Energy Efficiency in Transport

ECLAC’s Promoting Energy Efficiency in the Caribbean


Presented by: John A. Auguste
Presentation Overview

1. Importance of the Transportation Sector/Modes of Transport
2. Interlinks with Other Sectors
3. Trends in The Transportation Sector-Energy Consumption
4. Options for EE in The Transport Sector
5. Policies to Promote Transportation Sector-Energy Efficiency
6. Challenges to the Creation of an EE Landscape
Introduction

- From the wheel to the supersonic jet, to the Bullet Train, and the Space Shuttle, humanity has made leaps and bounds in transportation.
- Many people today take for granted the very means of travel available to them. Few stop to think of how life would be different had man never tamed that first wild horse, or shaped that very first wheel. How did ancient man hit on these life-altering ideas? Where did the thought first originate? How have the advances of time led humanity from the ground to the stars?
The transport sector is the largest and fastest-growing energy user, with a forecast annual increase of 2.1% worldwide and 4.3% for East Asia and the Pacific in 2002–2030 (International Energy Agency [IEA], 2004).
The transportation sector accounts for 22% of global energy use and 27% of global carbon emissions.

In the major energy-using industrialized countries (specifically the 11 highest energy using IEA countries), nearly all (96%) of transportation energy comes from petroleum fuels, such as gasoline (47%) and diesel (31%).
Energy use in the transportation sector is primarily for passenger travel and freight movements. Passenger travel vehicles consist of light-duty vehicles (automobiles, motorcycles, and light trucks) and high-duty vehicles (buses, airplanes, boats, and trains). The freight modes of transport include truck, air, rail, pipeline, and marine (domestic barge and cargo).
Road vehicles account for about three-quarters of all transportation energy use; roughly two-thirds of transport energy is used for passenger mobility while one-third is used to move freight (Price and others, 2006).
Vehicle Population and Distribution

Number of Vehicles by Region

- OECD Europe: 93-250
- Former USSR: 7-39
- Mid. East: 19-49
- China: 07-21
- Japan: 24-74
- USA: 06-225
- Africa: 48-20
- India: 11-12
- ASEAN 7: 23-21
- Oceania: 7-45
- S. America: 21-45
- N. America: 32% (in 2002)
- Europe: 37% (in 2002)
- Asia: 19% (in 2002)
- Oceania: 2% (in 2002)
- Mid. East: 2% (in 2002)
- Africa: 2% (in 2002)

Source: Based on EDMC

306 mil. in 1973
816 mil. in 2002
The Importance of Transportation

Walking, Unique Wheel Barrow

Human Carriage
The Importance of Transportation
The Importance of Transportation

Horse Drawn Vehicle

Messenger on Horse
The Importance of Transportation

Burley-Travoy Cargo-Loader

Three (3)-Wheeler
The Importance of Transportation
The Importance of Transportation
The Importance of Transportation
The Importance of Transportation

Minibus

Tour/Provincial Bus
The Importance of Transportation

Rapid Train

Japanese Bullet Train
The Importance of Transportation
The Importance of Transportation
The Importance of Transportation
The Importance of Transportation
The Importance of Transportation
Categories of Transportation

- Waterways
- Airways
- Bicycles and Pedestrians
- Railways
- Pipelines
Summary of Transportation Modes

1. Animal Driven
2. Walking
3. Bicycling:
4. Ships:
5. Automobiles:
6. Buses:
7. Trains:
8. Aircraft:
9. Rockets/Space Shuttle; and;
10. Other Means.
Relative Energy Efficiency by Modes
### Average EE for Different Modes of Transport

#### Energy Efficiency

<table>
<thead>
<tr>
<th>Mode</th>
<th>Average Energy Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Passenger</strong></td>
<td></td>
</tr>
<tr>
<td>Rail</td>
<td>104 (Unit: kcal/pass.-km)</td>
</tr>
<tr>
<td>Shinkansen</td>
<td>83</td>
</tr>
<tr>
<td>Bus</td>
<td>193</td>
</tr>
<tr>
<td>Private Car</td>
<td>665</td>
</tr>
<tr>
<td>Domestic Aviation</td>
<td>395</td>
</tr>
<tr>
<td><strong>Freight</strong></td>
<td></td>
</tr>
<tr>
<td>Rail</td>
<td>113 (Unit: kcal/t-km)</td>
</tr>
<tr>
<td>Commercial Truck</td>
<td>665</td>
</tr>
<tr>
<td>Private Truck</td>
<td>2646</td>
</tr>
<tr>
<td>Shipping</td>
<td>129</td>
</tr>
<tr>
<td>Domestic Aviation</td>
<td>5274</td>
</tr>
</tbody>
</table>

Source: MITI and Central Japan Railway Company
Undoubtedly, transportation plays a considerable role in the economy with its omnipresence throughout the production chain, at all geographic scales. It is an integral constituent of the production-consumption cycle. Economic impact indicators help to appreciate the relationship between transport systems and the economy as well as to inform on the economic weight of this type of activity.
# Energy Efficiency in the Transport Sector

## Common Economic Impact Indicators

<table>
<thead>
<tr>
<th>Factors of production</th>
<th>Scale-specific indicators</th>
<th>Macro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output / Capital</td>
<td>Transport sector income / Local income</td>
<td></td>
</tr>
<tr>
<td>Output / Labor</td>
<td>Output / Local income</td>
<td>Output / GDP</td>
</tr>
<tr>
<td>Capital / Labor</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Energy Efficiency in the Transport Sector

- **Efficiency** is usually defined as the ratio of input to output, or the output per each unit of input. Modal variations in efficiency will depend heavily on what is to be carried, the distance traveled, the degree and complexity of logistics required as well as economies of scale.

- Freight transport chains rest upon the complementarity of cost-efficient and time-efficient modes, seeking most of the time a balanced compromise rather than an ideal or perfect equilibrium.
Maritime transport is still the most cost-efficient way to transport bulk merchandise over long distances. On the other hand, while air transport is recognized for its unsurpassed time-efficiency versus other modes over long distances, it remains an expensive option. Thus, vertical integration, or the absorption of transportation activities by producers, illustrates the search for these two efficiency attributes by gaining direct control over inputs.
Energy Efficiency in the Transport Sector??

Macro Indicators

- Multimodal transportation networks rest upon the *combinatory costs and performance of transport modes*, or what is referred to as economies of scope. For instance, a single container shipped overseas at the lowest cost from its origin can go from road, to seaway, to railway and to road again before reaching its destination.
Macro Indicators

Freight shippers and carriers therefore require quantitative tools for decision-making in order to compare performances of various transport modes and transport networks. Time-efficiency becomes a set imperative for both freight and passenger transit in private as well as in public sector activities.
## Technical Performance Indicators

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Passenger</th>
<th>Freight</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger / freight density</td>
<td>passenger-km / km</td>
<td>ton-km / km</td>
<td>A standard measure of transport efficiency.</td>
</tr>
<tr>
<td>Mean distance traveled</td>
<td>passenger-km / passenger</td>
<td>ton-km / ton</td>
<td>A measure of the ground covering capacity of networks and different transport modes.</td>
</tr>
<tr>
<td>Mean per capita unit output (freight)</td>
<td>passengers / population</td>
<td>tons / population</td>
<td>Used to measure the relative performance of transport modes.</td>
</tr>
<tr>
<td>Mean number of trips per capita (passenger)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean occupation coefficient</td>
<td>number of passengers aboard / total carrying capacity (%)</td>
<td>actual load (ton) / overall load capacity (ton) (%)</td>
<td>Especially useful with increasing complexity of logistics associated with containerization of freight (i.e. the problem of empty returns). Can also be used to measure transit ridership.</td>
</tr>
</tbody>
</table>
Technical Performance Indicators

Performance indicators are widely used by geographers and economists to empirically assess the technical performance of differing transport modes, in other words their capacity to move goods or passengers around.

Passenger-km or ton-km are standard units for measuring travel that considers the number of people traveling or ton output and distance traveled. For example, 120 passenger-km represents 10 passengers traveling 12 kilometers or 2 passengers traveling 60 kilometers, and so on.
There isn’t an good indicator to reflect the overall efficiency trends in the transport sector, mainly because of the difficulty of separating out the energy used by different modes of transport, especially for road transport.

In the ODYSSEE project for Europe, an alternative indicator is used, combining in a single index the energy efficiency trends by mode (ODEX).

(see www.odyssee.indicators.org)
Transport Interlinks with Other Sectors

- Urban transport is not usually undertaken for its own sake, as it is a derived demand characterized by:
  
  (i) the movement of a large volume of people, freight, and vehicles in complex patterns;

  (ii) interlinks with other sectors, where transport is merely the means for participation in activities (Figure 1);

  (iii) the involvement of a diverse range of activities and ;
(iv) the presence of negative externalities, such as congestion, local tailpipe emissions (carbon monoxide [CO], oxides of nitrogen [NOx], sulfur oxide [SO], hydrocarbon [HC], and particulate matter [PM]), global emissions (such as GHG carbon dioxide [CO2], in the case of transport related impacts), and noise pollution.
Transport Interlinks with Other Sectors

Figure 1: Transport Interlinks with Other Sectors

Transport Interlinks with Other Sectors

- Transport improvements aim to realize the following desirable outcomes: (i) increased efficiency and productivity; (ii) better services, mobility, and access; (iii) reduced energy use, emissions, and noise pollution; and; (iv) improved road safety.

In turn, such positive results will contribute to broader desirable community outcomes (Table 1).
## Transport Objectives and Outcomes

### Table 1: Transport Objectives and Outcomes

<table>
<thead>
<tr>
<th>Transport Objectives</th>
<th>Transport Outcomes</th>
<th>Community Outcomes—Quality of Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficient road network (improved flow and traffic movement)</td>
<td>Improved transport efficiency and productivity</td>
<td>Industrial competitiveness and growth</td>
</tr>
<tr>
<td>Efficient movement of freight (delivery of goods on time and to the right place)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality integrated mass transit (better services, mobility, and access)</td>
<td>More affordable services and better mobility and access</td>
<td>Livable communities</td>
</tr>
<tr>
<td>Better management of travel demand (influencing travel choice)</td>
<td>Reduced energy use, emissions, and noise</td>
<td>Environmentally sustainable</td>
</tr>
<tr>
<td>Clean personal transport (reduce energy use, emissions, and noise)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safer roads, vehicles, and road users (improved road safety and security)</td>
<td>Improved road safety and security</td>
<td>Safer communities</td>
</tr>
</tbody>
</table>

Source: ADB. 2006.
Energy Consumption and Global Emissions

• The energy demand of the transport sector is increasing, particularly for fossil fuels, the combustion of which releases GHGs as a by-product.
• Transport activity generates a third or more of total GHG emissions in urban centers (World Bank, 2006).
IEA forecasts that, between 2002 and 2030 (Table 3), the total transport-related oil demand worldwide will grow from 1,827 million tons of oil equivalent (Mtoe) to 3,273 Mtoe at an average annual growth of 2.1%, with the rate falling slightly over time. In Asia, the total transport-related oil demand is expected to expand much faster, at 4.3% per annum during the same period. CO2 emissions (as a measure of GHG) in the region are projected to grow at a similar rate.
## Energy Consumption and Global Emissions

Table 3: IEA 2004 Reference Case Forecasts for Selected Areas in Asia and the World

<table>
<thead>
<tr>
<th>Region</th>
<th>2002</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>Growth Rate Per Annum</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>World Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total primary energy supply (Mtoe)</td>
<td>10,345</td>
<td>12,914</td>
<td>14,404</td>
<td>16,487</td>
<td>2.81</td>
</tr>
<tr>
<td>End consumption - Transport (Mtoe)</td>
<td>1,827</td>
<td>2,230</td>
<td>2,755</td>
<td>3,273</td>
<td>2.52</td>
</tr>
<tr>
<td>Total CO₂ emissions (Mt)</td>
<td>23,579</td>
<td>27,817</td>
<td>33,226</td>
<td>36,214</td>
<td>2.09</td>
</tr>
<tr>
<td>CO₂ emissions - Transport (Mt)</td>
<td>4,914</td>
<td>5,977</td>
<td>7,375</td>
<td>8,739</td>
<td>2.48</td>
</tr>
<tr>
<td><strong>PRC Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total primary energy supply (Mtoe)</td>
<td>1,242</td>
<td>1,622</td>
<td>2,072</td>
<td>2,539</td>
<td>3.39</td>
</tr>
<tr>
<td>End consumption - Transport (Mtoe)</td>
<td>87</td>
<td>136</td>
<td>212</td>
<td>306</td>
<td>5.74</td>
</tr>
<tr>
<td>Total CO₂ emissions (Mt)</td>
<td>3,307</td>
<td>4,386</td>
<td>6,708</td>
<td>7,144</td>
<td>3.59</td>
</tr>
<tr>
<td>CO₂ emissions - Transport (Mt)</td>
<td>244</td>
<td>383</td>
<td>582</td>
<td>852</td>
<td>5.80</td>
</tr>
<tr>
<td><strong>East Asia Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total primary energy supply (Mtoe)</td>
<td>533</td>
<td>712</td>
<td>955</td>
<td>1,188</td>
<td>3.69</td>
</tr>
<tr>
<td>End consumption - Transport (Mtoe)</td>
<td>91</td>
<td>137</td>
<td>205</td>
<td>269</td>
<td>5.25</td>
</tr>
<tr>
<td>Total CO₂ emissions (Mt)</td>
<td>1,055</td>
<td>1,459</td>
<td>2,092</td>
<td>2,701</td>
<td>4.14</td>
</tr>
<tr>
<td>CO₂ emissions - Transport (Mt)</td>
<td>236</td>
<td>354</td>
<td>530</td>
<td>693</td>
<td>5.20</td>
</tr>
</tbody>
</table>
Transport sector energy-related CO₂ emissions growth considering 1980 value as 100 for all regions (reference scenario)

Growth of CO₂ emissions considering 1980 as 100 for all regions/country

- United States
- Europe
- Japan
- Eurasia
- PRC
- India
- Other Asia
- Middle East
- Africa
- Latin America

PRC = People's Republic of China.
Energy Consumption and Global Emissions

Transport’s Contribution to Climate Change

Transport is the fastest growing energy use sector.

Transport is responsible for 60% of the increase in total world-wide GHG emissions 2002-2025.
Transport’s contribution to Climate Change

CO$_2$ Emissions from Transport and Other Sectors in Various Regions

CO$_2$ = carbon dioxide, OECD = Organisation for Economic Co-operation and Development.
Transportation energy use has grown considerably faster in developing countries than in industrialized countries over the last three decades—the average annual rate of growth over the period from 1971 to 2002 was 4.8 percent for developing countries and 2 percent for industrialized countries.
In absolute terms, however, industrialized countries still consume about twice as much energy (56 exajoules\(10^{18}\); SI prefix: \text{exa-} (EJ)) for transportation as do developing countries (26 exajoules).
U.S. Transportation Energy Consumption by Mode, 2005:

- Light vehicles: 63%
- Heavy duty road: 17%
- Air: 9%
- Water: 5%
- Pipeline: 3%
- Rail: 2%
- Motorcycles: 1%
Drivers of Transportation-Sector Energy Consumption

Transportation energy consumption in a specific country or region is driven by:

i. the amount of passenger and freight travel,

ii. the distribution of travel among various transportation modes, and

iii. the energy efficiency of individual vehicles or modes of transport.
EE Potential in the Transport Sector

- Overall demand for transportation services generally and personal vehicle travel specifically can be influenced by:
  1. patterns of development and land-use planning, as well as, by;
  2. the availability of public transportation,
  3. fuel costs,
  4. government policies (including congestion, parking, and roadway fees), and;
  5. other factors.
Different modes of transport also have very different energy and emissions characteristics—as a means of moving freight, for example, rail transport is as much as ten times more energy-efficient per kilometer as road transport.
At the level of individual vehicles, three types of approaches can be used to reduce energy consumption.

1. **The first** is to reduce the load on the engine, thereby reducing the amount of energy required to move the vehicle.
2. **The second** is to increase drive-train efficiency and capture energy losses (especially in braking).
3. **A third is to increase the engine load factor**—that is, the amount of time the engine operates near its rated or maximum power output for a given speed.

4. **If the primary objective is to reduce greenhouse gas emissions**, then a **fourth approach** (beyond improving efficiency) is to switch to a less carbon-intensive fuel.
Approaches to Reduce Vehicle Energy Consumption

- For road vehicles, load on the engine can be minimized by:
  1. reducing vehicle mass;
  2. aerodynamic drag, and;
  3. tire-rolling resistance.
- Mass reductions can be achieved by replacing conventional steel in the bodies and engines of vehicles with materials that are equally strong, but significantly lighter in weight. A 10% reduction in vehicle weight can improve fuel economy by 4–8 percent.
**Approaches to Reduce Vehicle Energy Consumption**

- Smaller engines, capable of operating at high revolutions per minute or with turbo-charge for additional power, can also be used, as can smaller and lighter transmissions.

- Aerodynamic drag can be reduced through more streamlined body design but may also introduce trade-offs in terms of stability in crosswinds.

- Technologies that turn the engine off when idling can also produce energy savings.
Some technologies, both commercially available and under development, can be used to increase the drive-train efficiency of road vehicles. Examples include multi-valve overhead camshafts, variable valve lift and timing, electromechanical valve throttling, camless-valve actuation, cylinder deactivation, variable compression ratio engines, continuously variable transmissions, and low-friction lubricants.
It is instructive to note that, in addition to the afore-mentioned, new types of highly efficient drive-trains—such as direct injection gasoline and diesel engines, and hybrid electric vehicles—are now in production.
Several studies have estimated the overall potential increase in fuel economy that could be achieved through the use of multiple technologies in light-duty vehicles. These estimates range from a 25–33 percent increase in fuel economy at no incremental cost (NRC, 2002) to a 61 percent increase in fuel economy using parallel hybrid technology at an incremental vehicle cost of 20 percent (Owen and Gordon, 2003).
The main opportunity for reducing energy consumption in heavy-duty diesel trucks is through body improvements to reduce aerodynamic drag. Electric or hybrid-electric drive-train technologies are not considered practical for heavy-duty vehicle applications, although fuel cells may well be.
However, hybrid-electric systems are well-suited for stop-and-go driving by buses and delivery vehicles in urban areas; studies have found that fuel economy improvements ranging from 10 percent (Foyt, 2005) to 57 percent (Chandler and others, 2006) could be achieved using hybrid technology in these applications.
Policies / Measures to Promote Energy Efficiency in the Transport Sector

<table>
<thead>
<tr>
<th>Policies to Encourage Vehicle Efficiency</th>
<th>Policies to Encourage Transport System Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Increasing Fuel Economy of New Vehicles</td>
<td>• Mass Transit</td>
</tr>
<tr>
<td>• Improving Operational Efficiency</td>
<td>• Reducing Road Congestion</td>
</tr>
<tr>
<td>• Energy Efficiency in Freight</td>
<td>• Land Use and Urban Planning</td>
</tr>
</tbody>
</table>
Policies /Measures to Promote Energy Efficiency in the Transport Sector

- **Increasing Fuel Economy of New Vehicles**
  - For economies that have fuel efficiency standards: Develop implementation and enforcement plans to ensure the standards have the desired maximum impact.
  - For economies that have fuel efficiency standards: Consider adopting more stringent standards, such as those advocated by the International Energy Agency (IEA)’s 50 by 50 Global Fuel Economy Initiative.
Increasing Fuel Economy of New Vehicles (Cont’d)

For economies that do not have fuel efficiency standards: Develop and adopt fuel economy standards. Prioritize the harmonization of new standards with existing ones in the region or coordinate with neighboring economies that are also in the development stages to facilitate manufacturers’ compliance with new standards.
Policies /Measures to Promote Energy Efficiency in the Transport Sector

- Increasing Fuel Economy of New Vehicles (Cont’d)
  - Internalize the external costs of transportation energy consumption by increasing fuel taxes and removing fuel price stabilization policies.
  - Invest in the research and development of new high-efficiency vehicle technologies.
Policies /Measures to Promote Energy Efficiency in the Transport Sector

❖ Increasing Fuel Economy of New Vehicles (Cont’d)
  - Provide economic incentives, e.g., tax credits, to promote market penetration of high-efficiency vehicles.
  - Complement policies with economic disincentives of the use of inefficient vehicles, such as higher fuel taxes or excise taxes on vehicle sales.
Comparison of Fuel Economy Standards Normalized by CAFE
By 2016, if the new rules take effect as planned, new passenger cars sold in the U.S. will have to meet an average mileage requirement of 39 mpg, up from 27.5 mpg currently. Light trucks would have to deliver an average of 30 mpg, compared with about 23 mpg today.
# Global Fuel Economy Standards

## Table 2

<table>
<thead>
<tr>
<th>Country/region</th>
<th>Type</th>
<th>Measure</th>
<th>Structure</th>
<th>Test method&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>Fuel</td>
<td>mpg</td>
<td>Cars and light trucks</td>
<td>U.S. CAFE</td>
<td>Mandatory</td>
</tr>
<tr>
<td>European Union</td>
<td>CO₂</td>
<td>g/km</td>
<td>Overall light-duty fleet</td>
<td>EU NEDC</td>
<td>Voluntary</td>
</tr>
<tr>
<td>Japan</td>
<td>Fuel</td>
<td>km/L</td>
<td>Weight-based</td>
<td>Japan 10-15</td>
<td>Mandatory</td>
</tr>
<tr>
<td>China</td>
<td>Fuel</td>
<td>L/100-km</td>
<td>Weight-based</td>
<td>EU NEDC</td>
<td>Mandatory</td>
</tr>
<tr>
<td>California</td>
<td>GHG</td>
<td>g/mile</td>
<td>Car/LDT1 and LDT2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>U.S. CAFE</td>
<td>Mandatory</td>
</tr>
<tr>
<td>Canada</td>
<td>Fuel</td>
<td>L/100-km</td>
<td>Cars and light trucks</td>
<td>U.S. CAFE</td>
<td>Voluntary</td>
</tr>
<tr>
<td>Australia</td>
<td>Fuel</td>
<td>L/100-km</td>
<td>Overall light-duty fleet</td>
<td>EU NEDC</td>
<td>Voluntary</td>
</tr>
<tr>
<td>Taiwan, South Korea</td>
<td>Fuel</td>
<td>km/L</td>
<td>Engine size</td>
<td>U.S. CAFE</td>
<td>Mandatory</td>
</tr>
</tbody>
</table>

<sup>a</sup> Test methods include U.S. Corporate Average Fuel Economy (CAFE), New European Drive Cycle (NEDC), and Japan 10-15 Cycle. See Appendix for more details.

<sup>b</sup> LDT1 and LDT2 are categories of light-duty trucks.
### Table 1: Average LDV on-road fuel efficiency in 2004 and 2030

<table>
<thead>
<tr>
<th>Region</th>
<th>2004 (km/l)</th>
<th>2030 (km/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OECD</td>
<td>10.7</td>
<td>16.1</td>
</tr>
<tr>
<td>North America</td>
<td>8.6</td>
<td>12.8</td>
</tr>
<tr>
<td>Europe</td>
<td>13.0</td>
<td>19.6</td>
</tr>
<tr>
<td>Pacific</td>
<td>11.6</td>
<td>17.5</td>
</tr>
<tr>
<td>Transition economies</td>
<td>10.0</td>
<td>14.3</td>
</tr>
<tr>
<td>Developing countries</td>
<td>9.7</td>
<td>14.1</td>
</tr>
<tr>
<td>China</td>
<td>8.8</td>
<td>13.3</td>
</tr>
<tr>
<td>India</td>
<td>9.9</td>
<td>14.1</td>
</tr>
<tr>
<td>Brazil</td>
<td>11.0</td>
<td>16.1</td>
</tr>
</tbody>
</table>
### Fuel Economy Standards (Japan)

**Japanese weight class fuel economy Standards for gasoline passenger vehicles**

<table>
<thead>
<tr>
<th>Vehicle classes by maximum vehicle curb weight</th>
<th>Fuel economy fleet average target by class</th>
</tr>
</thead>
<tbody>
<tr>
<td>kg</td>
<td>lbs</td>
</tr>
<tr>
<td>&lt;702</td>
<td>&lt;1,548</td>
</tr>
<tr>
<td>703–827</td>
<td>1,550–1,824</td>
</tr>
<tr>
<td>828–1,015</td>
<td>1,826–2,238</td>
</tr>
<tr>
<td>1,016–1,265</td>
<td>2,240–2,789</td>
</tr>
<tr>
<td>1,266–1,515</td>
<td>2,791–3,341</td>
</tr>
<tr>
<td>1,516–1,765</td>
<td>3,343–3,892</td>
</tr>
<tr>
<td>1,766–2,015</td>
<td>3,894–4,443</td>
</tr>
<tr>
<td>2,016–2,265</td>
<td>4,445–4,994</td>
</tr>
<tr>
<td>&gt;2,266</td>
<td>&gt;4,997</td>
</tr>
</tbody>
</table>
## Existing voluntary fuel economy targets

for general (standard) passenger cars in **South Korea**

<table>
<thead>
<tr>
<th>Vehicle engine size (by cylinder volume displacement) (cm³)</th>
<th>1996</th>
<th></th>
<th>2000</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>km/L</td>
<td>mpg CAFE</td>
<td>km/L</td>
<td>mpg CAFE</td>
</tr>
<tr>
<td>&lt;800</td>
<td>23.4</td>
<td>64.9</td>
<td>24.6</td>
<td>68.2</td>
</tr>
<tr>
<td>800–1,100</td>
<td>20.3</td>
<td>56.3</td>
<td>21.3</td>
<td>59.1</td>
</tr>
<tr>
<td>1,100–1,400</td>
<td>17.3</td>
<td>48.0</td>
<td>18.1</td>
<td>50.2</td>
</tr>
<tr>
<td>1,400–1,700</td>
<td>15.4</td>
<td>42.7</td>
<td>16.1</td>
<td>44.6</td>
</tr>
<tr>
<td>1,700–2,000</td>
<td>11.4</td>
<td>31.6</td>
<td>12</td>
<td>33.3</td>
</tr>
<tr>
<td>2,000–2,500</td>
<td>9.9</td>
<td>27.5</td>
<td>10.4</td>
<td>28.8</td>
</tr>
<tr>
<td>2,500–3,000</td>
<td>8.5</td>
<td>23.6</td>
<td>8.9</td>
<td>24.7</td>
</tr>
</tbody>
</table>
Improving Operational Efficiency

Consider a vehicle lifetime or scrappage policy, being mindful of unintended impacts to the import/export market for used vehicles and parts. A dedicated study on the topic of *Import/Export of Used Vehicles and Parts* will help inform this issue.
Improving Operational Efficiency (Cont’d)

- Enforce operational efficiency of used vehicles and particularly small vehicles/2-wheelers or mopeds where uniquely appropriate, through centralized inspection and maintenance (I/M) programs.
Energy Efficiency in Freight

Consider a three-pronged approach to improving the energy efficiency of freight operations:

- Improve the energy efficiency of freight vehicles
  - Provide incentives (e.g., Discriminatory tax, and tax credits for the purchase of fuel-efficient freight vehicles, or subsidies for their manufacture)
  - Invest in the research and development of more fuel-efficient freight vehicles
Energy Efficiency in Freight (Cont’d)

- Improve freight logistics
  - Provide incentives for greater cargo volume per trip
  - Provide incentives for two-way shipping (i.e., ensure vehicle is transporting cargo on return trips)
  - Provide incentives and build infrastructure to encourage a switch from truck freight to rail and ocean freight, where applicable.
Energy Efficiency in Freight (Cont’d)

Provide Driver Education

• Require freight drivers to attend courses that teach driving practices that improve a vehicle’s operational efficiency -- e.g., reducing speeding, minimizing gear changing, and scheduling regular inspections
Policies/Measures to Promote Energy Efficiency in the Transport Sector

- **Energy Efficiency in Freight (Cont’d)**

  - Provide driver education (Cont’d)
    
    - Implement an awareness campaign aimed at freight companies and drivers that emphasizes the link between fuel-efficient driving practices and safe operations, as well as the fact that saving 10 percent on fuel costs can increase a freight company’s bottom line by 15-35 percent.
Policies to Encourage Transport System Efficiency

Reducing Congestion

In response to increasing road congestion, consider demand-side measures (to reduce congestion on existing roads) before supply-side measures (to construct more roads), as experience has shown that the addition of more roads does not alleviate congestion.
Policies to Encourage Transport System Efficiency (Cont’d)

Reducing Congestion

Consider pricing parking in commercial business districts at a rate that prevents congestion from “parking cruisers.” Studies have shown that the ideal price for parking may be one that ensures a 15 percent vacancy rate at any given time, so that vehicles looking for parking will not contribute to congestion and emissions by circling city blocks for long periods of time.
Policies /Measures to Promote Energy Efficiency in the Transport Sector

- Policies to Encourage Transport System Efficiency (Cont;d)
  - Consider implementing congestion pricing systems:
    - Pricing congestion rather than, or in addition to, pricing car ownership enables policy to shape marginal behavior, so those who choose to own cars can still make energy-efficient decisions.
Policies /Measures to Promote Energy Efficiency in the Transport Sector

- Policies to Encourage Transport System Efficiency (Cont;d)
  - Consider implementing congestion pricing systems:
    - Design congestion pricing systems to maximize congestion reduction, rather than revenue generation.
    - Electronic congestion pricing systems can further promote energy efficiency in transport by varying charges according to vehicle fuel efficiency.
Policies /Measures to Promote Energy Efficiency in the Transport Sector

- **Policies to Encourage Transport System Efficiency (Cont;d)**

**Land Use**

- Coordinate land use planning with transportation planning, e.g., incentivize mixed-use development. Building retail, commercial, and residential developments together reduces the need for car trips.

- Adopt long-term visions for land use that integrate transportation goals, then develop medium-term plans to achieve the vision.
Policies to Encourage Transport System Efficiency (Cont'd)

Land Use

- Invest in infrastructure, such as underpasses and covered walkways, that creates a safe and comfortable environment for pedestrians, providing an alternative to driving.
- Consider land use and transportation planning that connects non-motorized transport users to mass transit systems, so that pedestrians and bikers can access mass transit systems.
Policies /Measures to Promote Energy Efficiency in the Transport Sector

- Policies to Encourage Transport System Efficiency (Cont;d)

Mass Transit

- Focus on improving ridership on existing mass transit systems before expanding these systems or building new ones.
- Consider funding repairs and expansions of mass transit systems through tax revenue on land whose value has increased due to the development of the systems.
Policies / Measures to Promote Energy Efficiency in the Transport Sector

- **Policies to Encourage Transport System Efficiency (Cont'd)**

**Mass Transit**

- Consider reforming mass transit pricing based on distance rather than multiple trips to make it more convenient and less expensive at modal interfaces.
Policies to Encourage Transport System Efficiency (Cont’d)

Mass Transit

- Consider reforming mass transit pricing based on distance rather than multiple trips to make it more convenient and less expensive at modal interfaces.
Policies to Encourage Transport System Efficiency (Cont’d)

Mass Transit

- When deciding which mass transportation system to build first, consider the related financial, economic, and social factors, and observe the experiences of similar economies, or island states.
What Are the Challenges to Achieve an EE Landscape??

1. All levels of government, from municipal to national, face challenges in the coordination of transportation and energy policy. These challenges are both horizontal (e.g., difficulty in coordinating policy among agencies at the same level) and vertical (difficulty in coordinating policy among agencies at different levels of government).
What Are the Challenges to Achieve an EE Landscape??

2. To address overlapping (and sometimes conflicting) interests among different layers of government and different agencies, as well as jurisdictional issues, policymakers should consider establishing cross-cutting task forces or consolidating leadership in transportation planning under one overarching agency.
What Are the Challenges to Achieve an EE Landscape??

3. Another significant challenge is educating the public on the transportation options available to them, the considerable benefits of a comprehensive transportation policy, and the urgent need for action to ensure a sustainable future. In a difficult economic climate, an effective education/outreach campaign can help create the political will to make long-term investments in sustainable transportation.
What Are the Challenges to Achieve an EE Landscape??

4. Public outreach also can help address cultural preferences and promote positive attitudes about using mass transit as an alternative to personal motorized transport.

5. The necessity of, ongoing education for policymakers on the interrelated impacts and challenges of energy and transportation, possible solutions, and potential benefits will facilitate every stage of this process.
Energy efficiency policies and measures are not free. Whatever policy structure and implementation scheme, whatever the measures taken, there is a cost to the taxpayer.

As a general rule, energy efficiency policies and measures are economically sound if the macroeconomic benefits of increased energy efficiency achieved by these policies and measures outweigh the overall cost to the taxpayers. The bigger the difference between the benefit and the cost, the more attractive and effective are the policies and measures.
There is significant potential for saving energy in the transportation sector.

Experience shows implementation of appropriate mandatory fuel efficiency standards for light duty vehicles in all countries would be a necessary condition for achieving significant energy savings in this sector.

The EU’s experience shows that vehicle taxation is a powerful instrument to stimulate demand for fuel efficient vehicles.
The Magic in the Message !

A conclusion is the place where you get tired of thinking…. *Martin H. Fisher.*

Teamwork is essential _ it allows you to blame someone else…. *Unknown.*
EE in Transportation...Expectations!!

Pathways to Sustainable Transport!!
Appreciation to: Lee Schipper, Herbert Fabian, and James Leather; ADB’s Officials, and to Mr. Adrian J. Bradbrook, Professor of Law, University of Adelaide, Australia, as well as, the IEA, the InterAcademy Council’s Reports, et al.