ENERGY INTENSITY OF TRANSPORT

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1. **INDICATOR**

(a) **Name:** Energy Intensity of Transport

(b) **Brief Definition:** Energy use per unit of freight-kilometre (km) hauled and per unit of passenger-km travelled by mode.

(c) **Units of Measurement:** Freight: tonnes of oil equivalent (toe) per tonne-km. Travel: toe per passenger-km.

(d) **Placement in the CSD Indicator Set:** Consumption and Production Patterns/Transportation.

2. **POLICY RELEVANCE**

(a) **Purpose:** Transport is a major user of energy, mostly in the form of oil products, which makes transport the most important driver behind growth in global oil demand. The transport indicators measure how much energy is used for moving both goods and people.

(b) **Relevance to Sustainable Development:** Transport serves economic and social development through the distribution of goods and services and through personal mobility. However, energy use for transport also leads to the depletion of resources and to air pollution and climate change. Reducing energy intensity in transport can reduce the environmental impacts of transport while maintaining the economic and social benefits.

(c) **International Conventions and Agreements:** There are no international conventions directly related to energy intensities in the transport sector. International conventions on energy emissions, such as the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol, are indirectly related to transport energy intensities. The European Union voluntary commitments on carbon dioxide (CO₂) emissions by European, Japanese and Korean car manufacturer associations are for reductions in CO₂ emissions per kilometre for new automobiles.

(d) **International Targets/Recommended Standards:** Many industrialized countries have targets for reducing energy use and carbon emissions from transport.

(e) **Linkages to Other Indicators:** This indicator is part of a set for energy intensities in different sectors (manufacturing, agriculture, service/commercial and residential), with energy use per unit of gross domestic product (GDP) as an aggregate.
energy intensity indicator. These indicators are also linked to indicators for total energy use, greenhouse gas emissions and air pollution emissions.

3. **METHODOLOGICAL DESCRIPTION**

(a) **Underlying Definitions and Concepts:** The transport indicators reflect how much energy is used to transport goods and people. The separation of freight transport and passenger travel is essential for energy analysis, both because they are largely based on different modes and because the activities driving energy use are different. The two activity measures (tonne-km and passenger-km) are quite distinct and are collected separately. However, separating the energy use in these two activities is often complicated given the way data are available from typical energy statistics. Changes in intensities are affected by factors other than energy efficiency; therefore, analysing intensity trends provides important insights into how energy efficiency and other factors affect energy use. Annex 3 includes a decomposition method for energy intensities.

(b) **Measuring Methods:**

**Energy Use:** Ideally, for road transport, energy use should be measured for each type of vehicle or means of transport, including two-wheel vehicles, automobiles, sport utility vehicles (SUVs) and buses for personal travel, and small trucks, heavy trucks and miscellaneous road vehicles for freight transport. Outside of road transport, both freight and personal travel should be divided into trains, ships and aircraft for domestic transport. In general, however, national energy balances are only disaggregated by fuel and broad traffic type or mode of transport: road, rail, water, air and pipeline. Thus, they give no information on energy use by individual means of road transport or, even more importantly, on the split between personal travel and freight transport. International air or maritime transport should not be included.

**Output or Activity:** For assessing the efficiency of road vehicles, vehicle-km is a useful activity measure, assuming that data are available for each vehicle type. However, to be able to construct indicators across all modes for personal travel and freight transport, passenger-km and tonne-km, respectively, must be used as activity variables. This also provides a better indication of how efficiently energy is used to provide personal mobility and distribution of goods. For example, from this perspective, a bus carrying 20 passengers for 10 km (200 passenger-km) is less energy intensive (more efficient) than the same bus carrying 5 passengers for the same distance (50 passenger-km). Similarly, a fully loaded truck is less energy intensive than the same truck carrying a partial load.

**Vehicle Intensities:** Energy use per vehicle-km by vehicle and fuel type is an important indicator, as many standards for air pollution (and more recently, goals for CO₂ emissions reductions) are expressed in terms of vehicle characteristics, that is, emissions per vehicle-km.

**Modal Intensities:** Energy use per passenger-km or tonne-km should be disaggregated by vehicle type, namely, two-wheel vehicle, automobile/van, bus, airplane, local and long-distance train, metro (also known as ‘subway’ or ‘underground’), tram, ship or ferry for passengers, and truck, train, ship or airplane for freight.
Note: Aggregate energy intensities for travel or freight are a meaningful summary indicator whose value depends on both the mix of vehicles and the energy intensities of particular types of vehicles. The energy intensities of public train and bus transport per passenger-km are significantly lower than the energy intensities for automobiles or air transport. Freight, rail and ship transport are commonly less energy intensive than is trucking per tonne-km. It should also be noted that fuel consumption per vehicle-km also depends on traffic conditions as well as vehicle characteristics.

The energy intensity of a vehicle depends on both capacity and capacity utilization. A large vehicle that is fully loaded generally has lower energy intensity per tonne-km than a fully loaded smaller vehicle, but a small vehicle fully loaded will have a lower energy intensity than a large vehicle with the same load.

For some developed countries, typical load factors for private automobiles are 1.5 persons per automobile. For rail and bus, load factors vary from well below 10% (e.g. United States city buses on average) to over 100% of nominal capacity at peak times (in many developing countries during most of the day). Typical load factors for trucking might be 60–80% of weight capacity when loaded, but trucks commonly run 20–45% of their kilometres empty, yielding a relatively low overall load factor. Underutilized transport capacity means more pollution and road damage per unit of transport service delivered; hence capacity utilization itself is an important indicator of sustainable transport.

(c) Limitations of the Indicator: Data availability may limit the disaggregation of the indicator to the desired level. Considerable work is often required to disaggregate energy balances into various modes of transport.

Some countries’ transport energy statistics include fuel consumed by domestic airlines or shipping lines in international transport. Efforts should be made to exclude such transport and energy use from the indicators.

Measurement and interpretation of energy intensities are complicated by differences among products within a category, such as size (e.g. automobile weight), engine technology (e.g. gasoline or diesel) and utilization (vehicle occupancy if passenger-km is the measure of output).

(d) Alternative Definitions/Indicators: An alternative, simpler measure of energy intensity for transport could be overall average fuel consumption per passenger-km or tonne-km for all modes, but the results would be strongly influenced by the mix of modes and vehicle types, which varies enormously among countries and over time.

4. ASSESSMENT OF DATA

(a) Data Needed to Compile the Indicator
- Energy use by mode of transport, vehicle type and fuel for passenger travel and freight transport separately
- Distance travelled by vehicles, passengers and freight, including load factors
- Distance travelled by urban public transport and corresponding share of electric vehicles

(b) **National and International Data Availability and Sources:** National energy balances and energy statistics from the International Energy Agency (IEA) and Eurostat normally do not disaggregate road transport into individual means of transport, but this information is sometimes published by transport ministries. Few sources of energy data separate fuel consumption for air, rail or domestic shipping into that for passengers and that for freight, but national or private rail and shipping organizations may have this information. Energy use for local electric transport (commuter rail, metro, trams) is often published separately by national authorities.

Eurostat, the European Conference of Ministers of Transport (ECMT) and the United Nations Economic Commission for Europe (UNECE) are leading agencies for the collection of data on vehicle-, passenger- and tonne-km in Europe. Transport ministries in the United States, Canada, Japan, Australia and other countries publish similar data, often through their statistical agencies. In developing and transitional countries, fewer data are available.

5. **AGENCIES INVOLVED IN THE DEVELOPMENT OF THE INDICATOR**

(a) **Lead Agencies:** The International Energy Agency

(b) **Other Contributing Organizations:** The International Atomic Energy Agency (IAEA)

6. **REFERENCES**

(a) **Readings**


