| ANNUAL ENERGY CONSUMPTION, TOTAL AND BY MAIN USER CATEGORY | | |
|---|---|---|
| **Consumption and Production Patterns** | **Energy Use** | **Core indicator** |

**1. INDICATOR**

**(a) Name:** Annual energy consumption, total and by main user category

**(b) Brief Definition**: The amount of energy - liquids, solids, gases and electricity – used in a given year in a country, total, and by main user category.

**(c) Unit of Measurement**: Tonnes of oil equivalent

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

**3. POLICY RELEVANCE**

**(a) Purpose:** The indicator should be used in combination with energy intensity/efficiency indicators to measure the development of energy use, individual and industrial energy consumption patterns and the energy intensity of a society. When compared in time it shows the trend in the absolute amount of energy used in a country and its distribution among main economic activities and households.

**(b) Relevance to Sustainable/Unsustainable Development:** Energy is a key factor in industrial development and in providing vital services that improve the quality of life. Traditionally energy has been regarded as the engine of economic progress. However, its production, use, and byproducts have resulted in major pressures on the environment, both from a resource use and pollution point of view. The decoupling of energy use from development represents a major challenge of sustainable development. The long term aim is for development and prosperity to continue through gains in energy efficiency rather than increased consumption and a transition towards the environmentally friendly use of renewable resources. On the other hand, limited access to energy is a serious constraint to development in the developing world, where the per capita use of energy is less than one sixth that of the industrialized world.

**(c) International Conventions and Agreements:** Currently there are no international conventions or agreements that specifically refer to the regulation and/or limitation of energy use. However, calls have been made for the prudent and rational utilization of natural resources (Article 174 of the Treaty Establishing the European Community – Nice 2001), improved energy efficiency (The Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects – Lisbon 1994) and a switch to cleaner forms of energy. The United Nations Framework Convention on Climate Change and its Kyoto Protocol call for limitations on total greenhouse gas emissions, which are dominated by CO2 from the combustion of fossil fuels.

**(d) International Targets/Recommended Standards:** None.

**(e) Linkages to Other Indicators:** The indicator is closely linked with other indicators of the economy, with environmental indicators such as climate change, air quality and land use, and also with social indicators.

## 3. METHODOLOGICAL DESCRIPTION

**(a) Underlying Definitions and Concepts:** Gross inland consumption of energy is a key aggregate in the energy balances. Total consumption of energy refers to "apparent" consumption and is derived from the formula that takes into account production, exports, imports and stock changes. Production refers to the first stage of production. International trade of energy commodities is based on the "general trade" system, that is, all goods entering and leaving the national boundary of a country are recorded as exports and imports. Bunkers refer to fuels supplied to ships and airplanes engaged in international transport, irrespective of the carriers' flag. In general, data on stocks refer to changes in stocks of producers, importers and/or industrial consumers at the beginning and the end of the year.

Consumption of energy by main user categories refers to final consumption. This is a different concept from the one used for total consumption. Apparent consumption refers to primary energy, and includes energy lost to the environment in transformation processes. Final consumption, on the other hand, mixes primary and secondary sources of energy and is linked to the concept of total energy requirement, not taking transformation losses into account.

The main user categories should be established ideally at the two-digit level of the International Standard Industrial Classification of Economic Activities (ISIC rev. 4), but at least on the one letter Alpha level. Domestic/household use is a separate category.

**(b) Measurement Methods:** Total energy requirement (gross inland consumption) is calculated from the following formula: Primary production + Imports – Exports – Bunkers +/- Stock changes = Total energy requirement. Consumption by main user categories is available from the national energy balances.

**(c) Limitations of the Indicator:** Apparent consumption may in some cases represent only an indication of the magnitude of actual gross inland availability. The actual value of the indicator is strongly influenced by a multitude of economic, social and geographical factors. When using it as an indicator of sustainability the indicator has to be interpreted in connection with other indicators of economic development and energy use, as smaller or larger values of the indicator do not necessarily indicate more or less sustainable development.

**(d) Status of the Methodology:** The methodology of energy balances has been developed by the United Nations Statistics Division, the International Energy Agency and Eurostat.

**(e) Alternative Definitions/Indicators:** None

## 4. ASSESSMENT OF DATA

**(a) Data Needed to Compile the Indicator:** Energy commodity data for consumption at the national level and by main user categories. National energy balances.

**(b) National and International Data Availability and Sources:** Energy commodity data for production and consumption are regularly available for most countries at the national level; and for some countries, at the sub-national level. The data are compiled by and available from national statistical offices and country publications.

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

**(a) Lead Agency:** The lead agency is the United Nations Department of Economic and Social Affairs (DESA). The contact point is the Chief of Energy Statistics, Statistics Division.

**(b) Other Contributing Organizations:** Other organizations involved in the indicator development include the International Energy Agency of the Organisation for Economic Co-operation and Development (OECD/IEA) and Eurostat.

**(c) Data References:** United Nations: Energy Statistics Yearbook. United Nations: Energy Balances and Electricity Profiles: IEA: Energy Balances of the OECD Countries; Energy Balances of the non-OECD Countries..

## 6. REFERENCES

**(a) Readings:** Concepts and Methods in Energy Statistics, with Special Reference to Energy Accounts and Balances. United Nations, 1982. Energy Statistics: Definitions, Units of Measure and Conversion Factors. United Nations, 1987. Energy Statistics: A Manual for Developing Countries. United Nations, 1991. IEA/OECD/Eurostat – Energy Statistics Manual, Paris, France, International Energy Agency

**(b) Internet Sites:** United Nations Statistics Division:
http://unstats.un.org/unsd/energy/default.htm

**International Energy Agency:** http://iea.org
IAEA, UN DESA, IEA, Eurostat and EEA, 2005. *Energy Indicators for Sustainable Development*. Vienna, IAEA.

| INTENSITY OF ENERGY USE, TOTAL AND BY ECONOMIC ACTIVITY | | |
|---|---|---|
| **Consumption and Production Patterns** | **Energy Use** | |

## 1. INDICATOR

**(a) Name:** Intensity of Energy Use, total and by economic activity.

**(b) Brief Definition**: Ratio of total energy use to GDP: ratio of energy use by economic activity to value added.

**(c) Unit of Measurement:** Tonnes of oil equivalent per unit of local currency or per US $

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

## 2. POLICY RELEVANCE

**(a) Purpose:** Trends in overall energy use relative to GDP indicate the general relationship of energy consumption to economic development and provide a rough basis for projecting energy consumption and its environmental impacts with economic growth. For energy policy-making, however, energy intensities by economic activities should be used.

**(b) Relevance to Sustainable/Unsustainable Development (theme/sub-theme):** Energy is essential for economic and social development, but consumption of fossil fuels is the major cause of air pollution and climate change. Improving energy efficiency and decoupling economic development from energy consumption, particularly of fossil fuels, is essential to sustainable development.

**(c) International Conventions and Agreements:** Currently, there are no conventions or agreements that specifically refer to the regulation and/or limitation of energy use per capita. However, calls have been made for the prudent and rational utilization of natural resources (Article 174 of the Treaty Establishing the European Community — Nice, 2001), improved energy efficiency (The Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects — Lisbon 1994) and a switch to cleaner forms of energy. The United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol call for limitations on total greenhouse gas (GHG) emissions, which result mainly from the combustion of fossil fuels.

**(d) International Targets/Recommended Standards:** Some voluntary targets at the national level have been established.

**(e) Linkages to Other Indicators:** This indicator is linked to indicators for total energy consumption, greenhouse gas emissions and air pollution emissions.

## 3. METHODOLOGICAL DESCRIPTION

**(a) Underlying Definitions and Concepts:** The ratio of energy use to GDP is called "energy intensity". The indicator could be called "aggregate energy intensity" or "economy-wide energy intensity". The term "energy intensity" is also used for ratios of energy use by the different economic activities to output.

The ratio of energy use to GDP indicates the total energy being used to support economic and social activity. It represents an aggregate of energy consumption resulting from a wide range of production and consumption activities. In specific economic activities, the ratio of energy use to output is the "energy intensity" (if the output is measured in monetary units) or the "specific energy requirement" (if the output is measured in physical units such as tonnes or passenger-kilometers).
The energy intensity of a process (energy consumed per unit of output) is the inverse of the "energy efficiency" of the process (output per unit energy consumed).

**(b) Measurement Methods:**
**Energy Use:** Total energy consumption is obtained from national energy balances. For the economic activities, services/commercial consumption should be carefully separated from households, and manufacturing should be separated from other industrial uses and agriculture.
**Unit:** tonnes of oil equivalent
**Output:** GDP for total energy intensity, value added for intensities by economic activity.
**Unit:** GDP and value added are measured in local currency for national purposes. For the purposes of international comparison, they are measured in US dollars, converted from real local currency at purchasing power parity for the base year to which local currency was deflated.

**(c) Limitations of the Indicator:** The ratio of aggregate energy use to GDP, often called "energy intensity" or the "energy ratio", is not an ideal indicator of energy efficiency, sustainability of energy use, or technological development, as it has been commonly used. The aggregate ratio depends as much on the structure of the economy as on the energy intensities of sectors or activities, and changes in the ratio over time are influenced almost as much by changes in the structure of the economy as by changes in sectoral energy intensities.

Interpreting the ratio of energy use to GDP in terms of environmental impact or sustainability is also complicated by differences in environmental impact among energy sources.

Given the large number of factors that affect energy consumption, the ratio of total energy consumption to GDP should not be used as an indicator of energy efficiency or sustainability in itself but in combination with other energy indicators.

**(d) Status of the Methodology:** The ratio of energy use to GDP, as well as sectoral and sub-sectoral energy intensities, are in widespread use, but without a standardized methodology.

**(e) Alternative Definitions/Indicators:**

## 4. ASSESSMENT OF DATA

**(a) Data needed to compile the indicator:**

(i) Total energy consumption and energy consumption by economic activity;
(ii) Real GDP (and/or value added by economic activity) in local currency or PPP GDP in US dollars.

**(b) National and international data availability and sources:** Energy balances at national level are available from most countries. The Asia Pacific Energy Research Centre (APERC), Eurostat, the International Energy Agency (IEA), the Latin American Energy Organization (OLADE) and the United Nations Statistics Division (UNSD) compile collections of regional or international energy balances from countries.

GDP and Value Added data are available from national statistical sourcesThe IMF "International Financial Statistics" provides nominal and real GDP for most countries. Data on components of GDP are often available from regional development banks or national sources.

**(c) Data References:**

**IEA: Energy Balances of Member Countries; Energy Balances of Non-Member Countries**

**Eurostat: Energy balances**

Latin American Energy Organization/ Organización Latinoamericana de Energía (OLADE): "Informe de Estadísticas Energéticas 2005" DE AMÉRICA LATINA Y EL CARIBE/ Energy Statistics Report

Asia Pacific Energy Research Centre (APERC): APEC Energy Demand and Supply Outlook

UNSD: National Accounts Statistics; Energy Balances and Electricity Profiles

IMF: International Financial Statistics

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

**(a) Lead Agency:** The lead agency is the United Nations Department of Economic and Social Affairs, Statistics Division.

**(b) Other Contributing Organizations:**

## 6. REFERENCES

**Internet site:** United Nations Statistics Division:
http://unstats.un.org/unsd/energy/default.htm
IAEA, UN DESA, IEA, Eurostat and EEA, 2005. *Energy Indicators for Sustainable Development*. Vienna, IAEA.

| SHARE OF RENEWABLE ENERGY SOURCES IN TOTAL ENERGY USE | | |
|---|---|---|
| **Consumption and Production Patterns** | **Energy use** | |

## 1. INDICATOR

**(a) Name:** Share of renewable energy sources in total energy use

**(b) Brief Definition:** The share of energy from renewable sources in total energy used by the country.

**(c) Unit of Measurement:** %

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

## 2. POLICY RELEVANCE

**(a) Purpose:** This indicator traces the use of renewable energy as a share of country's total energy use.

**(b) Relevance to Sustainable/Unsustainable Development:** Chapter 4 of Agenda 21 calls for an improvement of efficiency in the use of energy sources and for a transition towards the environmentally friendly use of renewable resources. Energy is a key aspect of consumption and production. Dependence on non-renewable sources can be regarded as unsustainable in the long term. Renewable sources, on the other hand, can supply energy continuously under sustainable management practices and their use in general create less environmental pressure. The ratio of renewable to non-renewable energy sources represents a measure of a country's energy sustainability.

**(c) International Conventions and Agreements:** Not available.

**(d) International Targets/Recommended Standards:** Some voluntary targets at national and regional levels have been established.

**(e) Linkages to Other Indicators:** Interpretation of this indicator is enhanced when combined with annual energy production, annual energy consumption per capita, and lifetime of proven energy reserves. It is also closely linked to some of the environmental indicators such as greenhouse gas emissions and land use change.

## 3. METHODOLOGICAL DESCRIPTION

**(a) Underlying Definitions and Concepts:** The two elements comprising this indicator are the consumption of energy from renewable sources, and the total energy consumption.

Renewable sources refer to energy collected from current ambient energy flows or from substances derived from them. They can be classified as combustible or non-combustible. Non-combustible renewables include geothermal, solar, wind, hydro, tide and wave energy. Combustible renewables and wastes include biofuels (biogas, ethanol, biodiesel); biomass products (fuelwood, vegetal waste, pulp and paper waste, animal waste, bagasse), and the portion of industrial and municipal waste (produced by the residential, commercial and public service sectors and collected by the local authorities for disposal) that is used for production of heat and/or power.

The total energy consumption can be found in a country's energy balances under names that can be interchangeably used: "apparent consumption", "gross inland availability", or "total energy requirements"

**(b) Measurement Methods:** This indicator is computed by dividing the consumption of energy from renewable sources by the total energy consumption.

The total energy consumption is calculated from the following formula: Production of primary energy + Imports – Exports – Bunkers +/- stock changes. (Only production of primary energy is taken into account to avoid double-counting).

Consumption of energy from renewable sources can be calculated using a similar formula, naturally taking into account only renewable energy sources.

However, in some countries, consumption of renewable energy might not always be easily measurable, since exports and imports of energy, and electricity in particular, are often given as totals, without a breakdown by the source. It such cases, the production of energy from renewable sources could be used as a first approximation.

**(c) Limitations of the Indicator:** Data availability; the lack of standardized methodology; the need to use conversion factors; the challenges associated with summation of various forms of energy (e.g., after-losses electricity with pre-losses energy of fossil fuels). Due to potential export and import of renewable energy, there might be significant differences between production of renewable energy and the actual consumption by the country, so in some cases an adjustment to account for these flows might be necessary.

**(d) Alternative Definitions/Indicators:** None

## 4. ASSESSMENT OF DATA

**(a) Data Needed to Compile the Indicator:** Consumption of energy from renewable resources and wastes; total energy consumption.

**(b) National and International Data Availability and Sources:** National data and estimates on renewable resources are available from national statistical offices and country publications for many countries. The United Nations Statistics Division and the International Energy Agency of the Organisation for Economic Co-operation and

Development compile data and estimates based on information from national and international sources. Due to the large variety of forms of renewables and their uses, data collection is difficult. Data availability for developing countries may be a limitation.

**(c) Data References:** United Nations: Energy Statistics Yearbook and Energy Balances and Electricity Profiles; International Energy Agency: Energy Balances of OECD Countries, Energy Balances of Non-OECD Countries; Eurostat, Energy Balance Sheets; World Energy Council: Survey of Energy Resources.

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

**(a) Lead Agency:** The lead agency is the United Nations Department of Economic and Social Affairs, Statistics Division.

**(b) Other Contributing Organizations:** Other agencies involved in the development of this indicator are the World Energy Council (WEC), the International Energy Agency of the Organisation for Economic Co-operation and Development (OECD/IAE), Eurostat, and the Economic Commission for Europe.

**(c) Data References:**

## 6. REFERENCES

**(a) Readings:**

World Energy Council: *Survey of Energy Resources*.

United Nations: *Energy Statistics Yearbook*

United Nations: *Concepts and Methods in Energy Statistics, with Special Reference to Energy Accounts and Balances--A Technical Report* (http://unstats.un.org/unsd/publication/SeriesF/SeriesF_29E.pdf)

IAEA, UN DESA, IEA, Eurostat and EEA, 2005. *Energy Indicators for Sustainable Development*. Vienna, IAEA.

**(b) Internet Sites:** United Nations Statistics Division: http://www.un.org/Depts/unsd

| GENERATION OF HAZARDOUS WASTES | | |
|---|---|---|
| **Consumption and Production Patterns** | **Waste Generation and Management** | **Core indicator** |

## 1. INDICATOR

**(a) Name:** Generation of Hazardous Wastes.

**(b) Brief Definition:** The total amount of hazardous wastes generated per year through industrial or other waste generating activities, according to the definition of hazardous waste as referred to in the Basel Convention and other related conventions (see sections 3(e) and 7 below).

**(c) Unit of Measurement:** Tonnes per unit of Gross Domestic Product (GDP).

**(d) Placement in the CSD Indicator Set**: **Agenda 21:** Consumption and Production Patterns/Waste Generation and Management.

## 2. POLICY RELEVANCE

**(a) Purpose:** It provides a measure of the extent and type of industrialization in a country and in this connection the nature of the industrial activities including technologies and processes generating hazardous wastes.

**(b) Relevance to Sustainable/Unsustainable Development (theme/sub-theme):** The generation of hazardous wastes has a direct impact on health and the environment through exposure to this kind of wastes. Normally, long-term exposure is required before harmful effects are seen. Reduced generation of hazardous wastes may indicate either reduced industrial activities in a country, introduction of cleaner production in the industrial processes, or changing patterns in consumers' habits, or changing in national hazardous waste legislation. The introduction of environmentally sound management systems for hazardous wastes implies reduction of risks to health and environment due to lesser exposure to hazardous wastes.
A review of different categories of wastes being generated provides an indication of the nature of industrial activities being undertaken in a country. In the case of other hazardous wastes such as hospital wastes, it is first of all a measure of the size of the population, and secondly, the percentage of this population being treated in hospitals and other medical care units.

**(c) International Conventions and Agreements:** The following conventions and agreements pertain to this indicator: *Basel Convention* on the Control of Transboundary Movements of Hazardous Wastes and their Disposal; *Bamako Convention* on the Ban on the Import into Africa and the Control of Transboundary Movement of Hazardous Wastes within Africa; *Waigani Convention* to Ban the Importation of Hazardous and Radioactive Wastes into Forum Island Countries, and to Control the Transboundary Movement and Management of Hazardous Wastes within the South Pacific Region;

*Central American Agreement*; Protocol for the *Prevention of Pollution of the Mediterranean Sea* by Transboundary Movements of Hazardous Wastes and Their Disposal; *Organisation for Economic Co-operation and Development (OECD), Council Decisions,* and *EC Council Directives* and Regulation on Waste and Hazardous Wastes.

**(d) International Targets/Recommended Standards:** No quantitative targets exist at the international level. In Agenda 21, Chapter 20, an overall target of "preventing or minimizing the generation of hazardous wastes as part of an overall integrated cleaner production approach" is provided. Targets exist at the national level in many countries.

**(e) Linkages to Other Indicators:** This indicator is linked to the amount of hazardous wastes exported or imported, as well as to the indicators on area of land contaminated by hazardous wastes, and expenditures on hazardous waste treatment or disposal. It is further directly connected to indicators related to material consumption and energy use, including intensity of material use, annual energy consumption per capita, and intensity in energy use. In a wider context, it is also related to the indicators on international cooperation concerning implementation of ratified global agreements.

## 3. METHODOLOGICAL DESCRIPTION

**(a) Underlying Definitions and Concepts:** In order to facilitate the definition of whether a waste, as defined under the Basel Convention, is hazardous or not, the Technical Working Group established under the Basel Convention has developed lists of wastes that are hazardous and wastes that are not subject to the Convention, as well as an outline of a review procedure for the inclusion, or deletion, of wastes from those lists. These lists were approved at the Fourth Meeting of the Conference of the Parties (UNEP, 1998). It is expected that such lists will considerably facilitate the development and application of indicators of hazardous wastes as mentioned later.

In relation to the definition of hazardous wastes under the Basel Convention (article 1 of the Convention), it should be noted that under article 3 of the Convention, Parties should inform the Secretariat of the Convention (SBC) of wastes, other than those listed in Annexes I and II of the Convention, considered as hazardous under national legislation. Such information is being disseminated by the Secretariat to all Parties in order to enable them to respect such definitions in relation to planned transboundary movements involving such wastes.

**(b) Measurement Methods:** In relation to the Basel Convention, its Secretariat requests information from the Parties to the Convention on a yearly basis regarding the amount of hazardous wastes generated at the national level. This information is being introduced in the SBC database, which includes data and information on hazardous wastes related issues in accordance with Articles 13 and 16 of the Convention. Other agencies, such as OECD, are also collecting information on hazardous wastes generated by OECD countries.

**(c) Limitations of the Indicator:** The problem of defining whether a waste is hazardous or not will, in some cases, cause difficulties in relation to the use of an indicator on hazardous wastes generation. The quantity of the hazardous wastes generated alone may not reflect changes towards a more "sustainable" society. Consideration of the nature of the different kinds of hazardous wastes generated would be a better indicator of sustainable development progress. Availability and accuracy of data represents another limitation of this indicator. Finally, the nature of the waste itself makes it sometimes difficult to use them as indicators because wastes are often mixed and not produced to specifications.

**(d) Status of the Methodology:** The methodology has not at present been considered by Parties of the Basel Convention. Decision V/14 of the Fifth Meeting of the Conference of the Parties requested the Secretariat of the Convention to explore possibilities of developing indicators on hazardous wastes to facilitate decision-making and report thereon to the Conference of the Parties at its sixth meeting. However, the Conference of the Parties to the Basel Convention at its seventh meeting ( October 2004) did not consider work on indicators as a priority issue for the current biennium and thus it was not included in the work programme of the Open-ended Working Group for 2005-2006.

**(e) Alternative Definitions:** The amounts and type of specific waste streams generated per year through industrial or other waste generating activities as defined in the Basel Convention represents an alternative indicator which would allow for normalization based on hazardous properties of the wastes (e.g., infectious, flammable, toxic, corrosive, ecotoxic).

Consideration of the waste management infrastructure at national level could constitute an indicator on the status of addressing hazardous wastes related issues in any particular country.

In general, hazardous waste indicators, in order to be useful for management, have to have some resonance with policy makers whether they are within the local community, or at the national level. There is, therefore, the need to develop hazardous waste indicators that reflect concern for the hazardous properties of waste, the implications of their impacts on the environment, on ecosystems and their functioning, as well as on human health. A profile or set of indicators that can address these multiple issues and meet the needs of a variety of users is essential. Such indicators would be broader than the indicator on generation of hazardous wastes as referred to in this paper and the Secretariat of the Basel Convention will take the lead in the further development of indicators on hazardous wastes in collaboration with relevant institutions.

## 4. ASSESSMENT OF DATA

**(a) Data Needed to Compile the Indicator:** Data on the generation of hazardous wastes.

**(b) National and international Data Availability and Sources:** Data are available for many developed countries, but, so far, few developing countries are collecting data on hazardous waste generation. The Parties of the Basel Convention are requested to provide data to the Conference of the Parties through the Secretariat of the Convention on a yearly basis.

Assistance to developing countries will be needed in identifying the main hazardous waste streams being generated in their countries in order to prepare and maintain inventories of hazardous wastes. In this connection difficulties may be encountered in relation to hazardous waste generation by small scale enterprises, since they are scattered and often operating on an informal basis and are therefore not registered. It may be less of a problem to identify amounts of hazardous wastes generated by larger industries, since they are normally registered.

**(c) Data References:** The primary source of data at the international level is the Secretariat of the Basel Convention.

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

**(a) Lead Agency:** The lead agency is the Secretariat to the Basel Convention (SBC), United Nations Environment Programme (UNEP). The contact point is the Executive Secretary, SBC; fax no. (41 22) 797 3454, e-mail: sbc@unep.ch.

**(b) Other Contributing Organizations:** Other organizations include: United Nations Statistics Division, UNEP, ICRED, OECD, European Topic Centre for Wastes, Denmark, US Environmental Protection Agency, Institute for Applied Environmental Economics, the Netherlands, European Institute of Business Administration, France, Technical University, Graz, Austria, Wuppertal Institute, CEFIC, Netherlands National Institute of Public Health and Environment, Canada. Additional organizations with expertise in the domaine of hazardous waste generation are: UN-ECE (Transport); IMO (Maritime); FAO (Pesticides); WHO; ILO; IAEA; UNIDO, SPREP.

## 6. REFERENCES

**(a) Readings:**

Basel Convention for the Control of Transboundary Movement of Hazardous Wastes and their Disposal.

Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa, 1991.

Waigani Convention to Ban the importation into Forum Island Countries of Hazardous and Radioactive Wastes and to Control the Transboundary Movement and Management of Hazardous Wastes within the South Pacific Region.

Protocol for the Prevention of Pollution of the Mediterranean Sea by Transboundary Movements of Hazardous Wastes and Their Disposal.

Bakkes, J.A. et al. *An Overview of Environmental Indicators: State of the Art and Perspectives.* Environment Assessment Technical Reports. Netherlands National Institute of Public Health and Environmental Protection in cooperation with the University of Cambridge, United Kingdom. June 1994.

Å. Granados and P.J. Peterson *"Hazardous Waste Indicators for National Decision-makers"*, Journal of Environmental Management (1999).

1. Reporting and Transmission of Information under the Basel Convention for the year 1993. Geneva, 1996.
2. Reporting and Transmission of Information under the Basel Convention for the year 1994. Geneva, June 1997, document SBC No. 97/014, 175 p.
3. Reporting and Transmission of Information under the Basel Convention for the year 1995. Geneva, May 1999, document SBC No. 99/004, 130 p.
4. Reporting and Transmission of Information under the Basel Convention for the year 1996. Geneva, June 1999, document SBC No. 99/006, 178 p.
5. Reporting and Transmission of Information under the Basel Convention for the year 1997: Part II (Statistics on generation and transboundary movements of hazardous wastes and other wastes). Basel Convention Series SBC No. 99/001, Geneva, November 1999, 148 p.

**(b) Internet sites:**

Secretariat of the Basel Convention: http://www.basel.int/
European Topic Centre on Waste: http://www.etc-waste.int/

| ENERGY INTENSITY OF TRANSPORT | | |
|---|---|---|
| **Consumption and Production Patterns** | **Transportation** | |

## 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 ($CO_2$) emissions by European, Japanese and Korean car manufacturer associations are for reductions in $CO_2$ 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 $CO_2$ 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)

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**(b) Internet site**:
The International Energy Agency: http://www.iea.org/