Transport energy consumption and emissions

Data from 2006. Most recent data: Further Eurostat information, Main tables and Database.

The transport sector is the fastest growing consumer of energy and producer of greenhouse gases in the European Union, despite advances in transport technology and fuel formulation that have resulted in marked decreases in emissions of certain pollutants.

Although both the environment and energy are issues in their own right, they clearly come together when looking at the subject of transport sustainability, for consumption and emissions are fairly closely linked: what goes into the fuel tank comes out of the exhaust pipe in the form of emissions.

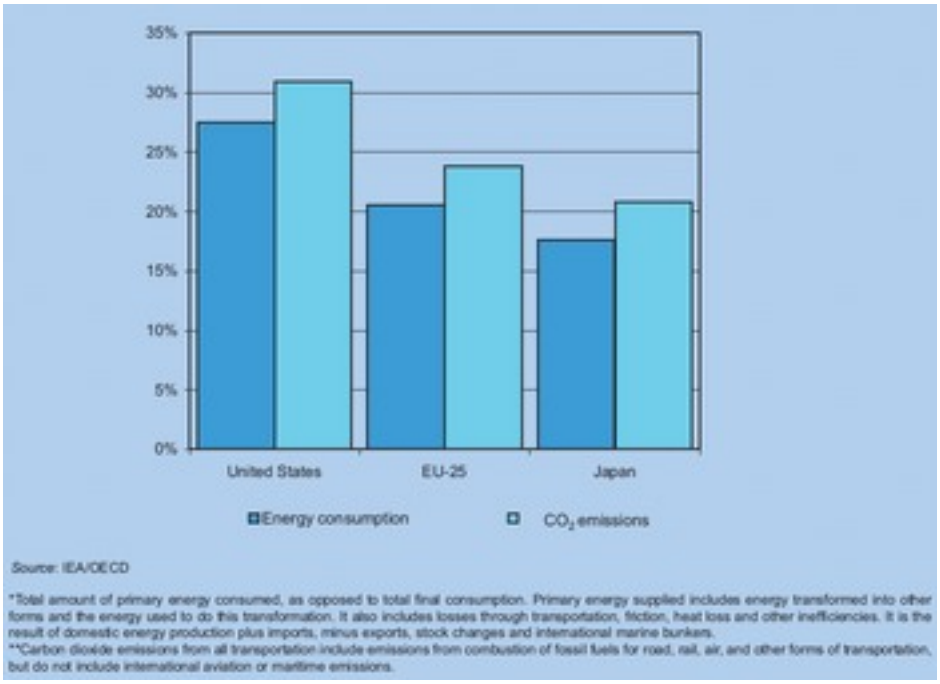

Figure 1: Importance of transport in total primary energy supply and in total CO_2 emissions, EU-25, United States and Japan, 2004 (%)

		1990	2004	% change 1990-2004	% share in total national consumption in 2004
EU-25	Road	227 957	290 013	27%	82.5%
	Railways	9 125	9 250	1%	2.6%
	Air transport	28 378	47 420	67%	13.5%
	Inland navigation	6 578	5 047	-23%	1.4%
BE	Road	6 442	8 488	32%	83.2%
	Railways	177	170	-4%	1.7%
	Air transport	955	1 427	49%	14.0%
	Inland navigation	129	116	-10%	1.1%
BG	Road	2 000	2 128	6%	89.9%
	Railways	216	65	-70%	2.7%
	Air transport	284	173	-39%	7.3%
	Inland navigation	18	0	-100%	0.0%
CZ	Road	2 311	5 550	140%	90.0%
	Railways	272	277	2%	4.5%
	Air transport	221	334	51%	5.4%
	Inland navigation	-	6	-	0.1%
DK	Road	3 066	4 027	31%	78.4%
	Railways	113	101	-11%	2.0%
	Air transport	683	888	30%	17.3%
	Inland navigation	150	121	-19%	2.4%
DE	Road	50 418	53 187	5%	84.9%
	Railways	2 116	1 877	-11%	3.0%
	Air transport	5 627	7 312	30%	11.7%
	Inland navigation	656	234	-64%	0.4%
EE	Road	730	581	-20%	87.1%
	Railways	65	48	-26%	7.2%
	Air transport	36	30	-17%	4.5%
	Inland navigation	7	8	14%	1.2%
IE	Road	1 546	3 811	147%	82.9%
	Railways	48	43	-10%	0.9%
	Air transport	365	727	99%	15.8%
	Inland navigation	26	18	-31%	0.4%
EL	Road	3 903	6 022	54%	75.7%
	Railways	75	61	-19%	0.8%
	Air transport	1 264	1 208	-4%	15.2%
	Inland navigation	566	669	18%	8.4%
ES	Road	17 676	30 617	74%	80.3%
	Railways	528	1 040	97%	2.7%
	Air transport	2 467	5 006	103%	13.0%
	Inland navigation	1 655	1 534	-7%	4.0%
FR	Road	36 171	42 273	17%	84.3%
	Railways	1 150	1 299	13%	2.6%
	Air transport	3 870	6 256	62%	12.5%
	Inland navigation	718	308	-57%	0.6%
IT	Road	30 393	39 094	29%	89.0%
	Railways	738	900	22%	2.0%
	Air transport	1 884	3 707	97%	8.4%
	Inland navigation	369	248	-36%	0.6%
CY	Road	:	553	:	64.6%
	Air transport	:	303	:	35.4%
LV	Road	798	818	3%	:
	Railways	188	93	-51%	:
	Air transport	73	48	-34%	:
	Inland navigation	:	:	:	:
LT	Road	1 719	1 197	-30%	90.8%
	Railways	132	77	-42%	5.8%
	Air transport	135	40	-70%	3.0%
	Inland navigation	9	5	-3%	0.4%
LU	Road	863	2 144	148%	83.1%
	Railways	13	10	-23%	0.4%
	Air transport	131	425	224%	16.5%

		1990	2004	% change 1990-2004	% share in total national consumption in 2004
HU	Road	2 580	3 484	35%	90.1%
	Railways	270	162	-40%	4.2%
	Air transport	164	221	35%	5.7%
	Inland navigation	9	1	-89%	0.0%
MT	Road	149	166	11%	62.2%
	Air transport	72	101	40%	37.8%
NL	Road	8 540	11 004	27%	73.2%
	Railways	167	188	28%	1.3%
	Air transport	1 614	3 563	121%	23.7%
	Inland navigation	556	283	-49%	1.9%
AT	Road	3 929	6 779	73%	88.2%
	Railways	357	304	-15%	4.0%
	Air transport	310	596	93%	7.8%
	Inland navigation	7	9	29%	0.1%
PL	Road	5 940	10 503	77%	92.8%
	Railways	1 095	528	-52%	4.7%
	Air transport	205	285	39%	2.5%
	Inland navigation	99	1	-99%	0.0%
PT	Road	3 026	6 343	110%	87.2%
	Railways	82	67	-18%	0.9%
	Air transport	576	842	46%	11.6%
	Inland navigation	43	25	-42%	0.3%
RO	Road	3 579	4 664	30%	90.1%
	Railways	282	333	18%	6.4%
	Air transport	233	140	-40%	2.7%
	Inland navigation	312	41	-87%	0.8%
SI	Road	872	1 330	53%	96.4%
	Railways	29	28	-3%	2.0%
	Air transport	27	21	-22%	1.5%
SK	Road	1 340	1 497	12%	96.4%
	Railways	100	61	-39%	3.8%
	Air transport	:	27	:	1.7%
FI	Road	3 631	3 606	8%	82.1%
	Railways	99	98	-1%	2.0%
	Air transport	463	554	20%	11.6%
	Inland navigation	195	208	7%	4.3%
SE	Road	6 103	7 140	17%	84.9%
	Railways	252	278	10%	3.3%
	Air transport	784	847	11%	10.1%
	Inland navigation	143	147	3%	1.7%
UK	Road	36 312	39 319	8%	72.6%
	Railways	1 076	1 530	42%	2.8%
	Air transport	6 794	12 232	80%	22.6%
	Inland navigation	1 269	1 107	-13%	2.0%
HR	Road	:	1 658	:	91.0%
	Railways	32	53	66%	2.9%
	Air transport	:	81	:	4.4%
	Inland navigation	:	29	:	1.6%
TR	Road	8 377	10 338	23%	80.7%
	Railways	243	230	-5%	1.8%
	Air transport	480	1 861	288%	14.5%
	Inland navigation	250	381	52%	3.0%
IS	Road	181	213	18%	61.9%
	Air transport	84	125	49%	36.3%
	Inland navigation	10	6	-68%	1.7%
NO	Road	2 591	3 285	27%	87.9%
	Railways	104	142	37%	2.9%
	Air transport	505	603	19%	12.5%
	Inland navigation	926	810	-13%	16.7%

Source: Eurostat (Energy)

*Data for 1990 may not always be reliable for some countries.

Table 1: Evolution of energy consumption by transport mode, 1990-2004, Member States (in thousand toe)

	1990	1995	2000	2001	2002	2003	2004	% change 1990-2004
Transport	**272**	**295**	**334**	**337**	**339**	**345**	**352**	**29%**
Rail transport	9.1	8.8	9.2	9.1	9.0	9.1	9.3	1%
% share	3.4%	3.0%	2.8%	2.7%	2.7%	2.7%	2.6%	
Road transport	228.0	245.5	274.0	278.4	282.0	284.8	290.0	27%
% share	83.8%	83.3%	82.1%	82.7%	83.1%	82.7%	82.5%	
Air transport	28.4	33.7	45.3	44.2	43.5	44.8	47.4	67%
% share	10.4%	11.4%	13.6%	13.1%	12.8%	13.0%	13.5%	
Inland navigation	6.6	6.7	5.4	5.0	5.0	5.7	5.0	-23%
% share	2.4%	2.3%	1.6%	1.5%	1.5%	1.6%	1.4%	

Source: Eurostat (Energy)

Table 2: Evolution of final energy consumption in transport, by transport mode, 1990-2004, EU-25 (in million toe)

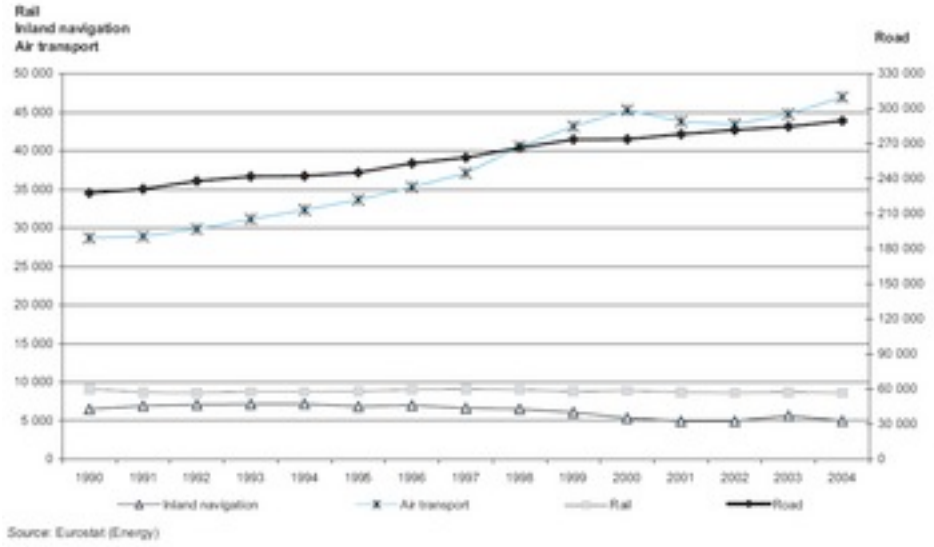

Figure 2: Evolution of energy consumption of main fuels by transport mode, EU-25 (in thousand toe)

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Main statistical findings

Energy consumption

Analysis of data on final energy consumption helps to estimate the scale of environmental impacts of energy use, such as air pollution, global warming and oil pollution (see correlation in Figure 1). They can be used to help monitor the performance of key policies aimed at modifying energy consumption and stimulating energy efficiency. The type and extent of energy-related pressures on the environment depends both on the sources of energy (and how they are used) and on the total amount of energy consumed.

Final energy consumption covers all energy delivered to the final consumer's door (in industry, transport, household and other sectors) for all energy uses. Deliveries for transformation and/or own use in the energy producing industries, as well as network losses are not included.

Air transport second largest energy consumer after road transport

Table 2 shows that within the transport share in the EU-25 countries energy consumption (excluding maritime transport and pipelines), road transport was clearly the largest energy consumer, consuming almost 83 % of the total in 2004, or 290 million tonnes of oil equivalent (mtoe). This translates as over a quarter of the total final energy consumption in the EU (i.e. transport, industry, households and services).

Air transport was the second largest consumer filling up at the pump, with a 13 % share in the transport total. Rail transport accounted for 2.5 %, with electric traction accounting for 66 % of all rail energy consumed. Inland navigation (which includes small vessels performing coastal shipping) consumed just 1.4 %.

This overall pattern was echoed in the individual Member States, but to varying degrees (see Table 1). For example, the share of energy consumption going to road transport was often highest in the new Member States in Eastern Europe (including Bulgaria and Romania), with shares reaching 90 % and above. In Slovenia this share reached as much as 96 %. By contrast, road shares were lowest in Cyprus and Malta, with 65 % and 62 % respectively.

When looking at the different shares of energy consumption between transport modes in the Member States, the main variation was the changeable balance between road transport and aviation - the two transport modes that have seen the highest growth over recent times. The shares of the other transport modes - rail and inland navigation - where applicable, did not vary much.

For example, Cyprus and Malta which displayed the lowest shares of consumption in road transport were also the Member States where the aviation shares were highest: respectively 35 % and 38 %. This also applied to EFTA country Iceland. Tourism and geographic isolation as islands are clearly the chief causes of this different balance, as well as, of course, the absence of alternative modes, for instance inland waterways and rail for Cyprus and Malta.

When it comes to energy consumption in rail transport, shares were generally highest in the new Member States, reflecting mainly the greater importance of rail transport in these countries. Shares were as much as 10 % in Latvia, and 6 % in Lithuania and Romania.

Finally, the share of energy consumption going to inland navigation reached as much as 8 % in Greece, which can partly be explained again by the significance of tourism; a share that was however overtaken by Norway (17 %). Although these shares might be surprising, readers should note that figures include consumption by small vessels (including leisure boats) performing coastal shipping tasks and not

using fuel from international maritime bunkers. This explains data for countries without a significant inland waterway network.

Energy consumption grew fastest in air transport

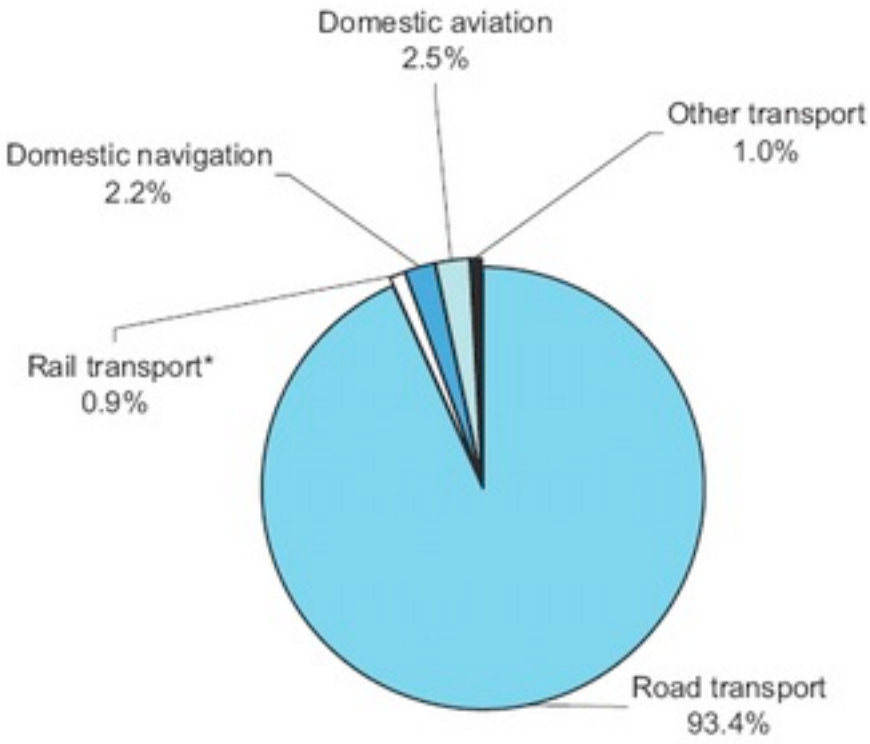
The increased criss-crossing of jet trails we see in the skies reflects the fastest rise in energy consumption of all transport modes (including maritime transport). As illustrated in Table 2 and Figure 2, between 1990 and 2004 energy consumption rose by 67 % in aviation, which was considerably greater than the 27 % growth recorded for road transport. Energy consumption in rail transport went up only marginally by 1 %. By contrast, the only decrease observed - and one which was quite significant - was in inland navigation (-23 %). In absolute terms however, road transport consumed an extra 62 million toe (mtoe), rising from 228 mtoe to 290 mtoe.

In the main these changes in energy consumption reflect the growth or decline in the popularity of transport modes, but also partly the development of more fuel-efficient traction technology. In rail transport for instance, the consumption of electricity for rail traction is generally increasing due to the growing share of electrified lines, which has been displacing diesel fuel usage.

The EU patterns reflect the global situation of all Member States, but there were some national particularities (Table 1). Growths in energy consumption of around 100 % or above between 1990 and 2004 were reached in one or more transport modes in several countries (Czech Republic, Spain, Ireland, Italy, Luxembourg, the Netherlands, and Portugal), with this high growth being most often seen in either road or air transport. Energy consumption in air transport grew by as much as 224 % in Luxembourg; an increase that was in fact overtaken by Turkey (288 %). In the other modes, Spain and Finland were the only Member States to stand out, with energy consumption growths of 97 % in Spain for rail transport and of 115 % in Finland for inland navigation.

Increases in road fuel consumption were not necessarily higher in the new Member States of Eastern Europe, apart from the Czech Republic (140 %). Moreover, energy consumption in road transport was not always driven upwards: in Estonia and Lithuania, consumption actually went down, by -20 % and -30 % respectively.

Emissions



Source: European Environment Agency

* Data cover diesel (and some coal-powered) trains only; electric traction is therefore excluded.

Figure 3: Greenhouse gas emissions from transport by transport mode, EU-25, 2004 (in %)

Nearly the entire energy consumption of the transport sector consists of fossil fuels. In fact, according to the European Environment Agency, the EU-25 is 98 % dependent on them [1]. Fossil fuel combustion produces carbon dioxide (CO_2) and other emissions resulting from human activity, many of them harmful to human health. The quantities and profile of these emissions depend on the quantity and quality of fuel used, the technology used in combustion, the end-of-pipe technologies (filters, catalytic converters) and other factors such as speed, loading factor, temperature and engine maintenance.

Greenhouse gas emissions result from burning petrol, diesel and kerosene in internal combustion engines. CO_2, the biggest contributor by volume to global warming, accounted for 97 % of greenhouse gas emissions in 2004 in the EU-25. However, although CO_2 is the most important anthropogenic GHG - and often the main focus of public debate on the 'Greenhouse effect'- it is not directly harmful (i.e. it is not toxic) to human health at ground level, however it is an asphyxiant.

Industrialised countries that are signatories to the Kyoto Protocol, adopted in 1997, are required to reduce their emissions of six greenhouse gases (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride) to on average 5.2 % below their 1990 levels, by 2008 to 2012.

However, the Kyoto Protocol does not cover emissions from international flights and maritime transport - which are fast becoming major polluters.

For its part, the European Union agreed to an 8 % reduction in its greenhouse gas emissions, with reductions for the EU-15 Member States agreed under the so-called burden sharing agreement, which allows some countries to increase their emissions, provided that these are offset by reductions in other Member States.

Emissions of the 'Kyoto basket' (the six greenhouse gases) covered by the Protocol are weighted by their global warming potentials and aggregated to give total emissions in CO_2 equivalent tonnes. Excluded are ozone depleting substances with global warming properties, as covered by the Montreal Protocol.

Readers should also note that the figures presented in the following section do not include greenhouse gases from international aviation and maritime transport. Moreover, rail transport data cover emissions from diesel and coal combustion only and not from electric traction. This is important to note as electric traction accounts for two-thirds of final energy consumption in rail transport.

Road transport: largest emitter

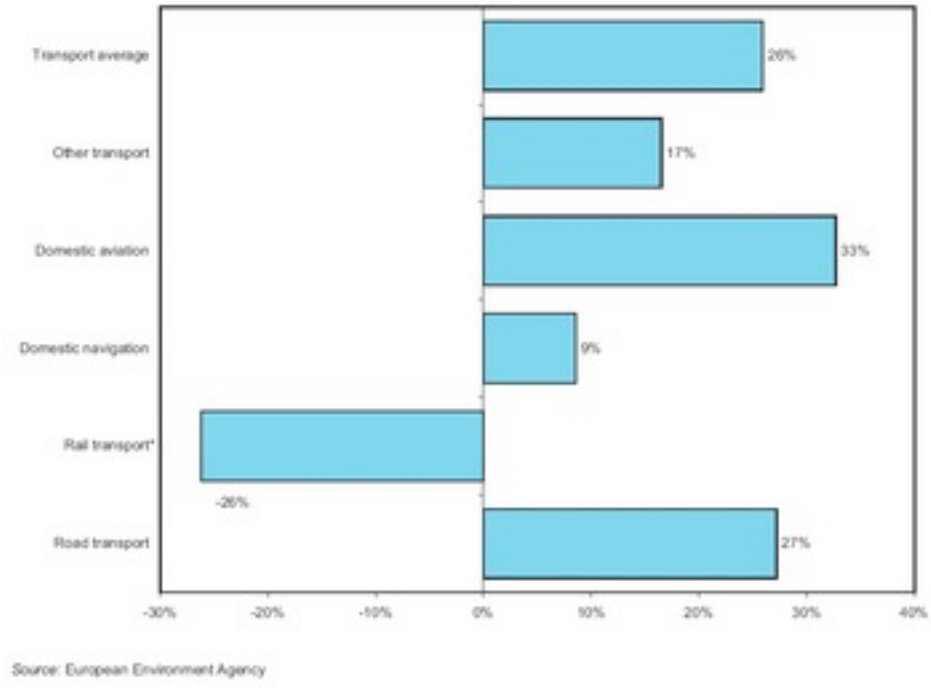


Figure 4: Evolution of total greenhouse gas emissions by transport mode, EU-25, 1990-2004 (in %)

As one could have suspected with the 83 % share of transport energy consumed by road transport (see above), this mode remains by far the largest single emitter. According to the European Environment Agency, 93 % of greenhouse gas emissions from transport came from road transport in 2004 (see Figure 3).

Readers should note however that although the modal share in emissions was proportionally higher than the share of energy consumed, this also reflects methodological differences, among which is the exclusion of international aviation and maritime transport from the emission data, which artificially increases the share

of road transport. Indeed, this exclusion of international aviation explains why the share of air transport emissions (domestic only) only reached 2.5 %, not much more than inland waterway transport (2.2 %), a similarity which would otherwise come as quite unexpected.

Moreover, although rail transport seems to have been the smallest polluter, with an apparent share of 0.9 %, the true proportion would be larger than this if electric traction were also taken into consideration. The share of electricity in total rail energy consumption was 66 %, twice the share of diesel energy.

Perhaps not surprisingly, road transport also accounted for 76 % of ozone precursor emissions, 72 % of particulate matter and 71 % of acidifying substances emitted in transport. However, here again, these shares are artificially inflated with a view to the particles emitted. Technologically speaking, the new emission standards under Euro V fuel regulations effectively make the use of particle filters and catalytic exhaust clean up compulsory.

The widespread availability of low-sulphur fuels is important for the introduction of cars equipped with direct fuel injection (already widely introduced for diesel engines), which offer considerable potential for fuel efficiency and allow a further reduction of NOx emissions. Fuels with reduced sulphur content (both gasoline and diesel) - of less than 50 ppm (parts per million) - have been mandatory in the EU since 2005. The sulphur level will be further reduced to less than 10 ppm by 2009, which is considered to be effectively 'zero' content.

According to the EEA, of the countries with data available, all of them had already met the 2005 limit value for low sulphur content in road transport fuels, while others were expected to do so. Some countries had even achieved the 2009 target on zero sulphur fuels. Moreover, steps towards sulphur reduction were being taken in other modes. [2].

Looking at the evolution of greenhouse gas emissions over the 1990-2004 period (see Figure 4), domestic aviation recorded the fastest growth (33 %). It was followed by road transport (27 %), other transport (17 %) and domestic navigation (9 %). The only drop (among the transport modes covered) was in rail transport (-26 %), but readers are reminded that these data reflect a drop in diesel (and some coal) rail energy only.

Data sources and availability

In this article, final energy consumption in transport refers to fuels used in all transport activities irrespective of the economic sector in which the activity occurs, i.e. fuels consumed in: land transport (NACE 60) excluding pipelines; water transport (NACE 61) excluding maritime transport; and air transport (NACE 62). Readers should also note that data show the amount of fuel supplied in the EU, but by the very nature of certain types of transport, and notably air transport, the fuel may be used outside the EU (i.e. on flights to non-EU countries).

In addition, the following points should also be noted when looking at the individual transport modes.

- *Road transport* fuels include leaded and unleaded petrol, diesel, motor spirits and LPG, but exclude lubricants.
- *Rail transport* includes main energy sources (electricity, diesel and LPG), but excludes coal because of its very small share; for electricity a conversion factor was used. Electrified urban transport systems such as metro and tramways are also included here.
- For *air transport*, the data show the amount of aviation fuel supplied, but as mentioned above, by the very nature of the industry, the fuel may in fact be used in or over many other countries.
- *Inland navigation* covers diesel oil and includes consumption by small vessels (including leisure boats) performing coastal shipping and not using fuel from international maritime bunkers (hence the term 'inland navigation' as opposed to 'inland waterways'). This explains data for countries without a significant inland waterway network.

Context

The transport sector is the fastest growing consumer of energy and producer of greenhouse gases in the European Union (EU), despite advances in transport technology and fuel that have resulted in marked decreases in emissions of certain pollutants.

Although issues in their own right, the environment and energy clearly come together when looking at the subject of transport sustainability, for consumption and emissions are fairly closely linked: what goes into the fuel tank comes out of the exhaust pipe in the form of emissions.

Improving the sustainability of the transport sector clearly requires a more comprehensive and integrated approach which reconciles transport, environment and energy policies. And it necessitates policies that combine legislation and economic instruments, with a shift in focus from 'end-of-pipe' actions to ones that are more preventative.

Against the backdrop of mounting energy concerns, among which an oil price hike in early 2006, 'Keep Europe Moving', the mid-term review of the 2001 White Paper, also highlighted the need to make transport contribute more to energy security, by consuming less. Of total final energy consumption in the EU, the transport sector (excluding maritime transport) accounted for a share of nearly 31% in 2004.

Integration of environmental considerations has been high on the political agenda following the Treaty of Amsterdam, which introduced 'sustainable development' as one of the EU's core objectives. But worryingly, according to the mid-term review, the measures taken so far will not be enough to counter the increasing environmental pressures of transport especially when it comes to CO_2 emissions.

Further Eurostat information

Publications

- Panorama of transport, 2009 edition

Main tables

- Energy (t_nrg), see:

Energy Statistics - quantities (t_nrg_quant)
Final energy consumption by transport (ten00100)
Energy consumption of transport, by mode (tsdtr100)
Share of biofuels in fuel consumption of transport (tsdcc340)

- Environment (t_env), see:

Air pollution/Climate change (t_env_air)
Emissions of particulate matter from transport (tsdtr440)

Database

- Environment (env), see:

Air pollution/climate change (env_air)
Indicators for air pollution and climate change (source: EEA) (env_air_ind)
Air emissions (source: EEA) (env_air_emis)
Environmental accounts (env_acc)
Physical flow and hybrid accounts (env_acp)
Air Emissions Accounts by activity (NACE industries and households) (env_ac_ainacehh)

Dedicated section

- Energy
- Environment
- Transport

Methodology / Metadata

- Energy consumption of transport relative to GDP (ESMS metadata file - tsdtr100_esms)
- Energy Statistics - quantities (ESMS metadata file - nrg_quant_esms)
- Share of biofuels in fuel consumption of transport (ESMS metadata file - tsdcc340_esms)

External links

- European Environment Agency - Transport