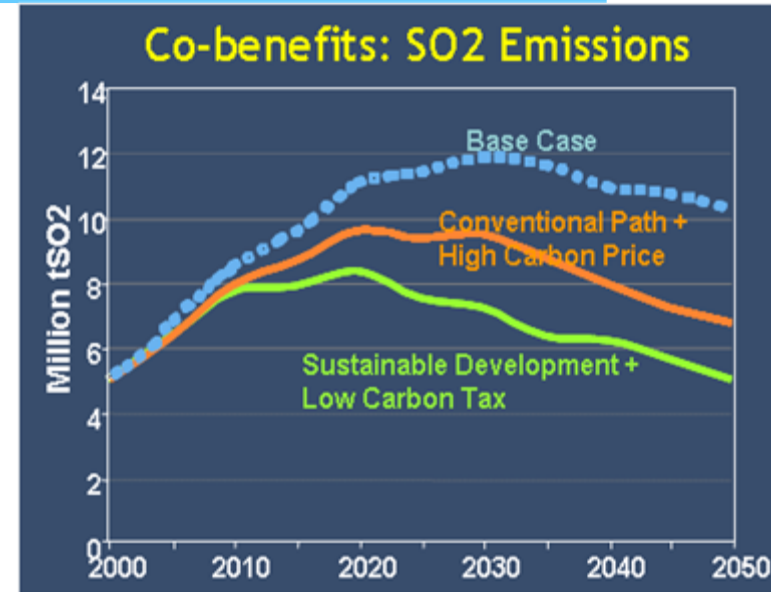
Implementation Strategy: 8 National Missions

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

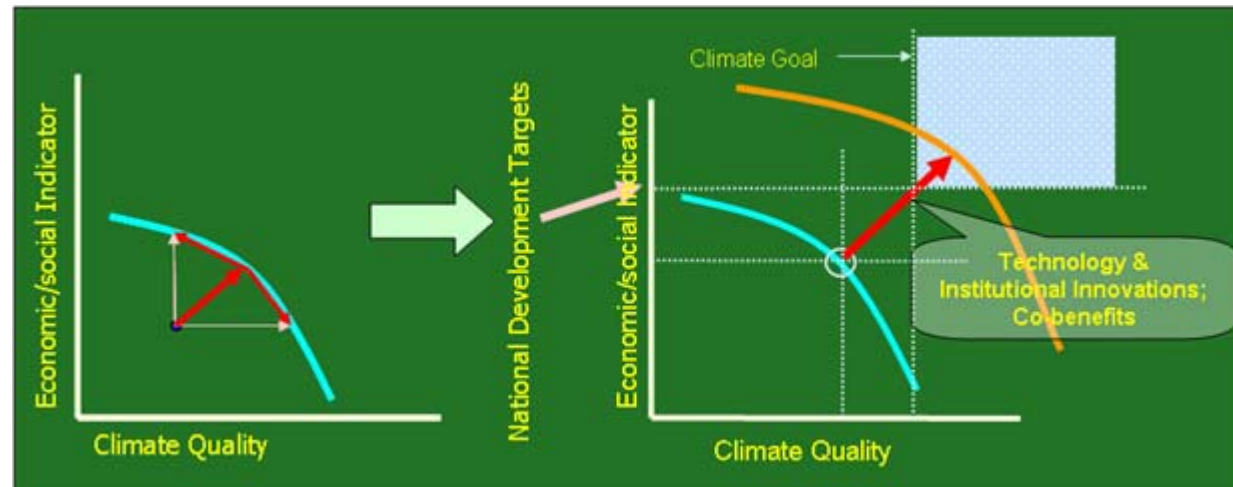
Technologies delivers multiple dividends

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



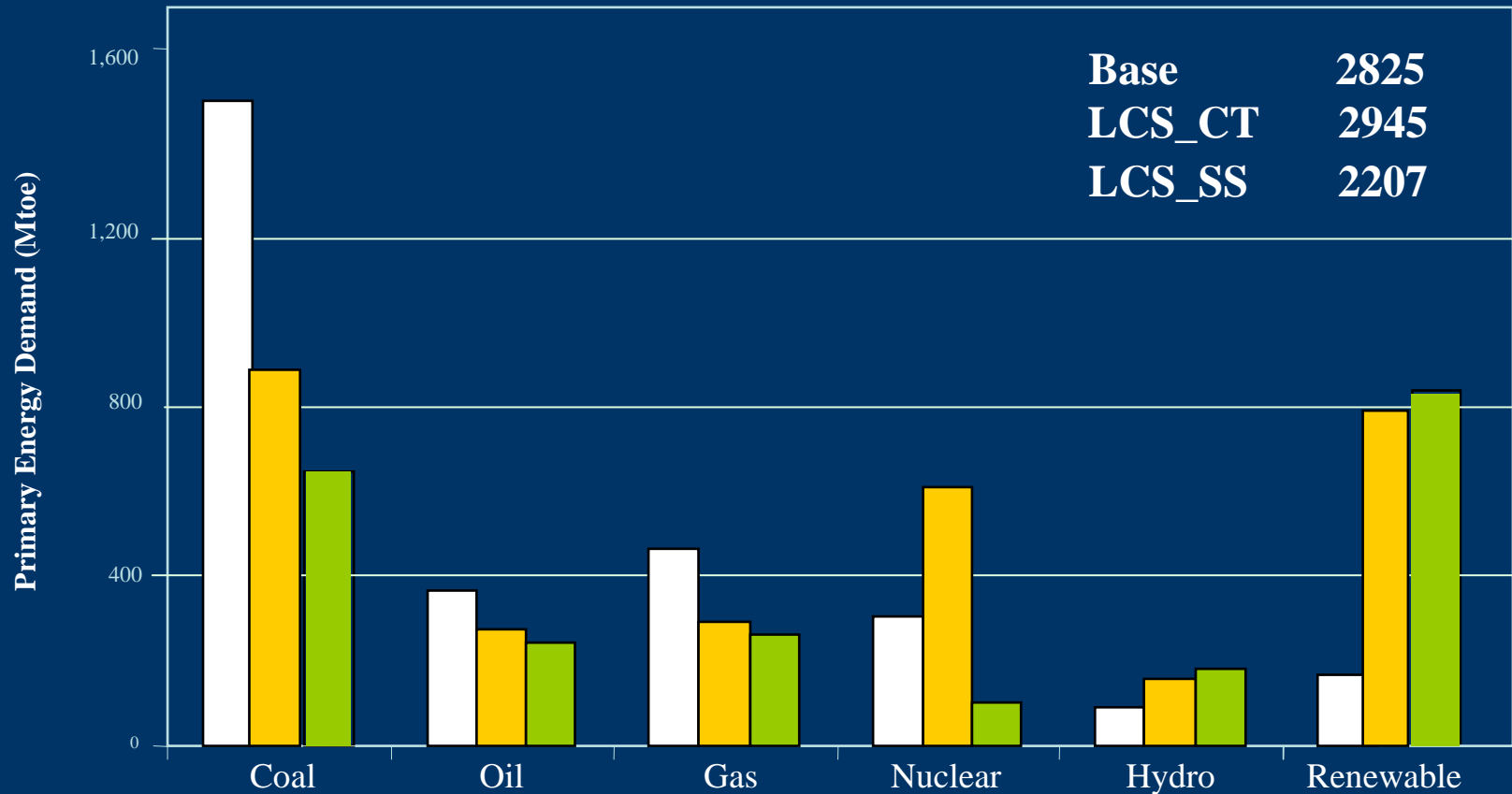
“For developing countries, the ‘good news’ is that their environment and natural resources policies are often so bad that there are reforms which would be both good for the economy and good for the environment.”

Joseph Stiglitz



Energy Security Co-benefits

Energy Mix in 2050

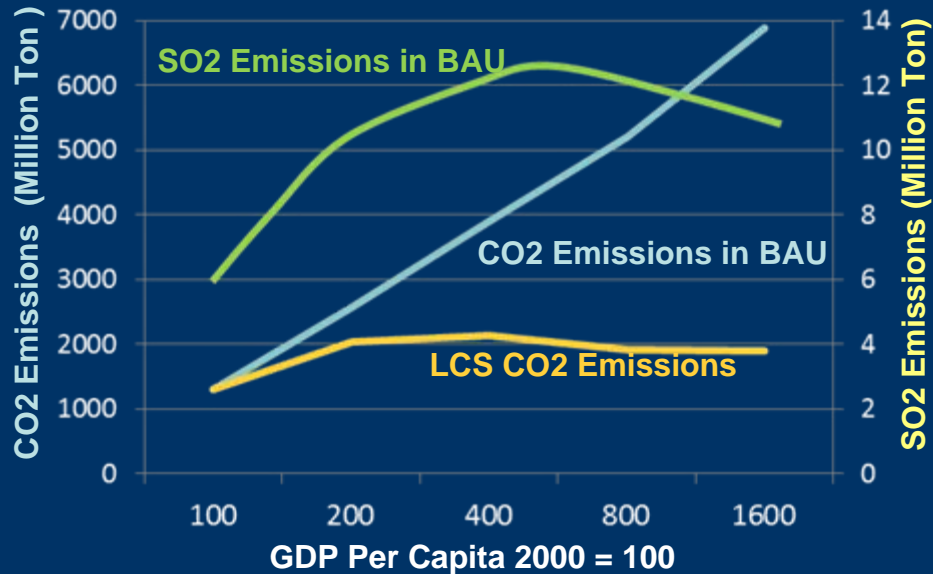


Base	2825
LCS_CT	2945
LCS_SS	2207

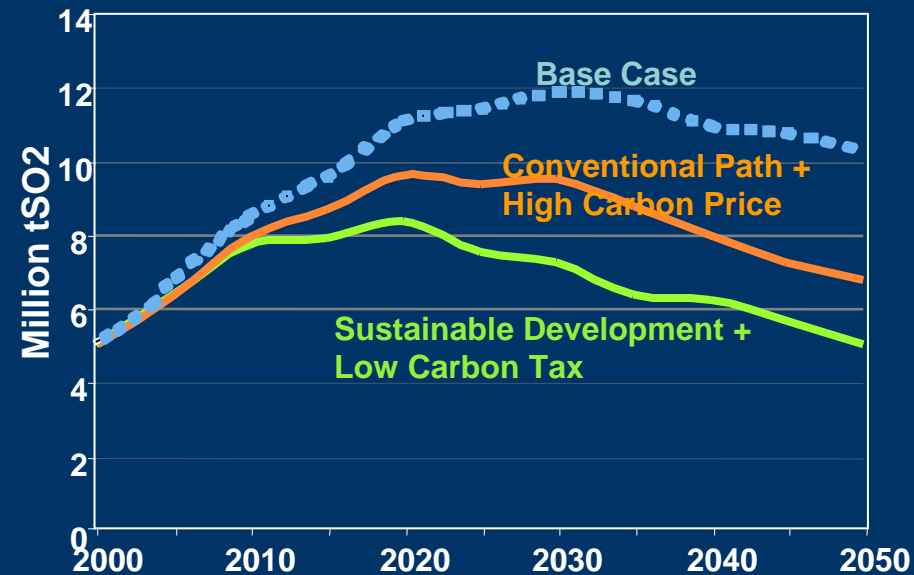
Analysis with ANSWER-MARKAL Model

Air Quality Co-benefits

Emissions and Income

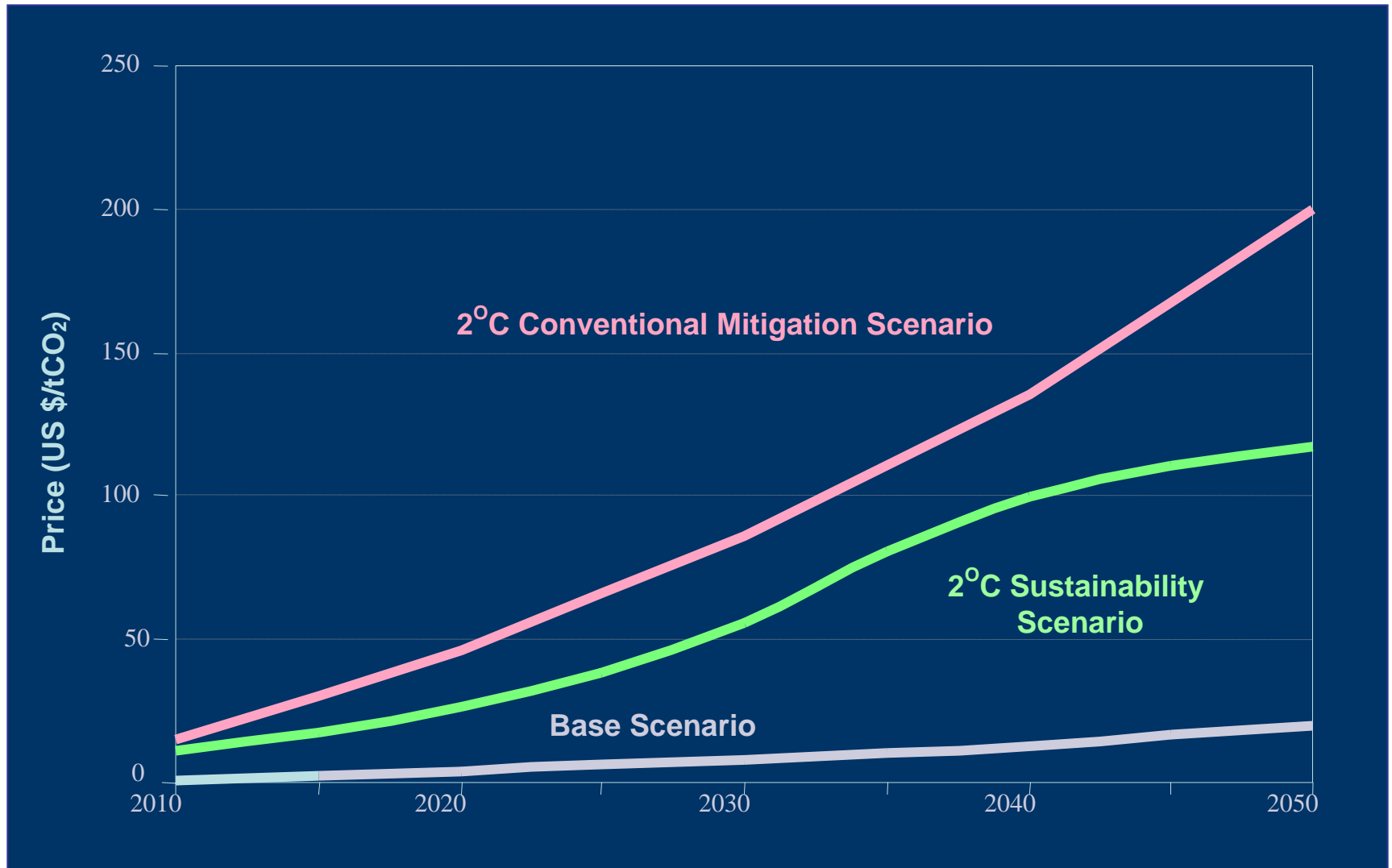


Co-benefits: SO2 Emissions



Analysis with ANSWER-MARKAL Model

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

