Transport Energy and Environment-pricing of transport

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Outline of the presentation

- Transport Sector
- Energy usage in Transport
- Comparing different modes
- Transport scenario in India/World-modal splits
- How does transport contribute to socio-economic development?
- Sustainability
- Role of Government in sustainable development
- Way forward

The Transport Sector

- Demand for freight and passenger transport in most developing and transition countries is growing 1.5 to 2.0 times faster than GDP
- Trend shows that as GDP/capita increases, passenger kilometers travelled increase. Therefore, growing economies demand ever higher speed transport.
- The estimated economic rate of return of projects in the transport sector is 20-22%, 50% higher than the Bank average

Costs of Building Transport Systems

- Land
- Construction (right of way, control systems)
- Vehicles
- Interest
- Depreciation
- Operations and maintenance

The Transport Sector

- Public investment in transport: 2.0 -2.5 percent of GDP (In India, 2.6% in 11th five year plan, 3.9% planned for 12th Five Year Plan)
- 40% investment of infrastructure is in transport
- Transport contributes to 3-5% in economy, In India, 6.4% in 2008-09 (5% road, 0.9% rail)
- Transport commonly accounts for 5-8%of total paid employment

Share of Transport sector in overall GDP in India

	2008-09	2009-10	2010-11	2011-12	2012-13 (1st RE)
Overall Transport	**6.6**	**6.6**	**6.5**	**6.6**	**6.7**
of which					
Railways	1.0	1.0	1.0	1.0	0.9
Road Transport	4.7	4.7	4.6	4.8	4.9
Water Transport	0.2	0.2	0.2	0.2	0.2
Air Transport	0.2	0.2	0.3	0.3	0.3
Services incidental to transport	0.4	0.4	0.4	0.4	0.4

Ref: white paper IR

General Comments on Transport

Traffic jams

Google images

- The advent of the automobile made the World smaller
- Facilitated businesses, stores, and industry that were farther away to become viable
- "Urban sprawl" -"bedroom community" -Concept of suburbs
  - Essentially, one goes there to sleep, and travels to other places for stores, work, and school
  - Cheap cars have enabled one to live even farther away from business, work, and stores

General Comments on transport

SUBURBS in Mumbai

Credit : Gorky M

- The combination of distant residences and vehicle mobility led to expansion of one's life
- Cheaper air travel -public inclined to journey to destinations that were too far from home for easy car travel; families dispersing
- Towns and cities now became so spread out that walking was no longer efficient or convenient

Economics of the "Last Mile" Travel

- A difficulty of public transit is that if one has to drive to a bus stop or train station, that distance has to be a small percentage of the driving distance
- In good weather, most people might walk
- One is not likely to ride a bus to near one's home and then take an expensive taxi the rest of the way home
- Still, in large cities, the cost of parking may be so great as to encourage public transit if the remaining distance is short

Consumer Demand

- Travel time budget: research shows that the mean time travelled per day is independent of income. Worldwide it is 1-1.5 hours.
- Likewise, around the world a person devotes on average 10-15% of their income to travel.

Energy, Development& Environment

ENERGY

- Ensures functioning of world economy
- Fuels industrial, agricultural, commercial, transportation, power generation activities
- Provides for habitat and subsistence needs

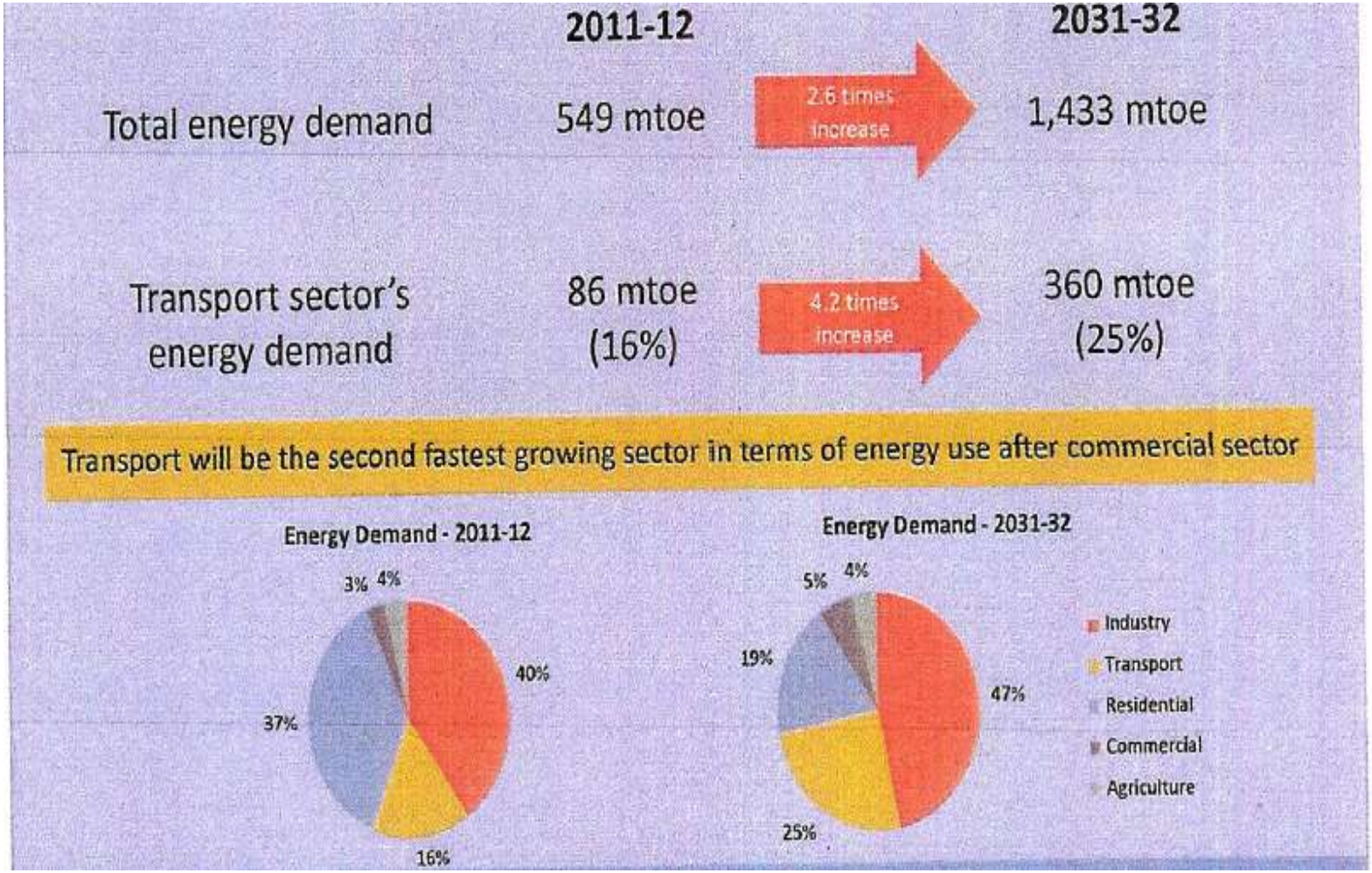
DEVELOPMENT

- Provides sources of energy, air, water and other resources needed to sustain life
- Enables the continued functioning of society and the economy

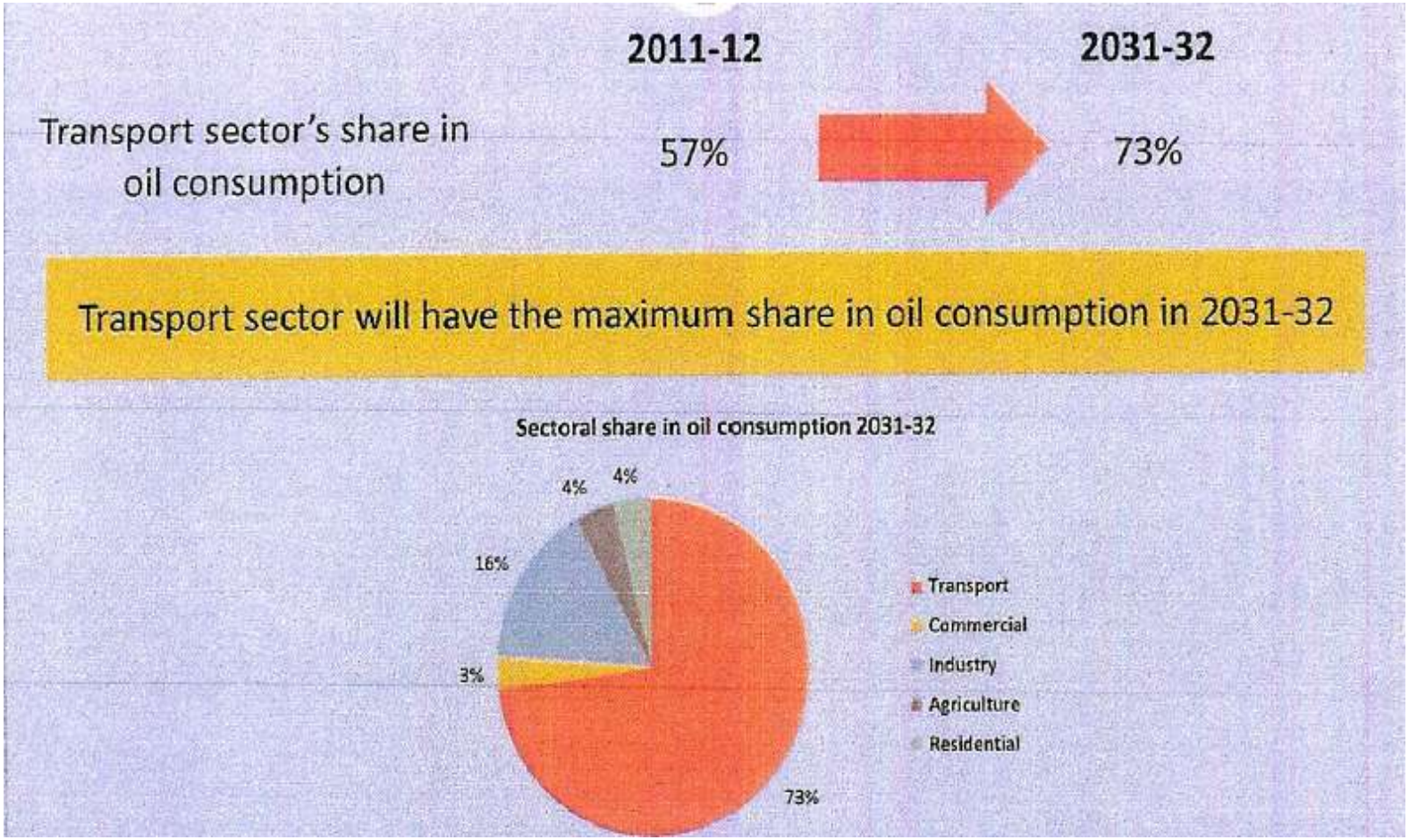
ENVIRONMENT

- Ensures perpetuity, Shapes and manages human society and the economy in a manner that satisfies the material and other needs of the world's population
- Enables the international community to evolve through mutual cooperation and co-exist in peace

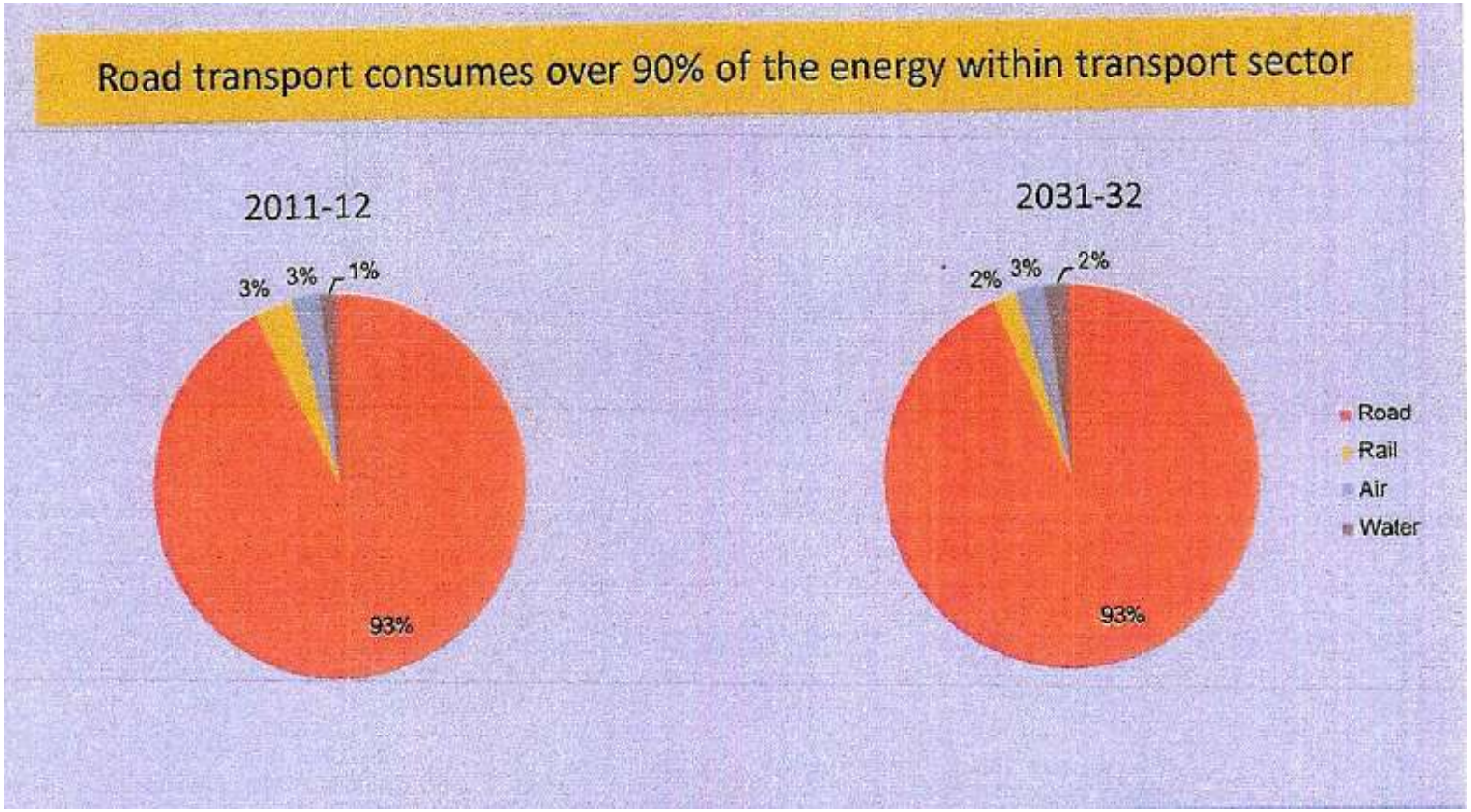
Transport sectors share in total energy consumption in India



TRANSPORT SECTOR HEAVY OIL DEPENDENCE



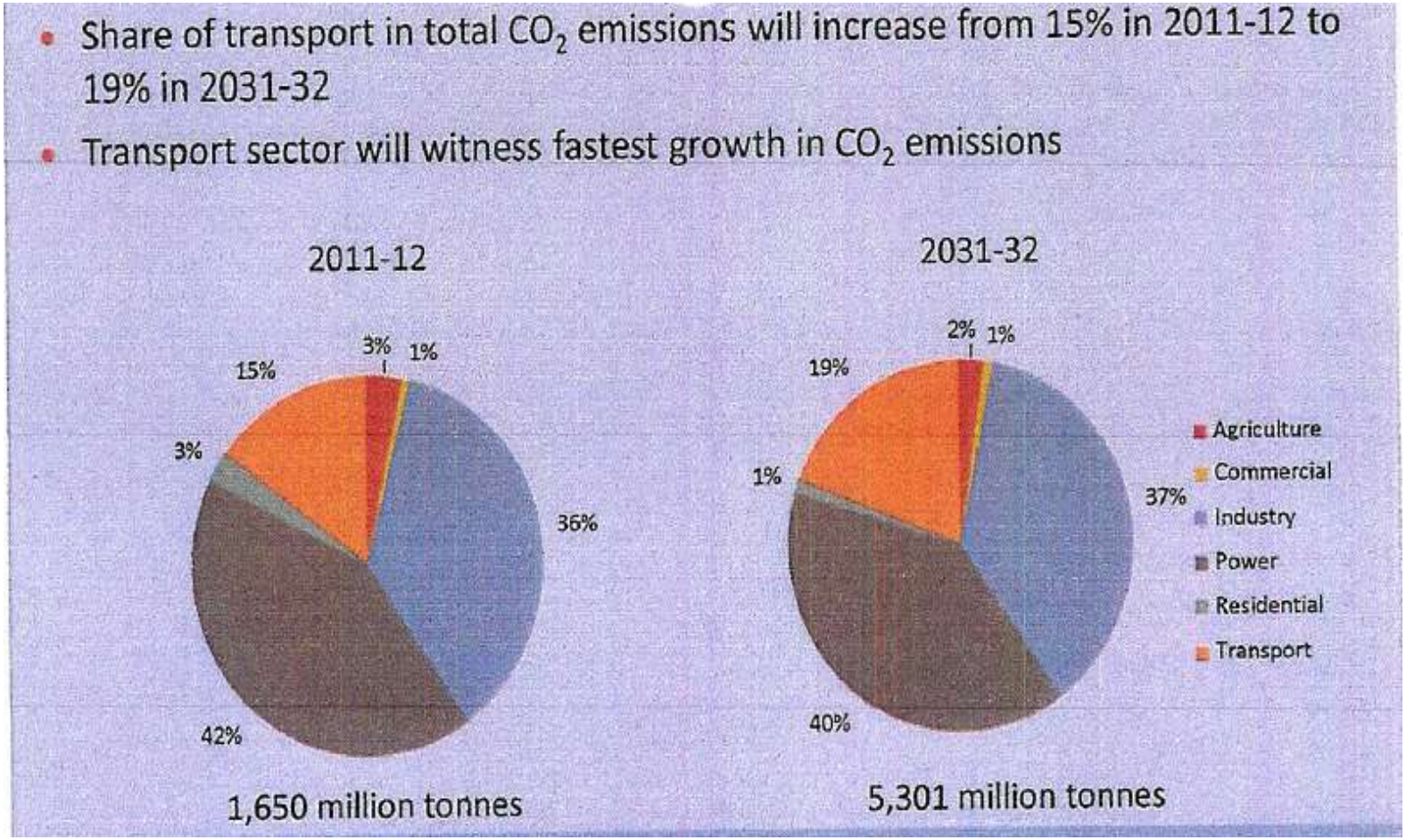
Mode wise energy consumption in transport



- Land vehicles use the majority of energy simply because there are so many of them.
- Transportation offers the best chance of reducing oil demand

EMISSIONS SET TO GROW IN TRANSPORT

- Share of transport in total CO_2 emissions will increase from 15% in 2011-12 to 19% in 2031-32
- Transport sector will witness fastest growth in CO_2 emissions



Comparing different modes

Road Transport

- National highways-69k
- State highways:600k
- Total 4689K kms Second in world
- Road density(000 people) 3.8
- Road density(000 sq km) 660

Competitive advantage:

- Flexible
- Door to door
- Cheap and Affordable
- positive economic and social benefits to our society

Road quality and road density, 2012

	Total Road Network, Km	Share of paved roads to total road network %	Population per km of road	Population per km of paved road
Indonesia	501,969	57	492	868
Malaysia	182,699	78	160	204
Philippines	215,088	27	450	1,672
Singapore	3,425	100	1,551	1,551
Thailand	231,620	81	288	357
Vietnam	258,200	66	344	519

Sources: Country Public Works Offices, ASEAN-Japan Transport Partnership, ASEAN Secretariat & author's calculations

Rail Transport

- RAILWAYS 64.5k km

  23 m1llion passengers and 3.0 MT daily- 21k trains, 1.4 million staff

  golden quadrilateral 55%fr and 60% pass

Competitive advantage:

Pollution
Congestion
Fuel efficiency

Yet our share is going down on IR

IW Transport

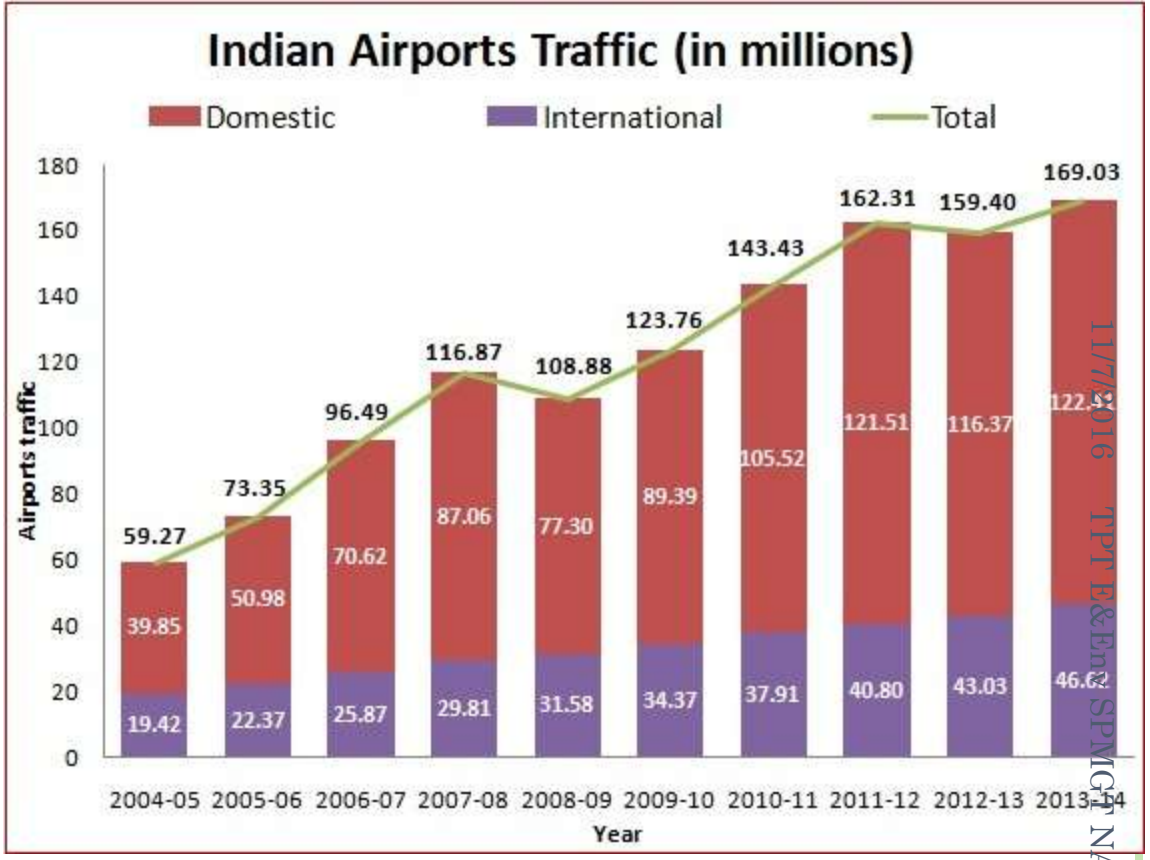
Photo Arnab Pratim Datta

- WATERWAYS: 14.5k km-
- WB, Goa, Kerela
- Only 0.15% of NTkm
- 0.1 MILLION passengers
- These waterways come under the Inland Waterway Authority of India (IWAI).
- IWAI is developing—Allahabad-Haldia, Sadiya-Dhubri (both in the Ganga and the Brahmaputra in the East) and Kottapuram-Kollam in Kerala

Competitive advantage:
Cheap
Green
Sea transport can carry intermodal containers

Ships travel in displacement mode, pushing the water aside rather than skimming over it

Airways Transport



Competitive advantage:
Fast
Can reach anywhere
More than 22 international airports
Can carry intermodal containers

TRANSPORT MODES AND THEIR COMPETITIVE ADVANTAGES

Road
Door to Door Transfer

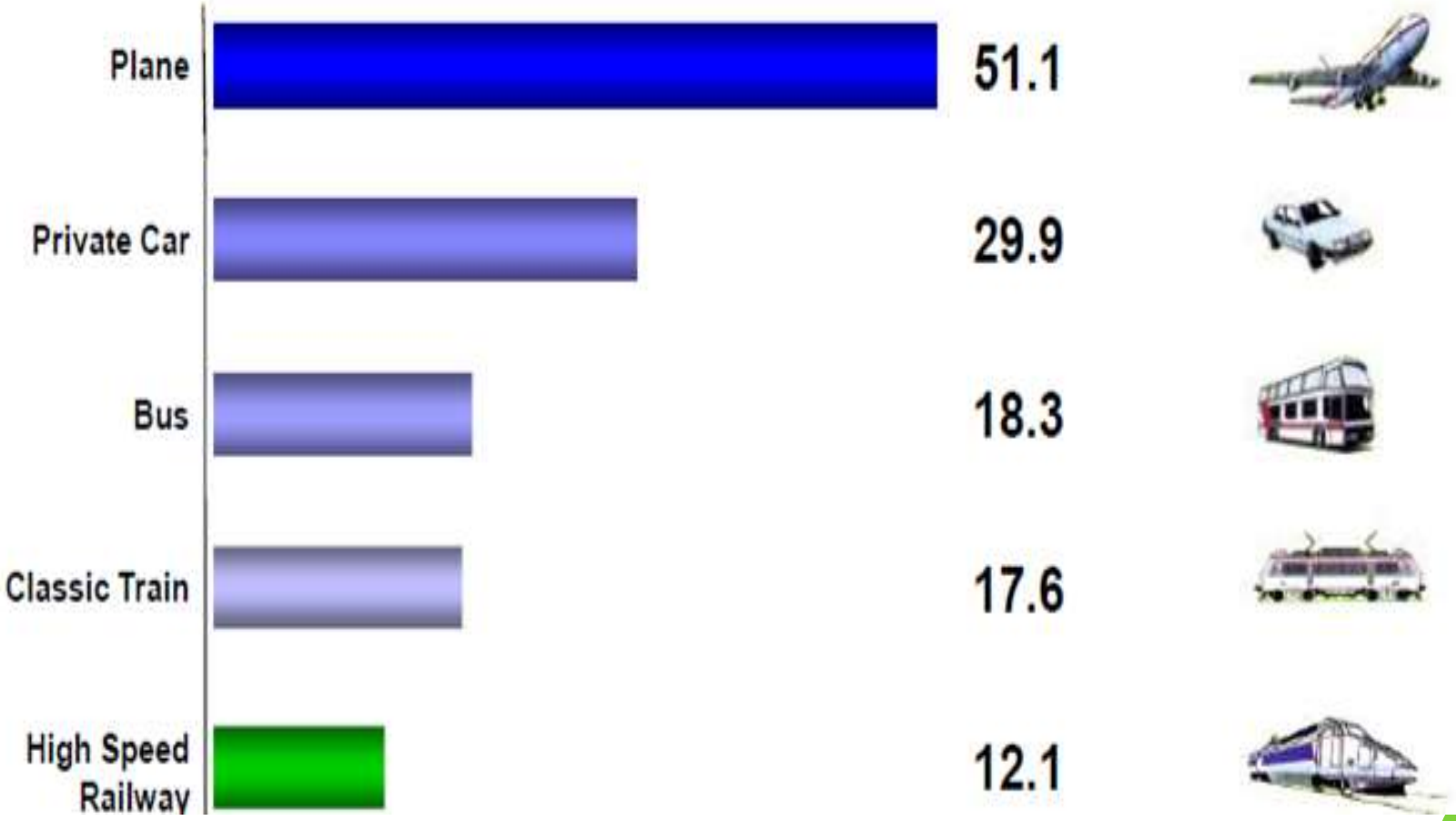
Air/Rail
High Speed

Water
Low Cost

Choice is driven by trade offs among prices, speed, safety, reliability and convenience

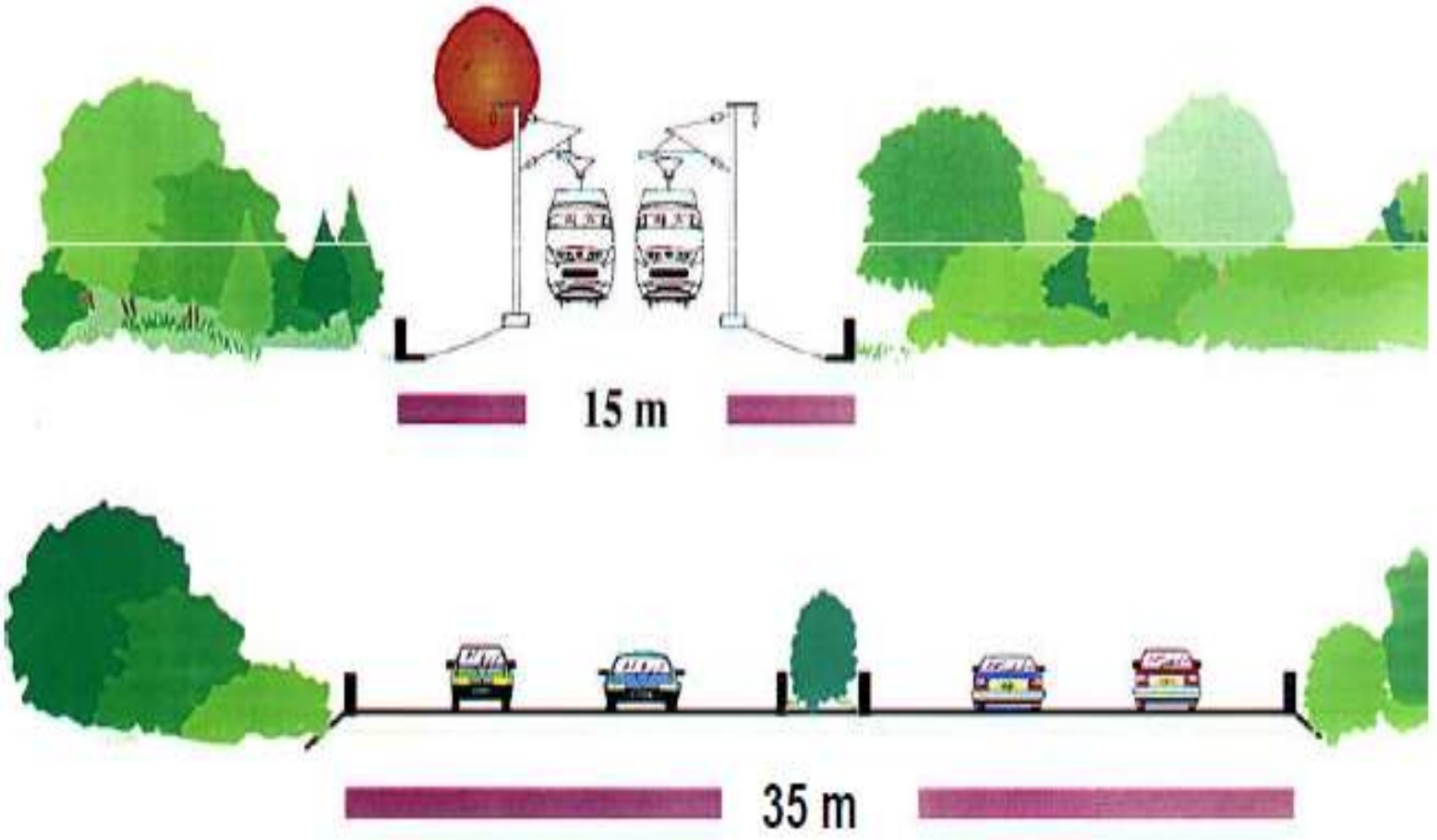
Supply price in a modal transport market and users' cost are the determinants of choice

Energy Efficiency



Fuel equivalent : per passenger-Kms (grams)

LAND USE EFFICIENCY



Dominance of Road in Freight in India

Table 1.1

Mode Share in Freight Traffic (2007-08)

MODE	MODAL SHARE IN TOTAL ORIGINATING TRAFFIC		PERCENTAGE SHARE IN TOTAL TRANSPORT OUTPUT (PER CENT)	
	TONNES(MILLION)	NTKMs (BILLION)	TONNES	NTKMs
Rail*@	769	508	30	36
Highways (Road)@	1,559	706	61	50
Coastal Shipping	59	86	2.3	6
Airways	0.28	0.29	0.01	0.02
IWT	55	3.5	2.1	0.24
Pipelines	113	105	4.5	7.5
TOTAL	**2,555**	**1,409**	**100**	**100**

Source: Total Transport System Study (TTSS) by RITES Ltd. (for Planning Commission, GoI).

Note:

* Includes IR & KRC 'non-revenue' inter-regional traffic as well as NTPC's MGR traffic aggregating to 1.86 million tonnes and 26.1 million tonnes respectively.

@ Excluding intra-regional traffic of 96.6 MT by rail and 4640 MT assessed separately.

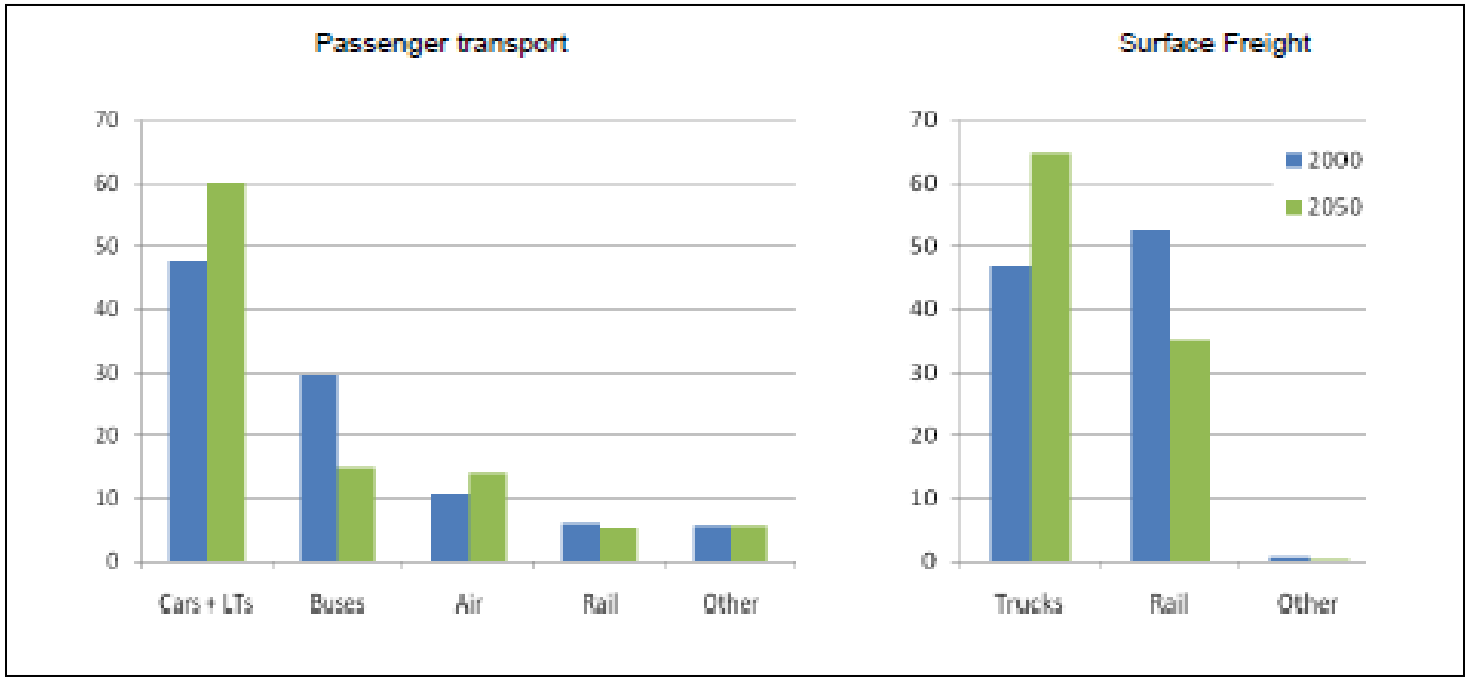
MODES: REALITY

- Being used for Long Haul
- Shortage of Skilled Drivers
- High Turn-Around Time

- Improper Utilization of Infrastructure
- Improper Management
- Non-Adherence to Standards

- Lack of Infrastructure at Inter-Change Points
- In-adequate draft through out the length
- Lack of Suitable Barges

Global Modal Split, 2000 and 2050 halfway case between high and low scenario (%)



- Share of private passenger vehicles is expected rise.
- Share of road in freight movement is also likely to rise as compare to the expected decrease in rail share in surface freight movement.

Passenger Modal Split by Region, 2000-2030-2050

Year	Region/countries	Road	Rail	Air	Other	Total
2005	OECD North America	85	1	14	0	100
	OECD Europe	76	5	16	3	100
	OECD Pacific	72	9	13	6	100
	China	50	15	9	26	100
	India (2006-07)	87	13	-	-	100
	Latin America	84	1	12	3	100
	Rest of the World	77	9	6	8	100
2030	OECD North America	75	1	24	0	100
	OECD Europe	66	5	26	3	100
	OECD Pacific	64	10	21	5	100
	China	67	9	12	12	100
	India (2031-32)	97	3	-	-	100
	Latin America	82	0	14	4	100
	Rest of the World	77	6	8	9	100

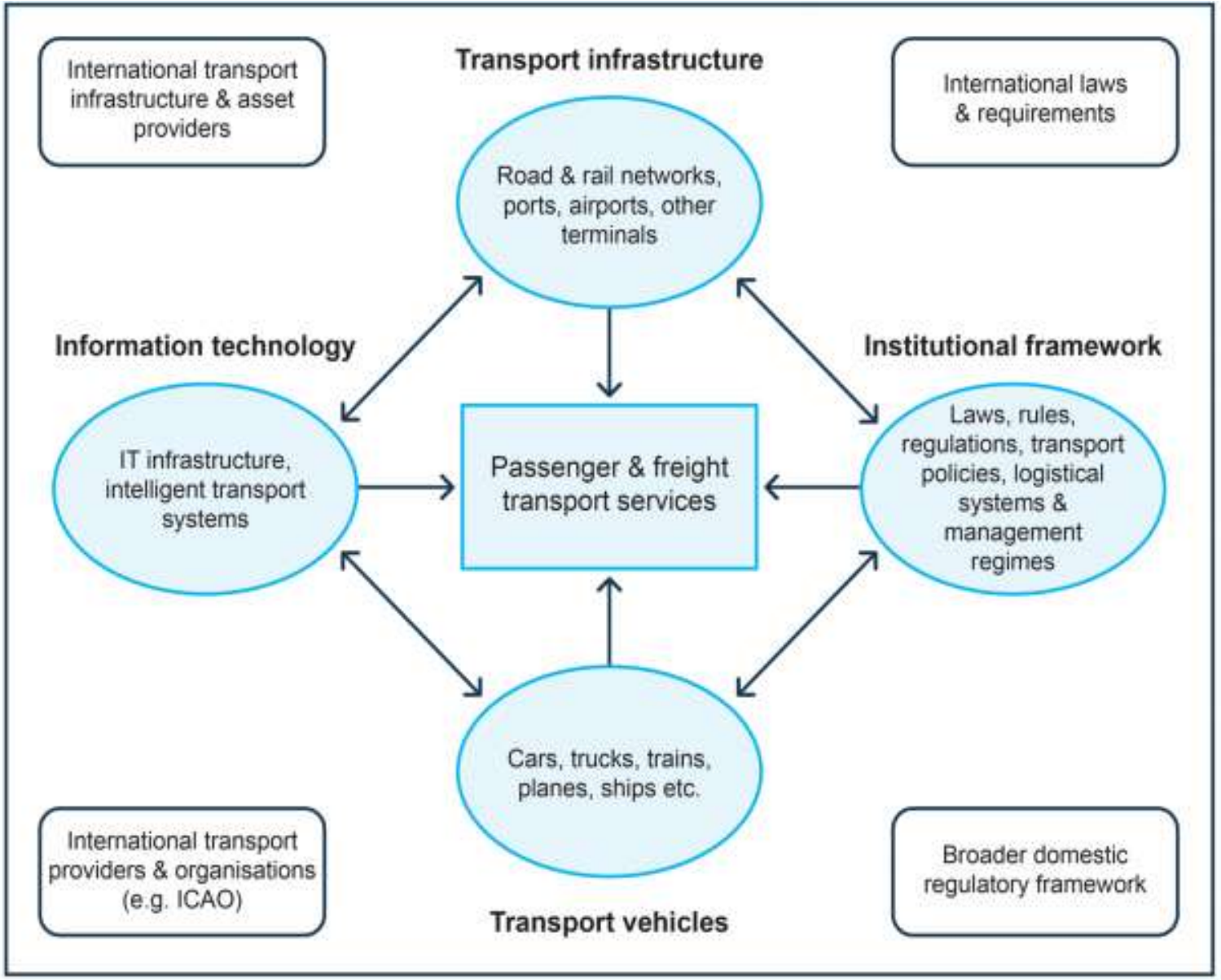
Freight Modal Split by Region, 2000-2030-2050 optimal

Year	Region/countries	Road	Rail
2005	OECD North America	40	60
	OECD Europe	86	14
	OECD Pacific	72	28
	China	25	75
	India (2004-05)	61	39
	Latin America	84	16
	Rest of the World	87	13
2030	OECD North America	48	52
	OECD Europe	89	11
	OECD Pacific	77	23
	China	46	54
	India (2031-32)	50	50
	Latin America	89	11
	Rest of the World	91	9

Intermodal Shipping Container-All modes can collaborate

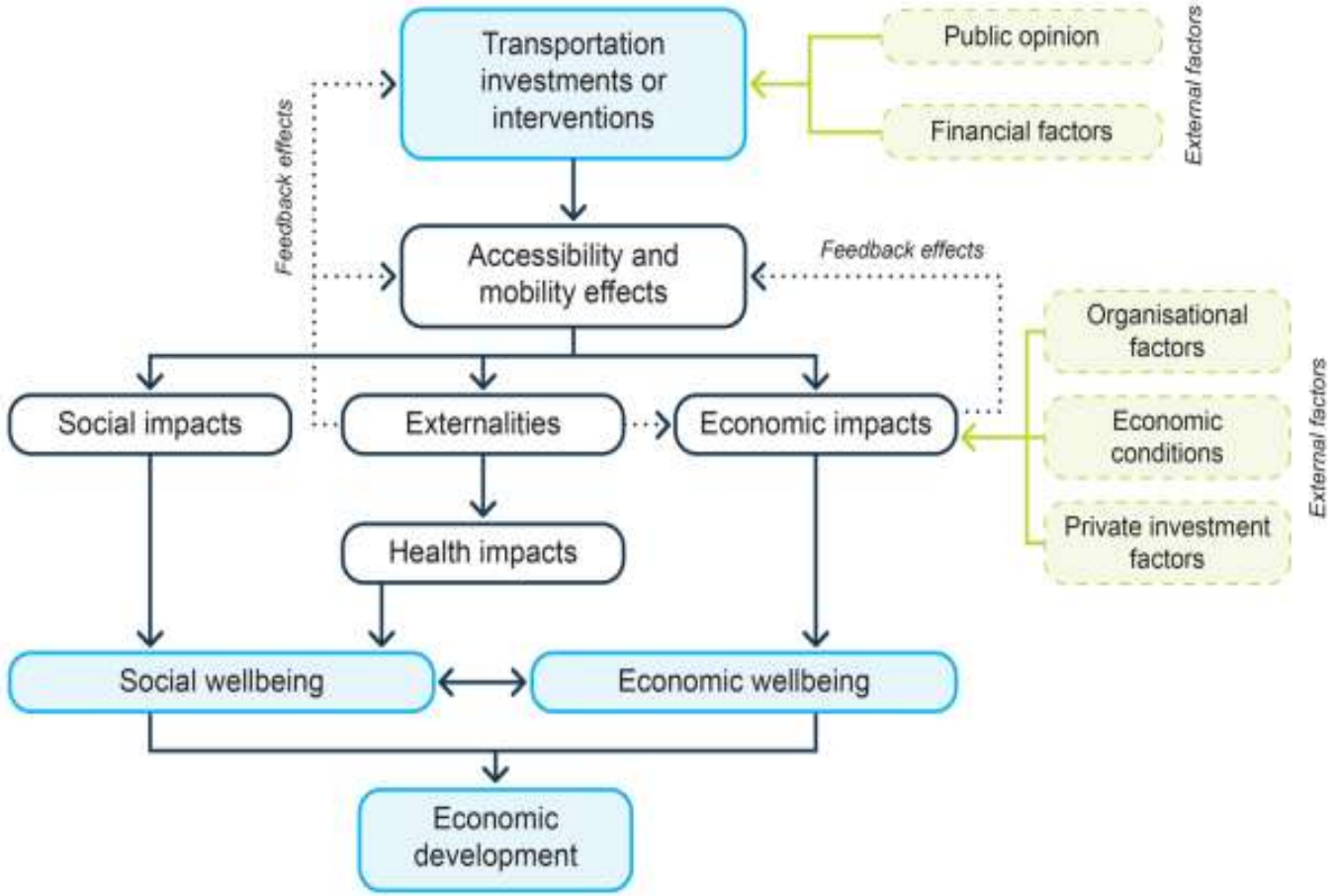
- Fits ships, trucks, trains, or sets on ground

Transport Infrastructure and (hidden)costs of transport



Source: adapted from Lakshmanan and Anderson (2002), Figure 9, p.21

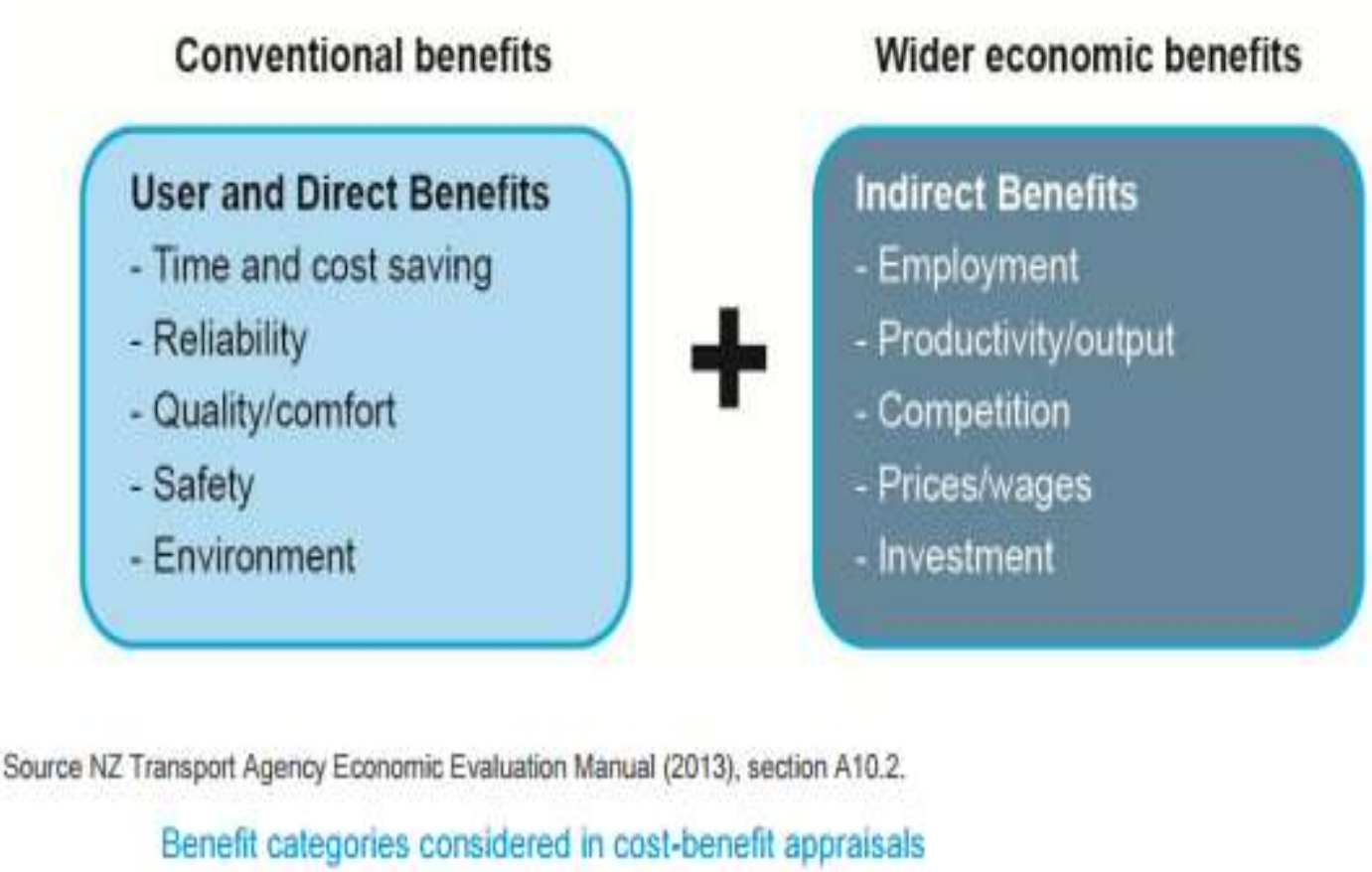
TRANSPORT AND ECONOMIC DEVELOPMENT



Source: adapted from Leung (2006)

Transport and economic development – key connections

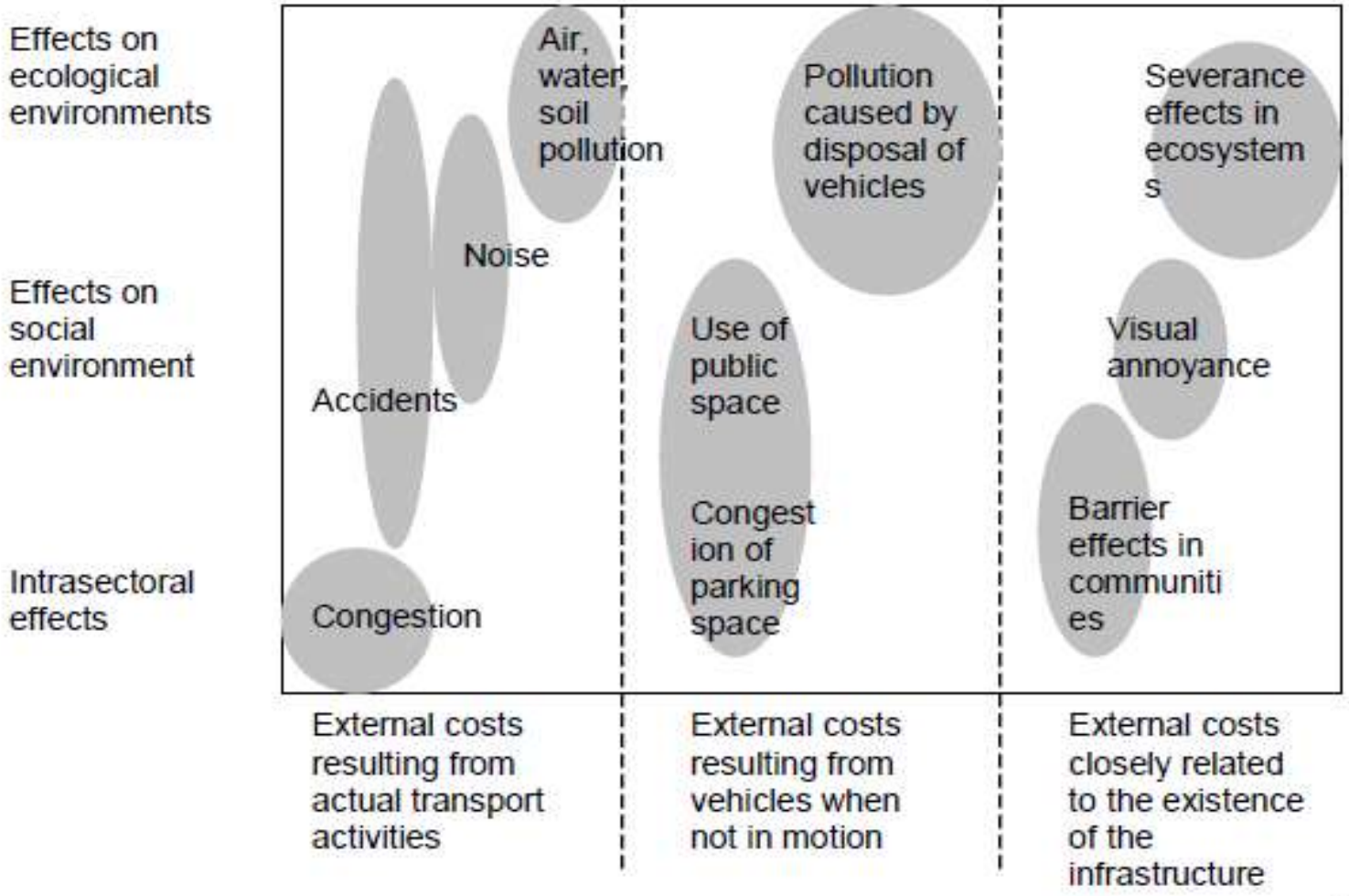
How transportation contributes



Source NZ Transport Agency Economic Evaluation Manual (2013), section A10.2.

Benefit categories considered in cost-benefit appraisals

External Costs---



Source: Verhoef (1996)

External Costs

- Air Pollution
  - Carbon Monoxide (CO)
  - Nitrogen Dioxide (NO_2)
  - Hydrocarbons and Volatile Organic Compounds(HC/VOC)
  - Carbon Dioxide (CO_2)
- Water Pollution
  - Air pollution fallouts
  - Marine vessel discharges and spills
  - Construction of infrastructure
- Noise pollution

Private (or internal costs)

- Directly borne by transport users
  - costs of depreciation and maintenance of vehicles
  - costs of insurance
  - fuel costs
  - own time costs
  - transport fares
  - transport taxes and charges
- Market mechanism charges these costs directly to the users

Government Expenditure

- Construction and maintenance of infrastructure (including facilities for the environment and traffic safety such as noise barriers and wild life viaducts)
- Traffic duties of police and justice
- Other government activities (license registration etc)
- Public transport subsidies
- Other transport related government expenditures

Indian Railways: Subsidies

- Carriage of essential commodities at below cost
- Passenger and other coaching service at below cost and loss in suburban services, uneconomic branch lines
- Freight concession on relief materials, other obligations such as education, security etc

Social Costs

- All costs occurring due to the provision and use of transport infrastructure
- Sum of internal, external and government expenditures

- Social costs = Internal costs + external costs + (government expenditure)

External Cost Estimates in EU

- As per UIC study, the total external cost of transport in the EU-27 plus Norway and Switzerland in 2008 amount to more than € 500 billion (4% of the total GDP of EU)
- About 77% of the costs are caused by passenger transport and 23% by freight
- The annual congestion cost of road transport delays amount to between € 146 and 243 billion (1 to 2% of the total GDP)

Externalities- Unintended external impacts !! Do we monetize them

Others: visual intrusion, physical intimidation(of cyclists/pedestrians), congestion and disruption

TCS Study-social cost of road accident

- Cost of a fatal accident (sum of)
  - Gross loss of future output
  - Notional value of pain, grief and suffering (as a percentage of gross output loss)
  - Hospital expenditure
  - Loss of earnings during hospitalization
  - Lawyers' fees
  - Surveyors' fees
  - Administrative expenses by police, insurance companies and courts
  - Relatives‘ costs.

TCS Study

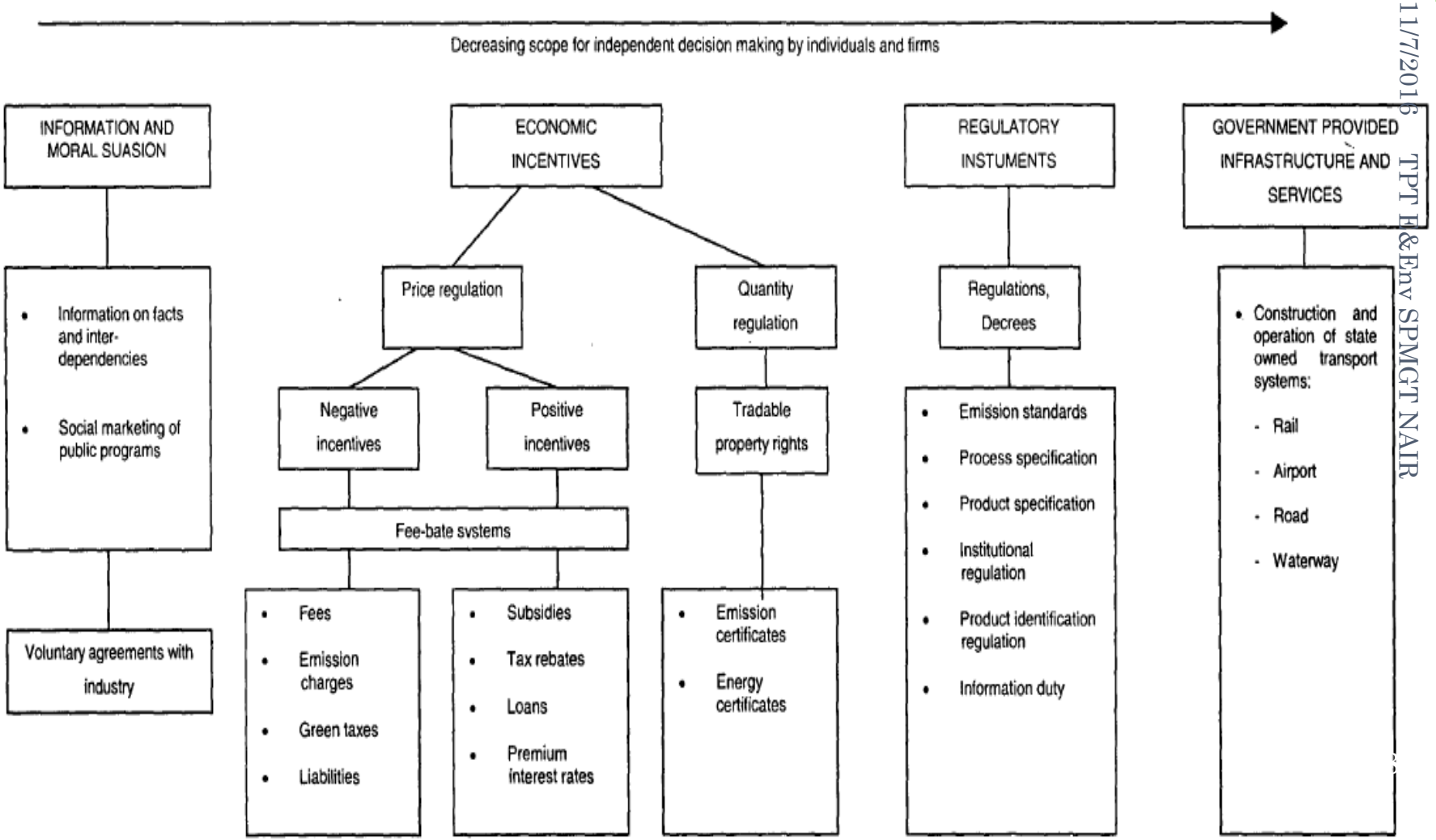
- Cost of damages to vehicle (sum of)
  - Repair charges of the damaged vehicle
  - Wages of the crew
  - Surveyors' fees
  - Administrative expenses of insurance companies

Internalization

- Is a way to give transport users the right incentives
- The internalization of external costs can done through
  - Regulation, i.e. command and control measures
    - Emission standards, process specification, product specification, institutional regulation
  - Market-based instruments (e.g. taxes, charges, emission trading, etc.)

Tall people have to pay for extra legroom …

Policy Instruments for Internalizing External Costs



Comparison of Rail and Road in India

Table 1.4

Comparison of Environmental and Social Sustainability of Rail and Road Transport

Energy Consumption	• As compared to road, rail consumes 75 per cent to 90 per cent less energy for freight traffic and 5 per cent to 21 per cent less energy for passenger traffic
Financial Costs	• Unit cost of rail transport was lower than road transport by about Rs 2 per NTKM and Rs 1.6 per PKM (in the base year 2000)
Environmental Damage	• Rail transport emits 17 gram CO_2 equivalent per PKM as compared to 84 gram per PKM in case of road transport • Rail transport emits 28 gram CO_2 equivalent per NTKM as compared to 64 gram per NTKM in case of road transport
Accident Costs	• Accident costs on road are significantly higher than those on rail • For passenger transport, road accident costs are 45 times higher than rail • For freight transport, road accident costs are 8 times that of rail
Social Costs (All-Inclusive Costs)	• In terms of all-inclusive costs or social costs, railways have a huge advantage over road transport (the advantage is more in case of freight traffic) • For urban areas, the cost advantage of rail (in the base year 2000) was as much as Rs 2.8 per NTKM and Rs 1.7 per PKM • For non-urban areas, the cost advantage of rail (in the base year 2000) was as much as Rs 2.5 per NTKM and Rs 1.7 per PKM

Source: AITD report on 'Environmental and Social Sustainability of Transport- Comparative Study of Rail and Road' (2000); International Union of Railways (UIC); McKinsey's Building India: Transforming the nation's Logistics Infrastructure, 2010; Report of the Working Group on Railways (NTDPC).

SUSTAINABILITY…

Meeting present needs of today's populations without <u>compromising</u> the needs of future generations.

GLOBAL EMISSION SCENARIO

2008 Emissions Data for Selected Countries

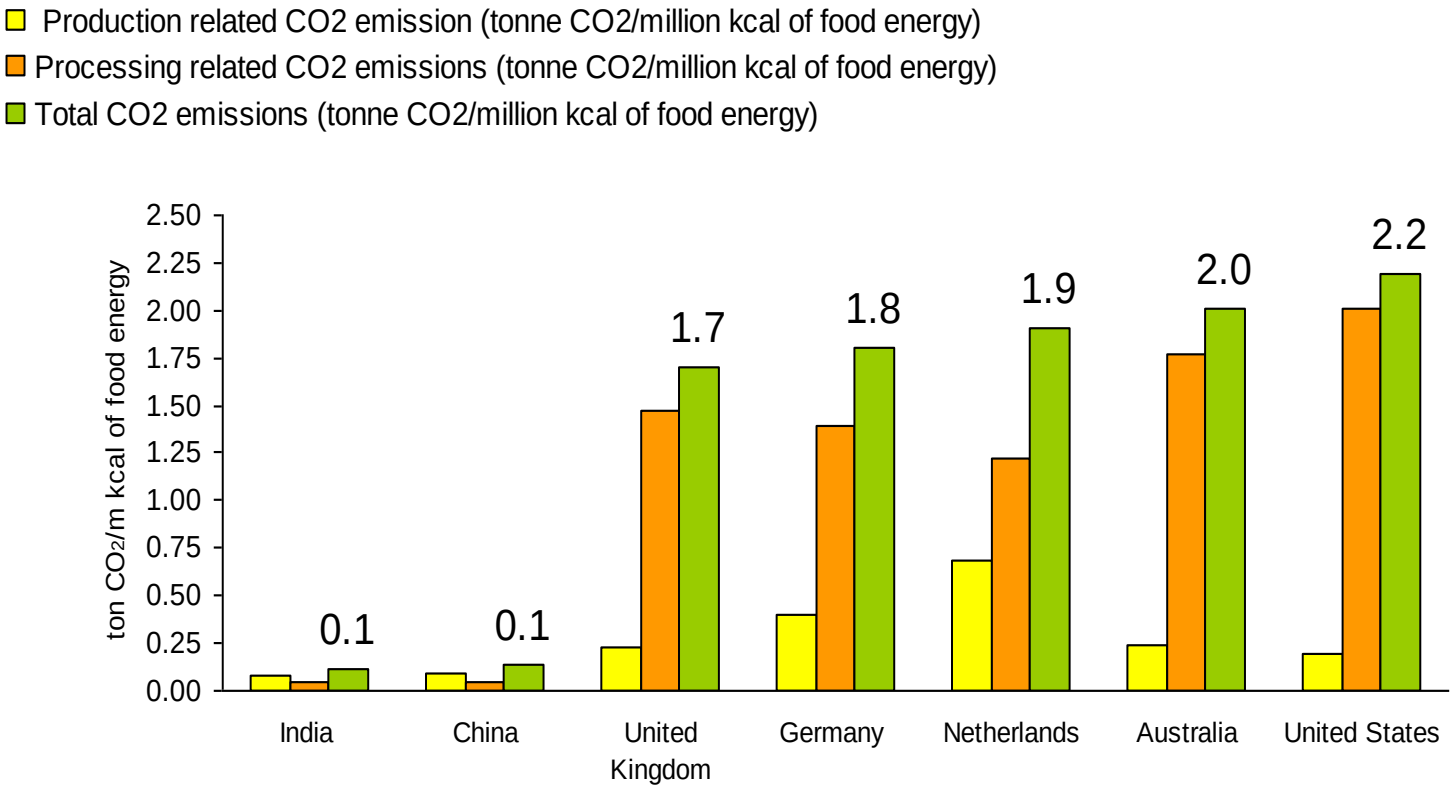
Region / Country	Population (million)	GDP (billion 2000 US$)	GDP ppp (billion 2000 US$)	Energy Cons. (MTOE)	CO_2 Emissions MT CO_2	Per-capita Energy Cons. (kgOE)	Energy Intensity KgOE/ $GDPppp	Kg CO_2/ $GDP ppp	Per-capita Electricity Cons. (kwh)	Per-Capita CO_2 Emission (tonnes)
World	6609	39493	61428	12029	28962	1.82	0.20	0.47	2752	4.38
China	1327	2623	10156	1970	6071	1.48	0.19	0.60	2346	4.58
Brazil	192	808.95	1561	235.56	347	1.23	0.15	0.22	2154	1.80
India	1123	771	4025	421	1146	0.53	0.10	0.28	543	1.18
Japan	128	5205	3620	513.5	1236	4.02	0.14	0.34	8475	9.68
S. Africa	48	178	517	134.3	346	2.82	0.26	0.67	5013	7.27
Thailand	64	173	548	104	226	1.63	0.19	0.41	2157	3.54
Turkey	74	372	821	100	265	1.35	0.12	0.32	2210	3.59
UK	61	1766	1833	211	523	3.48	0.12	0.29	6142	8.60
USA	302	11468	11468	2340	5769	7.75	0.20	0.50	13616	19.10
France	64	1506	1738	264	369	4.15	0.15	0.21	7573	5.81
Germany	82	2065	2315	331	798	4.03	0.14	0.34	7185	9.71
Russia	141.79	429.55	1651.17	786	1593.83	5.54	0.48	0.97	6443	11.24

Source: International Energy Agency 2009

GHG emissions depend upon lifestyles!

- Public transit was much more popular when private vehicles didn't widely exist.
- The mobility offered by a private personal vehicle meant that someone could go on a moment's notice to some arbitrary destination with persons of their choice.
- India's low per-capita GHG emissions are only partly due to poverty. *A significant part is due to inherently sustainable lifestyles that do not change significantly as people become better-off!*
- *Some international comparisons illustrate the point:*

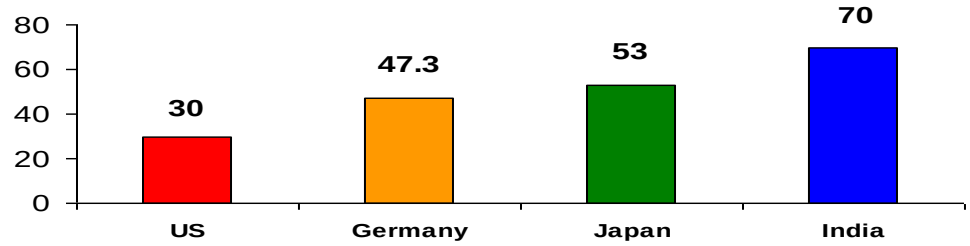
CO_2 emission from food sector--from Field (production) to Table (processed food)-*excluding cooking*



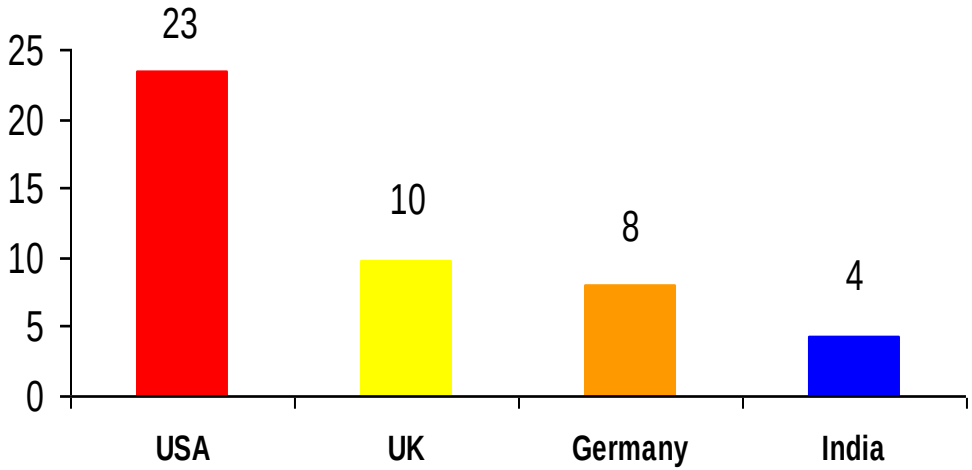
Source: TERI analysis (various data sources)

Municipal solid waste

Average rate of recycling (%) (excl. re-use)

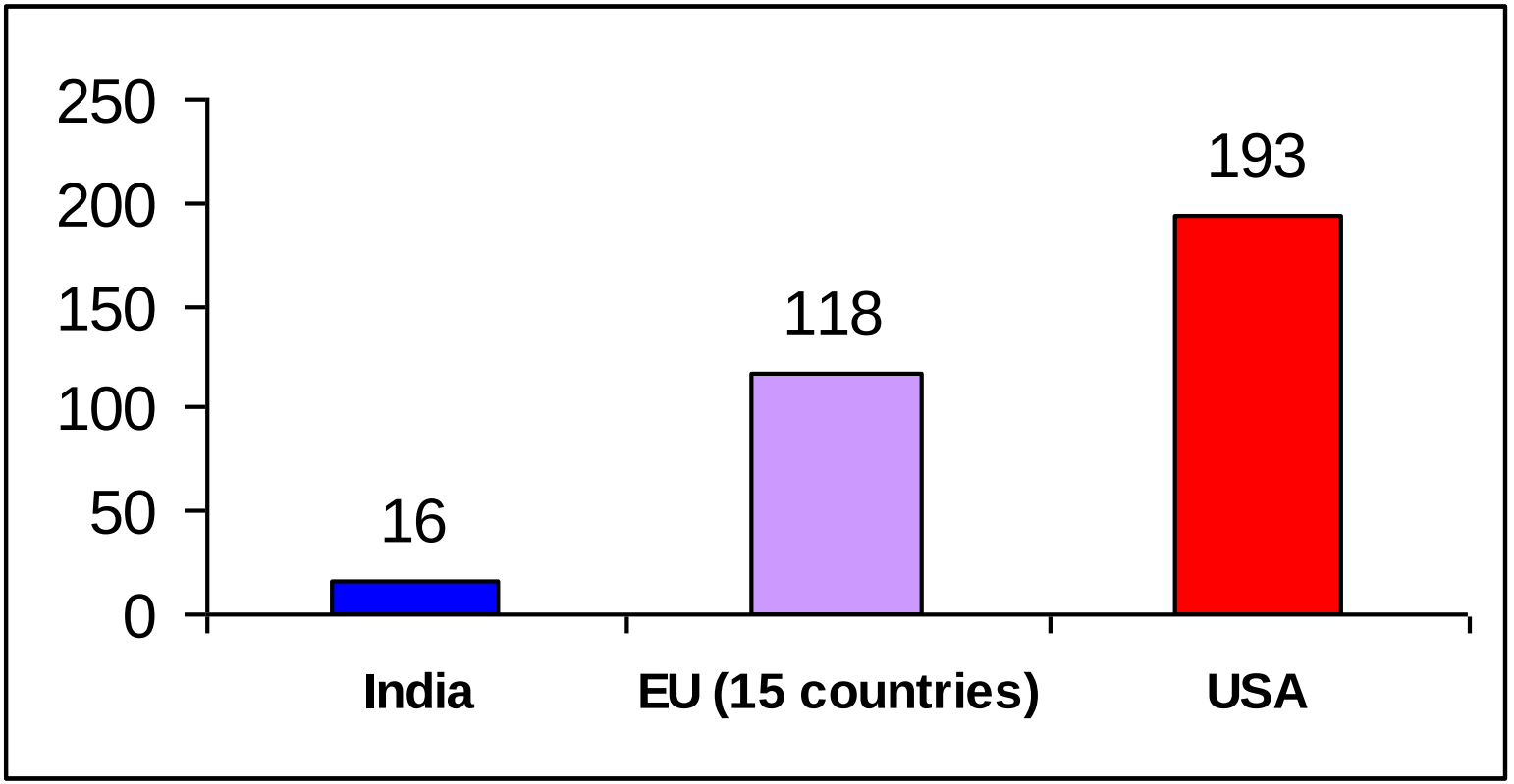


GHG emissions from waste (gm/'ooo$GDPppp)



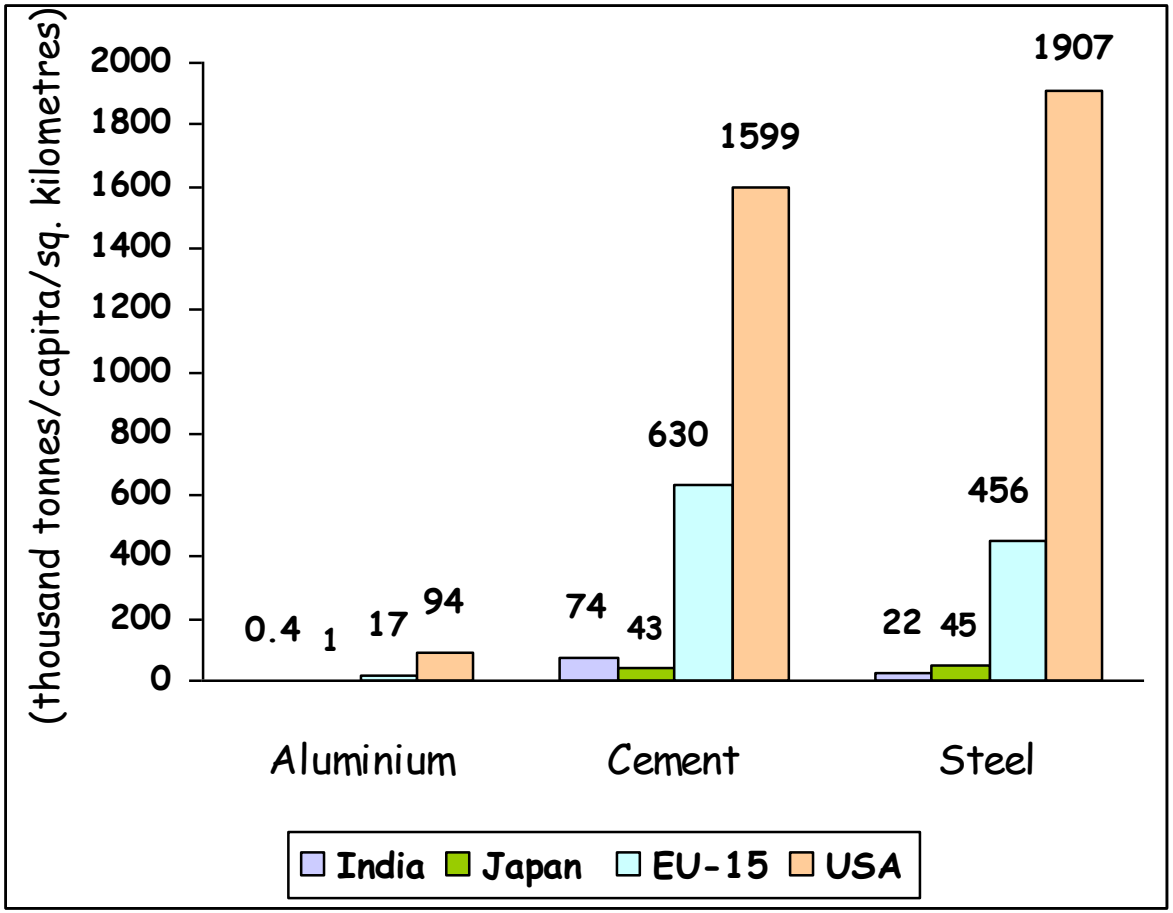
Source: TERI Analysis, based on National Communications of different countries

Estimated CO_2 emissions from passenger transport (gm/passenger-km)



Source: TERI Analysis, various data sources

Per-capita consumption of construction materials per-unit of inhabited land area



Tragedy of Commons

- Free access and unrestricted demand for a finite resource ultimately dooms the resource through its over-exploitation.

- This occurs because the benefits of exploitation accrue to individuals who are motivated to maximize his or her use of the resource, while the costs of exploitation are distributed between all those to whom the resource is available.

- That is, the individual benefits while the group pays for the use, extraction and consequences

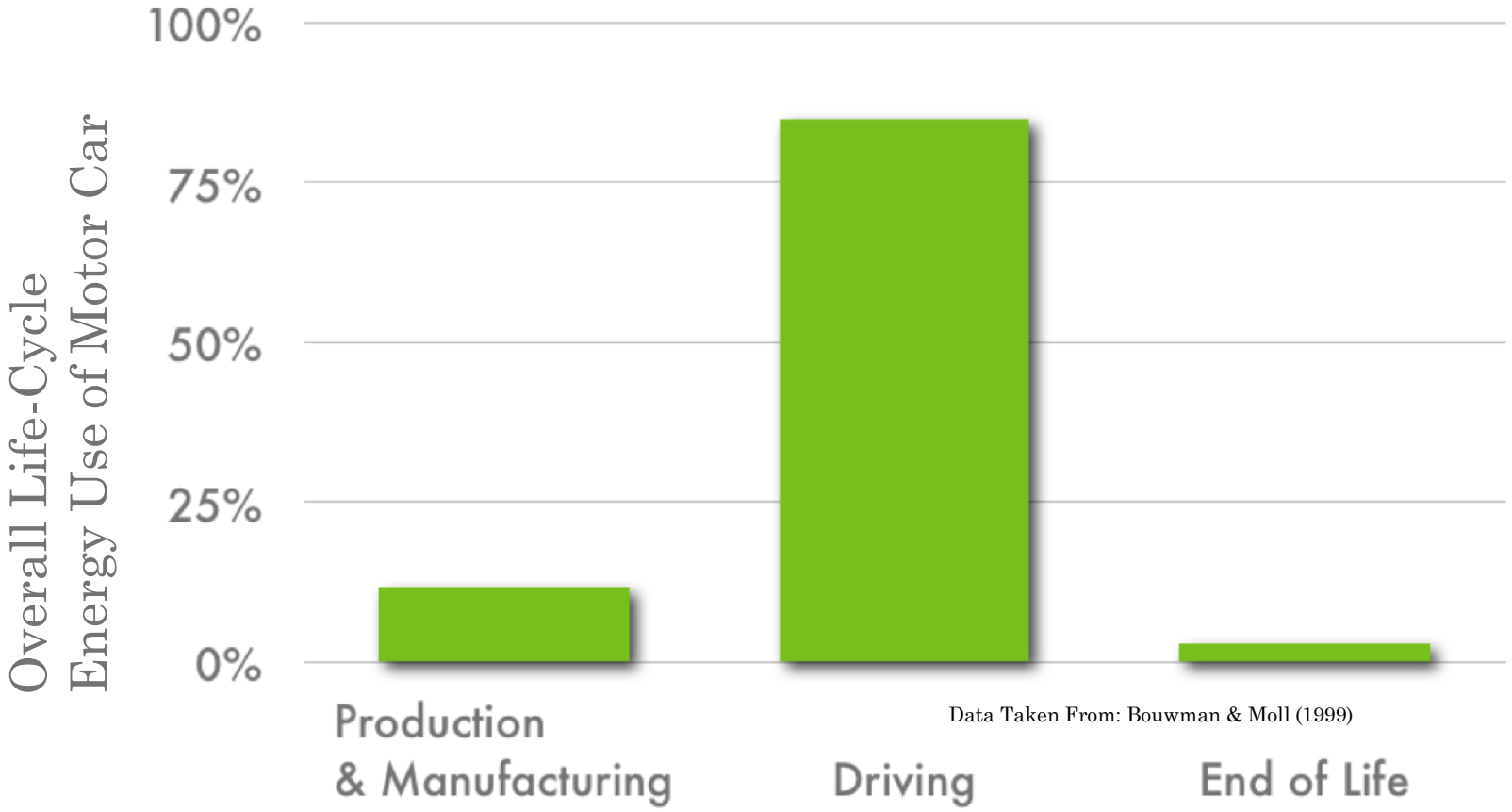
"A technological society has two choices. First it can wait until catastrophic failures expose systemic deficiencies, distortion and self-deceptions…
Secondly, a culture can provide social checks and balances to correct for systemic distortion prior to catastrophic failures."

- Mahatma Gandhi

"Speed is irrelevant if you are going in the wrong direction"
- Mahatma Gandhi

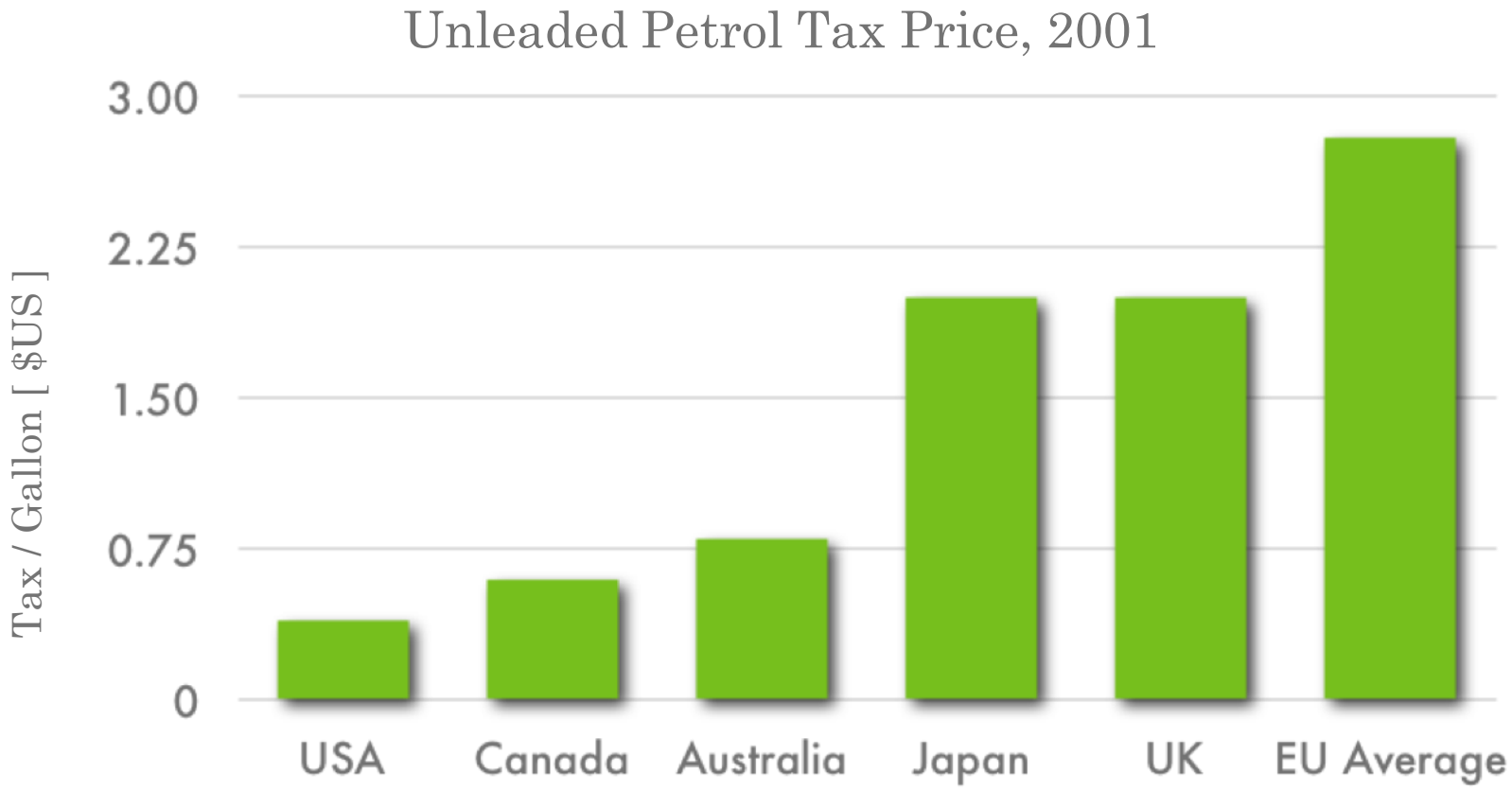
Government and its regulatory role

Motor Car Life-Cycle



In a typical motor car's life, the Use Phase (driving and maintenance) dominates energy consumption at 85%. This is typical of durable goods. The average car in OECD countries lasts for 13 years and travels 120,000 miles.

Social Policy: Tax



Does the big difference in petrol tax between Europe and the US partially explain the difference in private car ownership: 450cars/1000 people in EU and about 700 cars/1000 people in the US?

What the Government hopes to achieve

- To ensure the transport system adds to the economic and social benefits and reduces harm
- To create the transport system that is

  Effective-Timely moves people and freight to their destinations

  Efficient- delivers right infra and services/value for money

  Resilient-meets future transport needs and endures shock

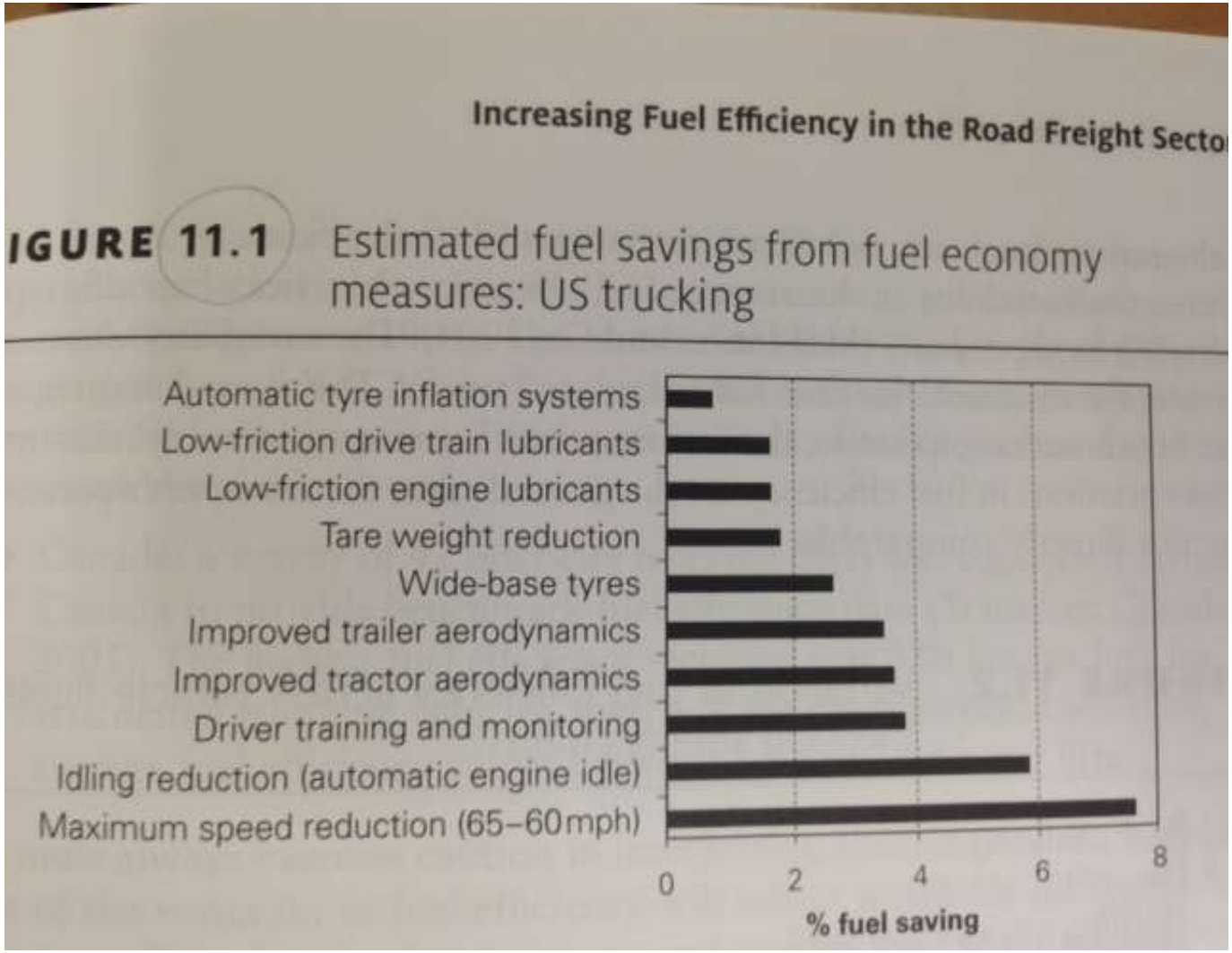
  Safe and Responsible-reduces harm
- Priorities-Investment in infrastructure, regulation, opening markets

Improve efficiency of road sector

- Set fuel efficiency standards and audit I&M
- Modernize the truck fleet and organize the trucking industry- productivity 300-500km/d~1000 internationally-introduce multi-axle trucks
- Emphasize logistics planning
- Better vehicle utilization-urban consolidation centers
- Use of IT-electronic processing of driver and cargo info for seamless movement
- Intelligent transport systems such as timed entry freeways and on-board traffic directors could reduce congestion and increase the mean speed of automobiles by 15%

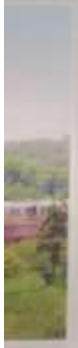
IMPROVE EFFICIENCY OF ROAD SECTOR

- Improve efficiency of SRTU's 3.5kmpl~best 5.5kmpl benchmarking, incentives to improve
- Introduce alternate fuels-biofuels
- Shift from private to public modes
- Shift to cycles and non polluting modes



Ref: green logistics Alan Mckinnon et al.

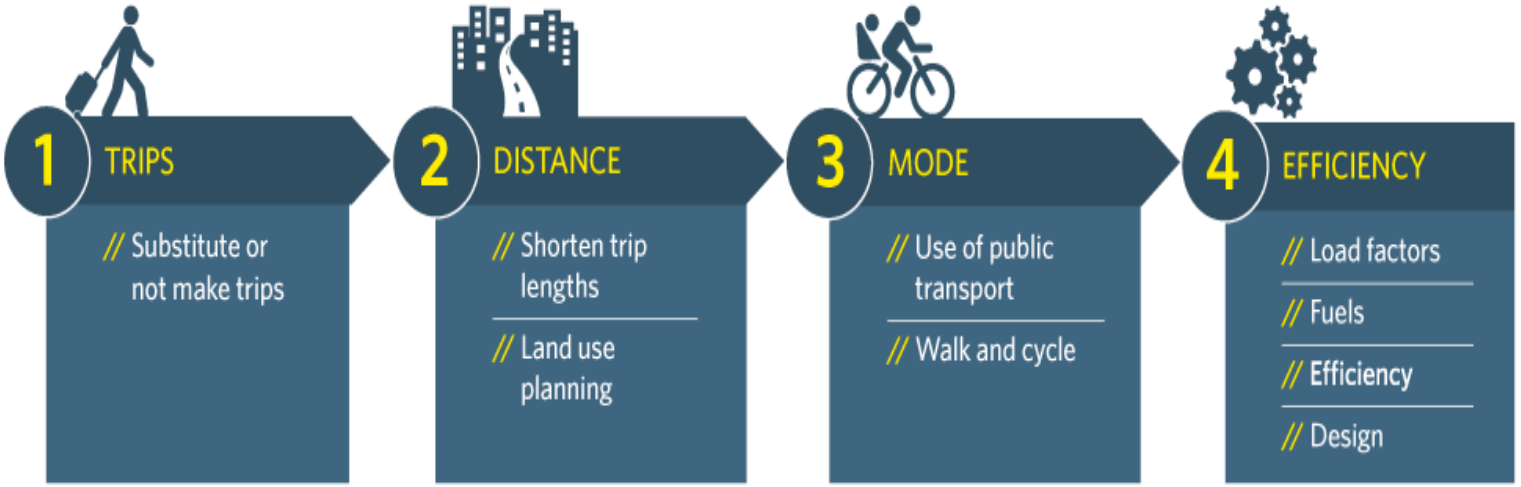
BENEFITS OF DELHI METRO



Descriptors	Phase - I 2007	Phase - I & II 2011	Phase- I & II 2014*
No. of vehicles off the road daily	16,895	117,249	390,971
Annual reduction in fuel consumption (t)	24,691	106,493	276,000
Annual reduction in pollutants (t)	31,520	179,613	577,148
Savings in time per trip (minutes)	31	28	32
Annual reduction in fatal accidents (no.)	21	111	125
Annual reduction in all accidents (no.)	93	591	937

*Extrapolated for ridership of 2.7 Million

Figure 1: the Sustainable Mobility Paradigm



SEVEN MAIN COMPONENTS OF THE SUSTAINABLE MOBILITY PARADIGM

1. **Reasonable travel time** – not minimisation of travel time
2. **Seeing travel as a valued activity** – not only a derived demand
3. **Reducing the need to travel** – through distance reduction and working remotely
4. **Achieving significant modal shift** – to walking, cycling and public transport
5. **Lower levels of pollution and noise** from transport, and greater energy efficiency
6. **More efficient management** and use of infrastructure and capacity through higher occupancy and load factors, and through pricing
7. **Increasing the quality** of places and spaces within cities

Source: Banister, 2008

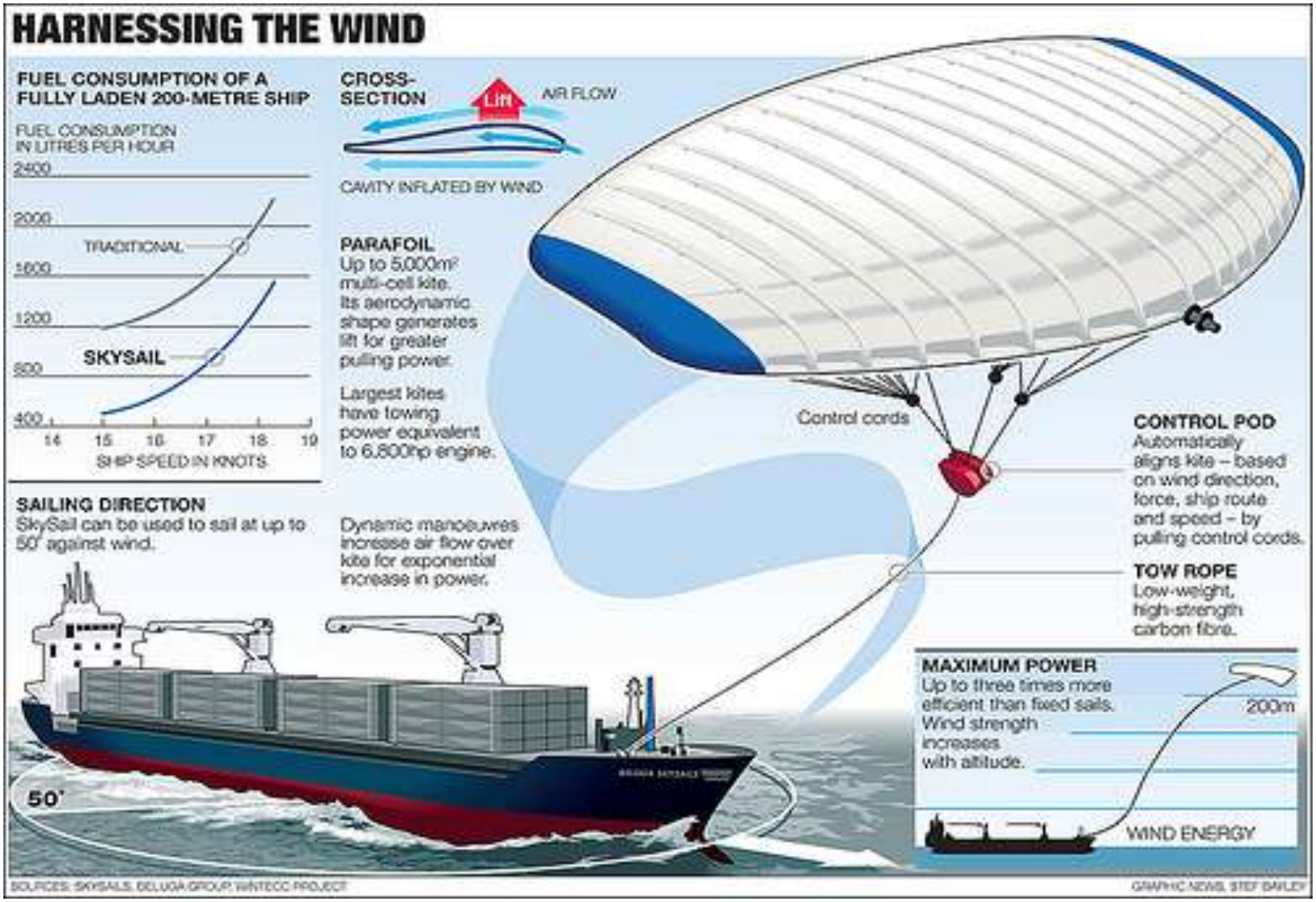
New mobility services offer transportation alternatives.

	Traditional mobility solutions	New mobility services	
Individual-based mobility	Private car ownership	Car sharing: peer to peer	A peer-to-peer platform where individuals can rent out their private vehicles when they are not in use
	Taxi	E-hailing	Process of ordering a car or taxi via on-demand app. App matches rider with driver and handles payment
	Rental cars	Car sharing: fleet operator	On-demand short-term car rentals with the vehicle owned and managed by a fleet operator
Group-based mobility	Car pooling	Shared e-hailing	Allows riders going in the same direction to share the car, thereby splitting the fare and lowering the cost
	Public transit	On-demand private shuttles	App and technology enabled shuttle service. Cheaper than a taxi but more convenient than public transit
		Private buses	Shared and Wi-Fi-enabled commuter buses available to the public or to employees of select companies. Used to free riders from driving to work

PROMOTE COASTAL SHIPPING AND IWT

- Water share only 6% as against 30% in China
- Set up dedicated ports and terminals in existing ports for coastal shipping
- Connect ports (Sagarmala)
- Intermodal integration with rail and road
- PPP in IWT infra
- Policy and Legislation for priority to IWT
- IT in water transport-Crewless ships

SKYSAIL

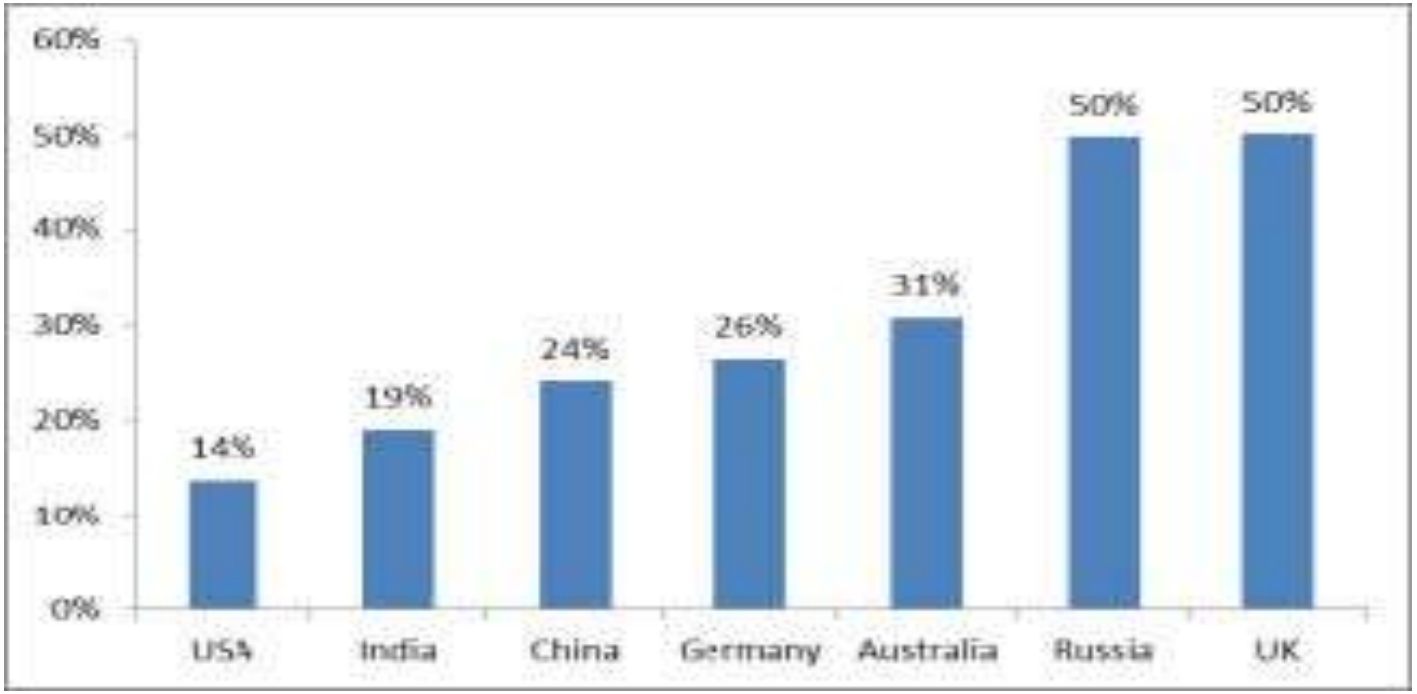

HARNESSING THE WIND
FUEL CONSUMPTION OF A FULLY LADEN 200-METRE SHIP
FUEL CONSUMPTION IN LITRES PER HOUR
2400
2000
1600
1200
800
400
TRADITIONAL
SKYSAIL
14
15
16
17
18
19
SHIP SPEED IN KNOTS
CROSS-SECTION
Lift
AIR FLOW
CAVITY INFLATED BY WIND
PARAFOIL
Up to 5,000m² multi-cell kite. Its aerodynamic shape generates lift for greater pulling power.
Largest kites have towing power equivalent to 6,500hp engine.
Dynamic manoeuvres increase air flow over kite for exponential increase in power.
Control cords
CONTROL POD
Automatically aligns kite – based on wind direction, force, ship route and speed – by pulling control cords.
TOW ROPE
Low-weight, high-strength carbon fibre.
SAILING DIRECTION
SkySail can be used to sail at up to 50° against wind.
50°
MAXIMUM POWER
Up to three times more efficient than fixed sails. Wind strength increases with altitude.
200m
WIND ENERGY
SOURCES: SKYSAILS, BELUGA GROUP, WINTECC PROJECT
GRAPHIC NEWS, STEF BAYLEY

Promote initiatives to improve market share of railways

- Benchmarking of energy efficiency across Railway systems
- Augment capacity -especially GQ for IR
- Introduce HSR
- Introduce private freight operators in areas where no rail share
- Empty flow direction policy
- Increase investment
- Promote renewable

- What can we do to make public transport the preferred mode?
- Facilities at our terminals to promote use of second mode of public transport for the next leg of the journey

Rail Spending (% of rail & road spending), C2013



Rightsizing between rail and road could result in 10% decline in logistics costs,5-6% increase in trade and 100-120% increase in the range of products

Sectoral Infra Spending as % of GDP

Sectoral Infra Spending as % of GDP

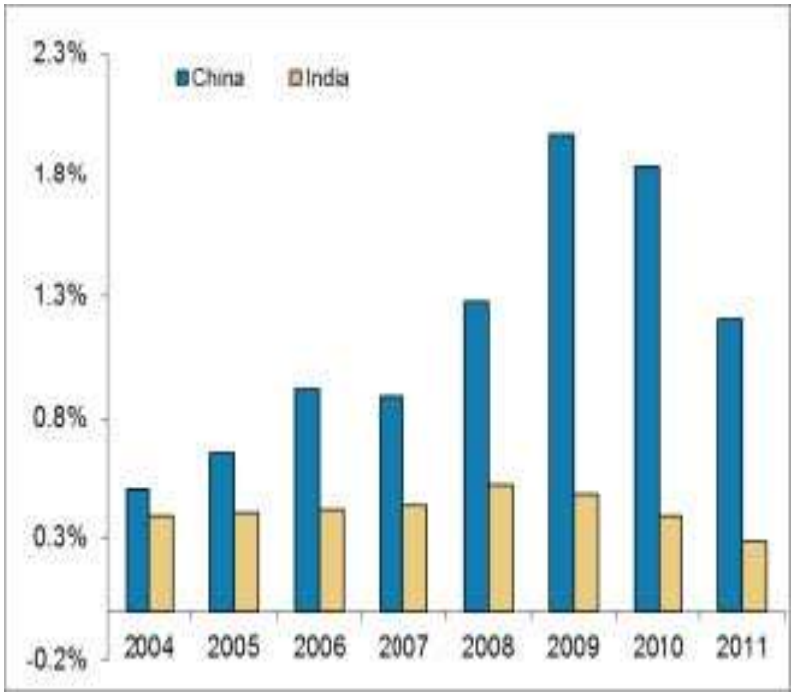
F2014E/2014	India		China
	% of GDP	Pvt%	% of GDP
Electricity	2.8%	51%	2.8%
Railways	0.8%	14%	1.2%
Communication	1.2%	89%	0.7%
Roads	1.4%	30%	3.9%
Others	1.1%	25%	1.1%
Total	7.3%	42%	9.6%

Source: Planning Commission, CEIC

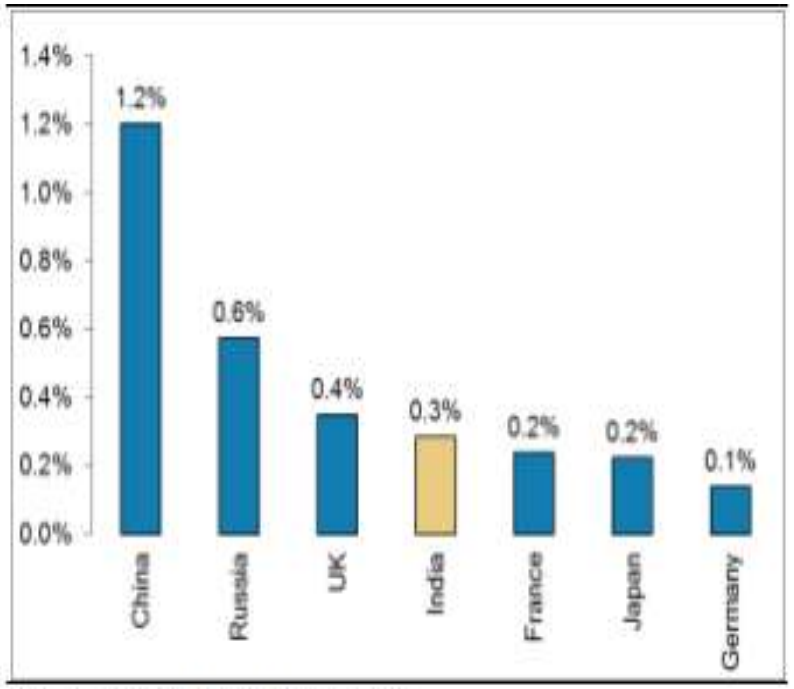
There has been comparative success in the infra sectors where the private sector has taken the lead

RAIL SPENDING AS A PERCENTAGE OF GDP

China vs India



World benchmarks



Source: Euromonitor, Morgan Stanley Research

Policy measures to Promote inter modal shift to more efficient modes

- Tax –polluter pays principle-fuel/vehicle excise duty, ERP, tolls
- Marco polo program of the EU- subsidy provided for every 500tkm of load shifted from road to rail
- Advice and exhortion-UK's freight best practices program (FBP) to reduce logistics footprint

  www.freightbestpractice.org.uk

  US smart way program to reduce transportation footprints-approves emission reducing products, financial support for green tech, and anti-idle features

Policy measures to Promote inter modal shift to more efficient modes

- Financial incentives: Support green investment or subsidize green freight
- Liberalization: encourage back loading, own account operators permission to backload,
- Infra and land use planning: construction and management of network infra and terminals-access to infra and zoning for logistics related activity
- Regulation: vehicle design-weight, length/ operation-environment zones-time or geographically, tariffs
- Logistics efficiency-food miles debate

Summary

- Changes in lifestyles -highly mobile society- reduced need for public transport-last mile
- Different modes of transport –competitive advantages and socio-economic benefits
- Transport impacts the environment -unintended consequences
- Sustainability and the tragedy of commons
- As engineers, solutions include social systems (public transport) and technological improvements (hybrid cars, engineering for sustainable design).

SUMMARY

- Design of Intelligent transport systems /shifting to non polluting ones
- Convenience to Customer is to be ensured
- FUTURE-The Internet connectivity is leading to virtual meetings and may eliminate the need for passenger transportation

Reduce your Carbon footprint

Thank You/Any Questions