INTELLIGENT USE OF ENERGY AT SCHOOL

IUSES

Sustainable transport & mobility

Student handbook

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Copyright notes

Key to symbols

Definition: this is to indicate a definition of a term, explaining what it means.

Notes: this shows that something is important, a tip or a vital piece of information. Watch out for these!

Learning Objective: these are at the beginning of each chapter and they explain what you will learn in that chapter.

Experiment, Exercise or Activity: this indicates something for you to do, based upon what you have learned.

Weblink: this shows an internet address where you can get more information

Reference: this indicates where some information came from.

Case Study: when we give an actual example or a real situation.

Key Points: this is a summary (usually in bullet points) of what you have covered, usually at the end of a chapter

Question: this indicates when we are asking you to think about a question, especially at the end of chapters

Level 2: this marks an in-depth section

Index

Chapter 1 Main Impacts of Transport and statistics

Learning Objective**:** In this chapter you will learn:

- What the main externalities of transport are
- About energy consumption in the transport sector
- How transport influences our health and safety

Going to school by bus, driving to the shopping mall, visiting relatives or going on holiday, in each and every action that requires us to go from one point to another or to get things from often quite far away, we depend on Transport. But it's not only the big truck or ship that supplies us with tonnes of goods from all over the world. It's also our daily traffic by car, bus, train or plane that has a main impact on energy consumption and furthermore on environment. Transport and traffic that brings people closer together and keeps our economy running, has also some severe side effects that directly influence our daily life. As shown in Figure 1 not only air pollution and noise are significant influences based on transport, traffic contributes also a big part to climate change for example trough CO_2 emissions. Looking on the transport sector, one should also think about hazards connected with traffic Transport is responsible for a large number of often deadly ending accidents.

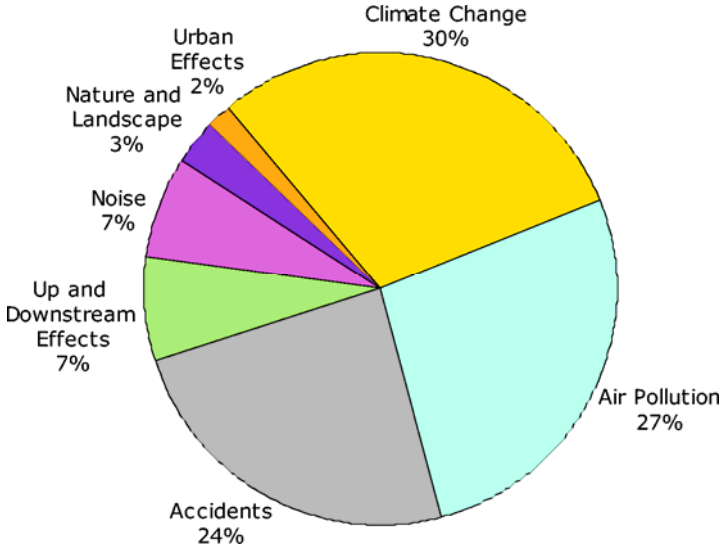


Fig.1: Transport externalities (in terms of costs) in Europe 2004
http://dataservice.eea.europa.eu/atlas/viewdata/viewpub.asp?id=4153

In the following few pages we will take a closer look on these externalities of transport, to get a better understanding on the basic problems connected with transport and traffic. Transport numbers are growing from year to year. Transport in general can not be totally avoided but our transport needs could be fulfilled more efficiently. The question is how to get more out of less…

Energy consumption

The Transport of people and goods requires a large amount of energy, transport is responsible for about a third of EU's energy consumption. This large energy demand is nowadays mostly covered by non renewable energy sources like oil or gas. As you can see in Figure 2, road transport is responsible for up to 85% of the energy consumption in the transport sector. Train, ship and plane are only responsible for about a fourth of the whole transport energy demand together.

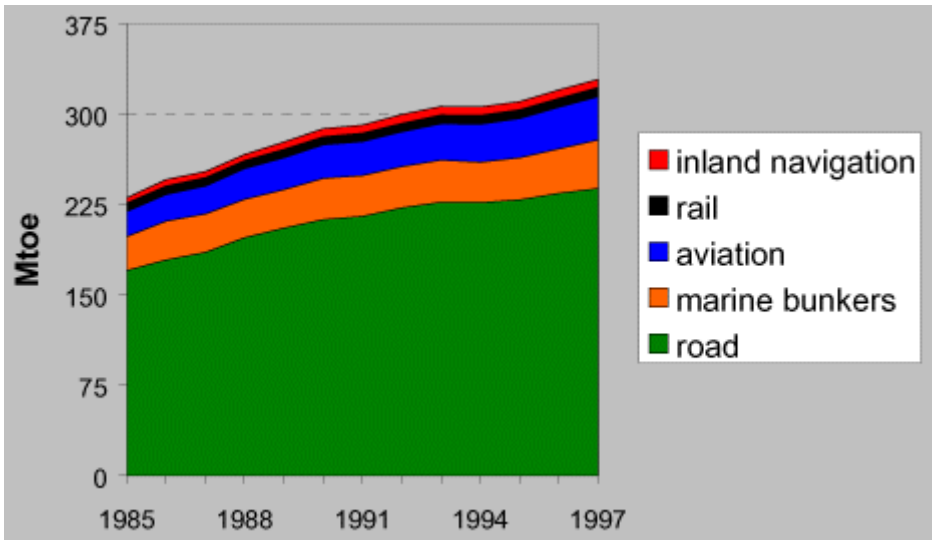


Figure 2: Energy demand by mode of transport
http://dataservice.eea.europa.eu/atlas/viewdata/viewpub.asp?id=351

The Energy consumption in the transport sector is strongly linked to economy. A growing economy also means an increase in Transport demand to meet the higher level of requirements on the exchange of goods and services. Transport demand is usually expressed in terms of number of people, volume, or tons per unit of time and space. For passenger transport, transport demand is related to the changing nature of activities that necessitate transport, such as holidaying, shopping and commuting to work and school.

Measured by the conventional scale of passenger□kilometres and tonne-kilometres, the EC predicts that transport activity will nearly double for both passenger and freight transport between 1990 and 2020.

Pollution, Emissions

Living our every day life we are not noticing that we are surrounded by several different types of gases building Earth's Atmosphere. Earth's Atmosphere is a layer of gases surrounding the globe and retained by gravity. The Atmosphere is responsible for the climate on earth and without it life on earth would not be possible. The major parts of the atmosphere are nitrogen with about 78% and approximately 21% oxygen considering dry air. There is also a considerable amount of water vapour and other gases like carbon dioxide in the Atmosphere that are responsible for the natural greenhouse effect. Changing the composition of the Atmosphere also means changing our living conditions and also our environment.

Definition: The greenhouse effect is the rise in temperature that the Earth experiences because certain gases in the atmosphere (water vapour, carbon dioxide (CO_2), nitrous oxide, and methane, for example) trap energy from the sun by absorbing infrared radiation. Without these gases, heat would escape back into space and Earth's average temperature would be about 30°C colder. Because of how they warm our world, these gases are referred to as greenhouse Gases.

Greenhouse gases in general have two origins, one source is the ecosystem that produces natural greenhouse gases and the other one are human activities. Those greenhouse gases released through human activities are called anthropogenic greenhouse gases. Anthropogenic greenhouse gases are mostly produced by burning fossil fuels, livestock farming and agriculture. This emis-

sion of greenhouse gases in addition to the natural sources leads to the effect called "Global Warming". Since the start of the recordings of global temperature in 1860 a significant increase of temperature can be observed. This increase is strongly linked to the industrial development and the emission of Greenhouse Gases like CO_2.

CO_2 is responsible for about 60% of the anthropogenic greenhouse effect and is a reference substance for all other anthropogenic greenhouse gases.

Fig. 3 shows the Trend in greenhouse gas emissions throughout the European continent. EU-15 refers to 15 EU Member States prior to May 2004, EFTA-4 to the four EFTA countries (Iceland, Liechtenstein, Norway and Switzerland), EU-12 to 12 new EU Member States as of January 2007 (Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia) and CC-1 to the candidate country Turkey.

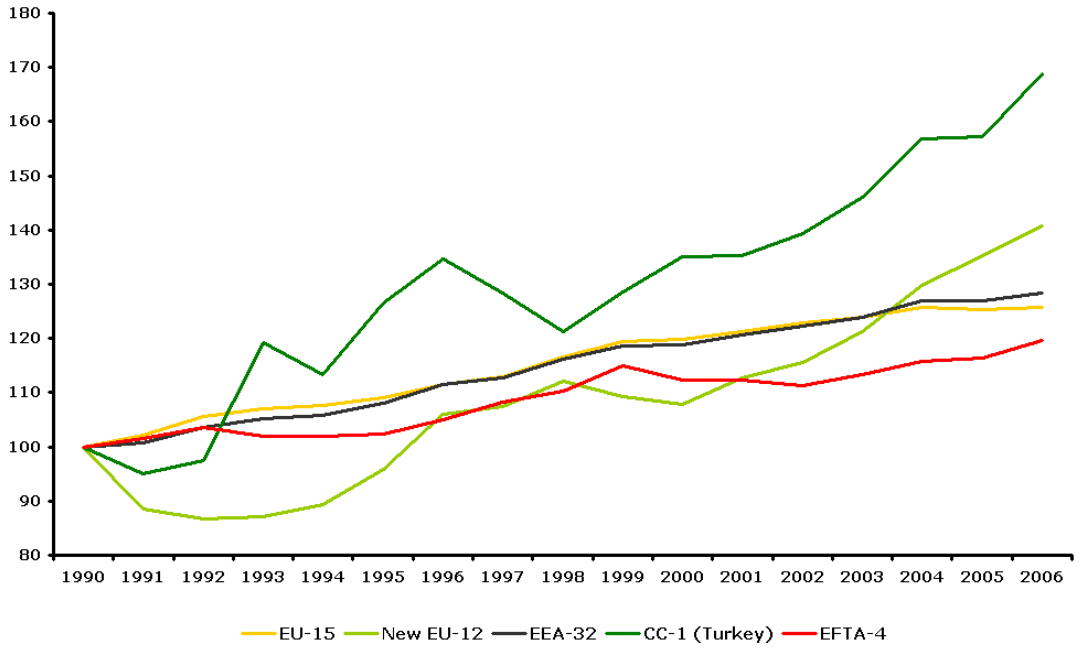


Figure 3: Greenhouse gas emissions throughout the European
http://dataservice.eea.europa.eu/atlas/viewdata/viewpub.asp?id=3860

As shown in greenhouse gas emissions are still rising, especially in the new EU 12 countries. Organisations like the United Nations try to reduce or even stabilise the emissions of greenhouse gases through treaties and conventions between industrial countries which are largely responsible for the emission of greenhouse gases. Due to economic and political concerns treaties like the "Kyoto Protocol" are often far behind the goals that were agreed.

Questions:

What are the effects of Global Warming? How does Global Warming influence our every day life?

What are the difficulties of reaching goals in climate protection on an international basis? Which problems concerning greenhouse gas emissions and environmental protection in general occur in countries that are still in the industrialising process?

Dust

Transport not only produces gaseous pollutants but also small particles that can cause various diseases. These particles are mostly produced in the residential sector and by transport especially from diesel engines.

Definition: Dusts with a particle size lower than 10 micrometers are considered as fine particles or particulate matter (PM_{10}). Particles with diameters below 10 micrometer are considered as respirable, particulate matter smaller than 2,5 micrometer can penetrate into the gas exchange regions of the respiratory tract and also affect other organs besides the lung itself.

The WHO (World Health Organisation) and the EU have set up different limits to reduce the amount of PM_{10} emissions. Fig. 4 shows the emission of PM_{10} in the European region weighted by the population of the different countries. TSP in the diagram means "Total Suspended Particulates" and refers to all suspended particles in air.

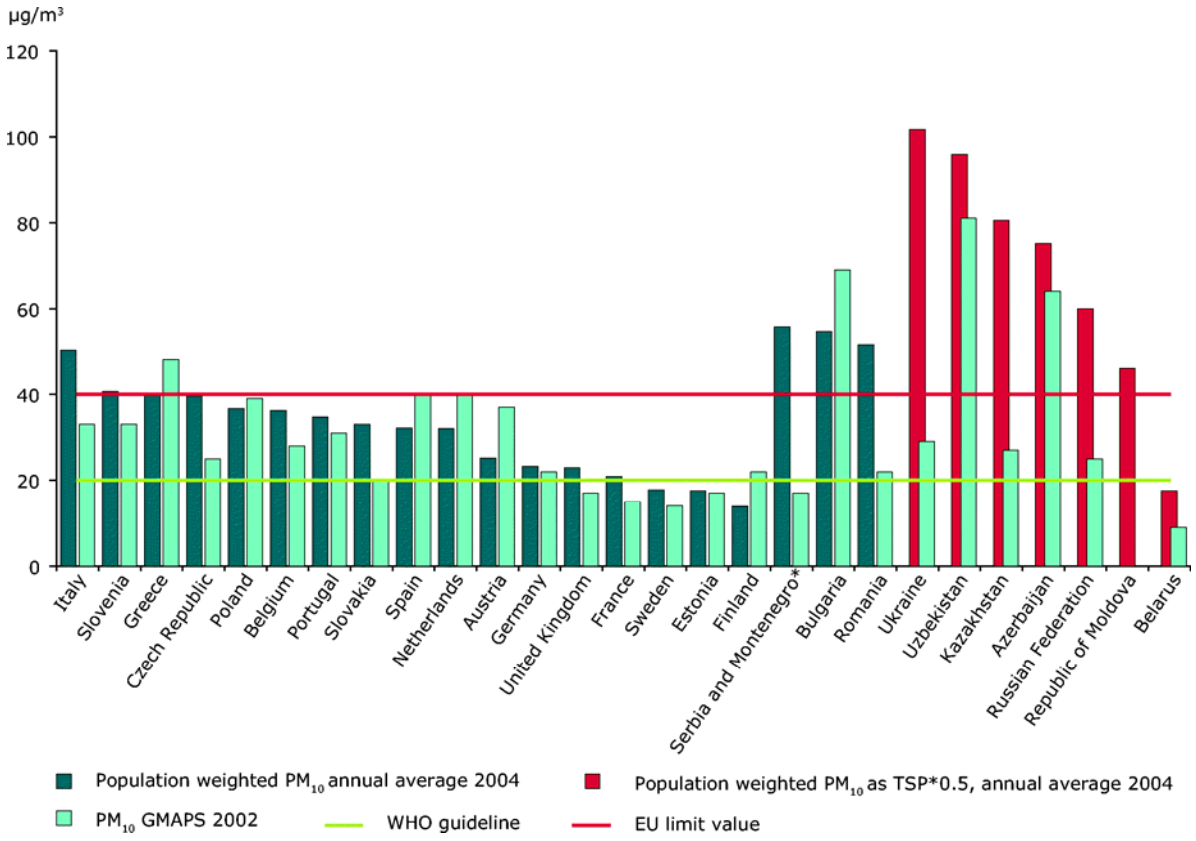


Figure 4: PM_{10} Emissions throughout the European Region

http://dataservice.eea.europa.eu/atlas/viewdata/viewpub.asp?id=2677

In the diagram the monitored data is compared to PM_{10} concentrations modelled by GMAPS. GMAPS or Global Model of Ambient Particulates, is a model that helps predict peaks in particle emissions and set up measures before reaching concentrations that could be hazardous for different groups of the population, for example for children or older people. To fulfil different standards and guidelines various countries set up measures like speed limits or pay governmental aids to equip older cars with particle filters to reduce the emission of particles especially through the winter period where the emissions by residential heating reach the highest values.

Acid rain

Theoretically hydrocarbons like fossil fuels, used as energy source for transportation in large amounts, are totally burnt to carbon dioxide and water with the restriction that this is true for pure hydrocarbon mixtures speaking in terms of a complete combustion. The fuels we use to run our vehicles contain more or less impurities, depending on different quality standards. Crude oil for example includes a large amount of sulphur which leads to sulphur dioxide (SO_2) emissions if no proper separation process is carried out.

These sulphur dioxide emissions lead, together with nitrogen compound emissions, trough several reactions in the Atmosphere to a phenomenon called "Acid rain". Pure Water normally has a pH-Value of 7, acid rain shows pH-Values of 5,5 and below.

Definition: The pH-value gifs information whether an aqueous solution reacts as a base (pH above 7) or as an acid (pH below 7). A solution with a pH-value of 7 is called "neutral". Distilled water shows a pH-value of 7 for example.

Acid rain has serious impacts on the environment in general but especially on the forest. Especially forests situated in high altitudes are often exposed to clouds of toxic emissions that are far more acidic as the rain itself like the example in Pic. 1 from the Bavarian Alps shows.

Picture 1: Destroyed forest due to the impacts of acid rain.
http://www.bund.net/index.php?id=2128

In the last decades SO_2 emissions have be reduced by several measures throughout industry and the transport sector. Industry, especially coal burning plants, has installed flue gas desulphurisation devices and the amount of sulphur in fuels like diesel, petrol or kerosene has been reduced. Cars and trucks have been equipped with catalytic converters that reduce the emission of nitrogen oxides (NO_X).

Fig. 5 shows that within member countries of the European Environment Agency the emission of acidifying pollutants has dropped significantly. But there is still a large potential to lower these emissions.

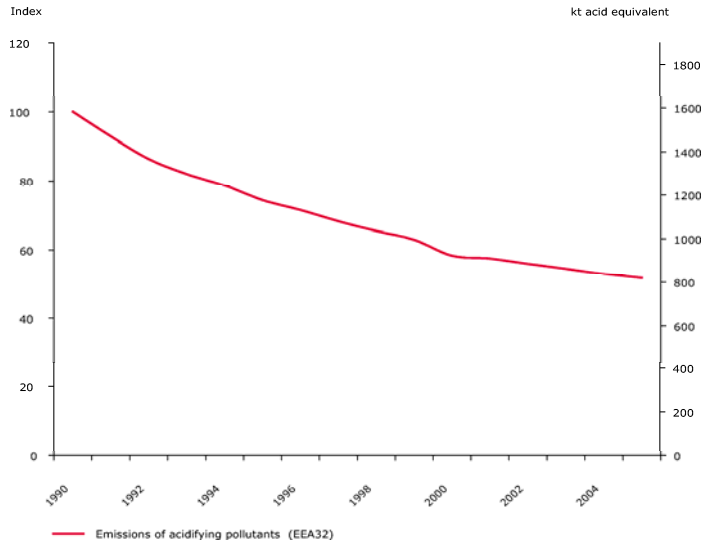


Figure 5: Emissions of acidifying pollutants within the member countries of the EEA
http://dataservice.eea.europa.eu/atlas/viewdata/viewpub.asp?id=3337

Die emission of acidifying pollutants also depends on the mode of transport. Due to the measures mentioned above the share of road transport has dropped significantly from about a third in the beginning of the 90's to nearly about 10% in 2004.

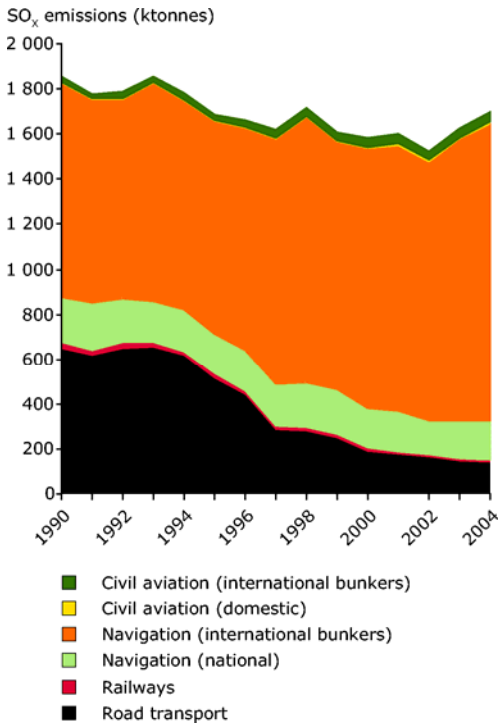


Figure 6: SO_X Emissions by different modes of Transport between 1990 and 2004
http://dataservice.eea.europa.eu/atlas/viewdata/viewpub.asp?id=2924

Though the SO_X emissions on the road transport sector have dropped, the total amount of emission stayed nearly the same and is again increasing since 2002, so SO_X emissions have shifted from road to maritime transport as shown in Fig. 6. This fact is a result of increasing transport numbers in general and less strict regulations on emissions on the maritime transport sector.

Questions:

Looking around in your hometown can you find any damage related to the emission of pollutants?

How do Industrial plants in your proximity deal with the Problem of air pollution?

Health

Several medical studies show that traffic has serious impacts on people's health. Pollutants and emissions as mentioned above can cause several different types of chronic diseases.

Studies on the impacts of small particle (>0,1µm) emissions for example show, that this respirable dust causes an increase of lung cancer, bronchitis and other severe respiratory diseases. These small particles are also able to pass trough the respiratory system right into the blood and can also cause cardiovascular diseases.

But it's not only the solid or gaseous pollutants that influence our health in a negative kind of way, also the noise from cars, trains, airplanes or trucks has a serious impact on peoples health. People exposed to a surrounding influenced by noise, are suffering from insomnia or disturbed sleep. These effects can be avoided if the continuous noise level is kept below 30dB indoors.

Noise does not only influence people in a physiological way, it also mental activities or social life. Children exposed to aircraft noise show impaired reading acquisition, attention and problem solving ability. Noise also raises the stress and aggression level, what directly influences the social life of people.

Note: An average car causes a noise level of about 60-80dB while an airplane reaches values of up to 150dB. Long term continuous noise levels of over 85dB can cause hearing damage.

Noise from road traffic can be reduced through different constructive measures like sound proof walls (Pic. 2), hedges or by setting up speed limits that can also be temporarily throughout different daytimes.

Picture 2: Noise protection wall along a motorway in Austria
http://www.tirol.gv.at/uploads/pics/abb004wiesengasse3.jpg

But transport can also influence your health in a positive way. To walk to school or ride the bike can reduce the risk of getting coronary heart disease, adult diabetes or the risk of becoming obese about up to 50%. Even 30 minutes of walking or cycling every day can have these Positive effects.

Questions:

Do you have any experiences with traffic noise?

Do you know any noise protection measures in proximity to your home or school?

Exercise:

Find out how much time you spend using different modes of transport throughout a "normal" week, and think about which trips you could go by bike or just walk.

Also find out whether driving to shool by car or going by bus is always the fastest way, especially in large cities.

Space occupancy

Transport and especially individual transport is not only a question of energy consumption or emissions but also a question of space. Looking around in an average city one recognises cars standing on every side of the street, large parking spaces in front of shopping malls or even park houses.

Note: The average car requires a parking area of 2,5 x 5m, that's 12,5m²! A bike in comparison only needs an area of 1,5m² in average.

Picture 3 shows an experiment carried out at the city of Münster in Germany, where the space occupancy for the transport of about 70people by different modes of Transport is shown. It's obvious that travelling by car is not only causing the most pollution but also consumes a lot of space. This large amount of room is for example also the origin of traffic jam.

Picture3: Space occupancy of different modes of Transport (Presseamt Münster)

Looking at different cities with historical city centres one recognises in comparison to the newer built parts of a city, that the streets are quite small. Streets are often only wide enough for cars going in one direction. Thinking about the amount of traffic that was present when these parts of the cities where built, one can easily imagine, that an increase of traffic also increases the demand of space.

Exercise:

Assume that the parking space of an average shopping Centre has a capacity of 2000Cars. Find out how much Space is needed for parking 2000cars and how much Space would be needed if everybody substituted his car by a bike.

Safety and accidents

Nearly every Day you can read in the local papers or see in the evening news reports of severe accidents related to Transportation. Dramatic news about plane or rail crashes seem to cost the majority of lives on the transport sector.

Picture 4: Road accident

A close look on statistics shows a completely different picture. Between 2000 and 2005 in average about 90 People in the EU-15 died in rail accidents every year. A quite small number compared to the 37.000 people that died in road accidents in average every year in the same period. Recognising that only about 70 people in the EU every year die on plan crashes, one can assume that the way to the airport is far more dangerous than travelling by plane itself.

Note: Every year about 37.000 people in the EU die in accidents related to road traffic. So road traffic is the most dangerous way of transportation.

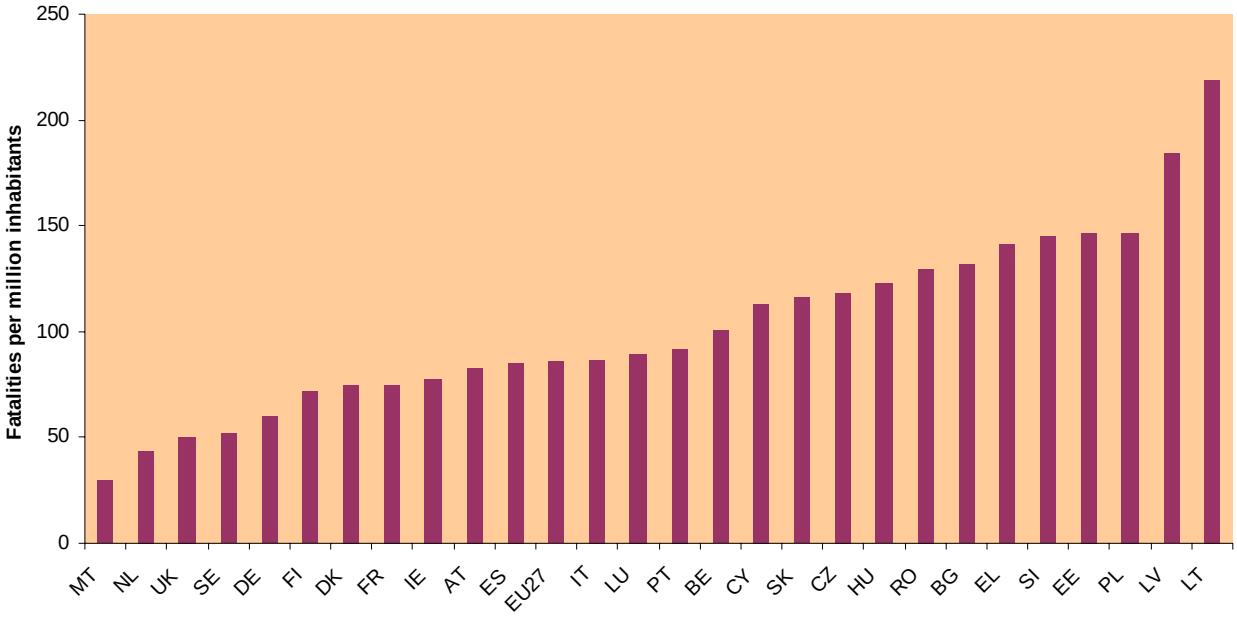


Fig.7.: Road fatalities per million inhabitants troughout the EU 27

Fig. 7 shows the differences in road safety throughout the EU-27. Nevertheless road traffic in Malta seems to be safer than in Lithuania, it's still the most dangerous mode of transport.

Besides the human losses, accidents from transport business can also cause some severe ecological hazards. Every year thousands of tonnes of dangerous goods are transported on our roads, waterways or right over our heads by plane. Accidents with transports like these often cause heavy damage to the environment and may cause also hazards to the public.

If you keep in mind that just one drop of oil contaminates 1 million (!) litre of drinking water, you can imagine what environmental impact an accident with a large oil tanking ship has, where thousands of tonnes of crude oil are spilt.

In Europe road transports of dangerous goods must be specially labelled with different signs and pictograms one can easily recognise. Signs used to mark such transports as shown in Fig. 5 give also information about the hazards of the transported material.

Picture 5: Sign used by transport of hazardous material.

Question:

Why does the majority of people think, going by car is safer than travelling by plane?

How do you think about it and what might have influenced your personal opinion on this topic?

Exercise:

Transports of dangerous goods are marked with signs like shown in Pic. 5. Find out how many of those transports you can find observing a busy road or motorway from a safe place or by travelling around in your spare time or holydays.

External impacts

As mentioned above transport has a serious impact on health and environment. But not only in terms of pollution the transport sector influences our surrounding, it has also some serious impact on our Landscape and also the fauna.

Especially in the alpine regions road transport and tourism have major influences on the landscape trough the construction of motorways with the need of large bridges over whole valleys or tunnel constructions.

The following Case Study of the "Tauernautobahn" trough the Austrian Alps shows, the enormous constructive efforts and ecological impacts of such a major project.

Tauern Autobahn

Thousands of trucks or cars are crossing the Alps between the two Austrian cities of Salzburg and Villach every day using the nearly 200km long A10 "Tauern Autobahn" on the European route E55 from Sweden to Greece (Pic.5). The Tauern Autobahn leads right through the heart of the Austrian Alps passing the "Hohe Tauern" where also Austria's highest mountain, the "Großglockner" with 3798m, is situated. Construction works in those alpine regions is a challenge for itself, but to build a motorway right through the centre of it means an enormous technical effort.

While travelling the whole length of 192km of the Tauern Autobahn, one passes 12 tunnels and over 20 bridges. The length of all tunnels together leads to a total length of 24km. Just walking through these tunnels would take you up to 4 or 5 hours without seeing any daylight! The longest tunnel is the so called "Tauerntunnel" with a length of over 6km.

But not only the tunnel constructions are enormous the longest bridge of the motorway over the "Liesertal" is 2,6km long and was, when it was built in the early 1980's, Europe's longest suspension bridge with pylons of over 80m in height (Pic. 6). Especially these large road bridges are the most impressing but also most influencing buildings along the valleys crossed by the Tauern Autobahn. These bridges often reach out from one End of the valley to the other and change the view of it completely.

Picture 5: The "Tauern Autobahn" from Villach to Salzburg
http://www.oeamtc.at/verkehrsservice/output/html/img/a10.jpg

Picture 6: Bridge at the Liesertal along the A10
http://bauwiki.tugraz.at/pub/Baulexikon/BrueckenInOesterreichC/Kremsbruecke.jpg

The Alps can be seen as on of Europe's water reservoirs. This water comes from countless springs which are often originating right in the centre of the big mountain massifs like the Hohe Tauern for example. Tunnel construction often leads directly through the origins of these springs and influences the natural water balance of these regions.

Buildings like motorways have, because of the big amount traffic they have to handle, also an impact on the quality of life of the people living near by and around it. In case of the Tauern Autobahn abutting owners are complaining over years now about the noise coming from the motorway. Protests and demonstrations led to a speed limit throughout night-time. Between 10pm and 5am it not allowed, to drive faster then 110km/h. Millions of Euro had do be invested in sound attenuating Walls and other measures to protect the neighbours from the noise. People are suffering from insomnia and the number of heart diseases among the population of the neighbouring towns is increasing. Beyond the noise problems several studies show that People living around the motorway and especially children are suffering from respiratory problems due to the emissions related to the Traffic.
Prognoses say that in 2020 up to 29.000 Cars and 14.000 trucks will pass the Tauern Autobahn every day, emitting over 18t of CO_2 every hour!

Streets, motorways, railway tracks or large Airports often divide whole landscapes influencing especially the fauna of the region negatively. Animals are following their instincts and have their own paths trough nature. Toads for example only spawn in traditional areas and often travel great distances to get to these places. But also the paths of deer or other animals living in the woods are disturbed by such buildings. Influences on their natural paths can cause a withdrawal or extinction of whole species in these regions.
Due to the pressure organisations for environmental protection ecological the impacts of large scale constructions are considered more and more. Constructive alternatives have to be consid-

ered or constructive measures are established to reduce the ecological influence of the structure. Such measures could be bridges over railway tracks or motorways for example that allow animals to pass over these barriers on their instinctual ways.

Questions:

What do you think?

Why is environmental protection and protection of species so important?

Are there any major projects refering to transport planned in your surrounding are?

What influence could they have on environment? What are the major concerns?

Key Points: The key points from this chapter are:

- Transport is necessary for all of us but has some serious side effects.
- Our environment and health is influenced by transport in differnt kinds of ways. Pollution, noise and other side effects can influence life circumstances in a negative kind of way
- Transport is always accompanied with the risk of accidents. The safest mode of transport is not always the one we thougt it is.

Web links

International Energy Agency (IEA): *http://www.iea.org*
European Environment Agency: *http://www.eea.europa.eu/themes/energy*
World Health Organisation *: http://www.who.int*

References:

European Commission: EU Energy and Transport in Figures Statistical Pocketbook, 2009

European Environment Agency: Transport at a crossroads, No 3/2009

World Health Organisation: Transport, Environment and Health, No 89, 2000

2 Conventional and alternative fuels

2.1. Important concepts (traditional and new fuels)

Learning Objective In this chapter you will learn:

- basic information (definitions, characteristics) about conventional and alternative fuels, including renewable sources
- aspects related to consumption and how to reduce pollution and tips for saving energy (fuel) during your daily transport
- How to keep things simple, healthy and environmental (KISS principle)

Definition: Traditionally, the word fuel denoted any substance, or mix of substances, that after a burning chemical reaction, produces a big amount of heat.

The term "fuel" was generally limited to the substances that quickly burn in air or oxygen, emanating big amounts of heat. The fuels are used for heating, for producing energy in internal combustion engines and as a direct source of energy in the case of rocket propulsion. But this handbook discusses fuels in other terms…

Definition: The alternative fuels are any substances or sources of energy other than conventional fuels (gasoline and diesel), that can be used for transport. They are also called "non – conventional fuels".

Focus on alternative fuels was mainly related to transportation fuels, since 70% of petroleum is consumed by the transportation sector. Vehicles can run on many kinds of fuels that are not made from petroleum. We can recognize **alcohols , compressed natural gas (CNG), electricity (stored in batteries or fuel cells), hydrogen, liquefied natural gas (LNG, and liquefied petroleum gas LPG or propane)** as alternative fuels. Other alternative fuels include **biodiesel, wood, vegetable oil, biomass, and peanut oil.**

Note: An important fact to keep in mind: One tonne of CO_2 fills a swimming pool of the following size: 10m wide, 25m long and 2m deep. How many swimming pools of CO_2 does your family produce each year? (See the Greenhouse Gas Emissions Calculator at the end of the chapter). Going through this chapter, bear in mind the following question: how can my family empty the swimming pools?

Furthermore, we will use the following dot notation: a red dot (or red light of the semaphore) for fuels very harmful to the environment (something we all have to fight with), a yellow dot (or yellow light of the semaphore) for caution and fuels less harmful. And of course, a green dot (or green light of the semaphore) will stand for the cleanest and most environmental friendly sources of energy.

We'll start our journey in the world of fuels with a view on the most commonly used fuels at the moment…

2.1.1 Conventional fuels

Figure 1 below presents the petroleum refining process. The gases are pushed into the distillation column with its different temperature chambers that enforce the fractional distillation. Any compound in gaseous state cooling below its boiling point condenses into a liquid. The figure shows the temperature ranges at which the different liquid hydrocarbons are obtained. In parentheses one finds the number of Carbon atoms of each resulting hydrocarbon (the higher the carbon chain length, the higher the boiling point).

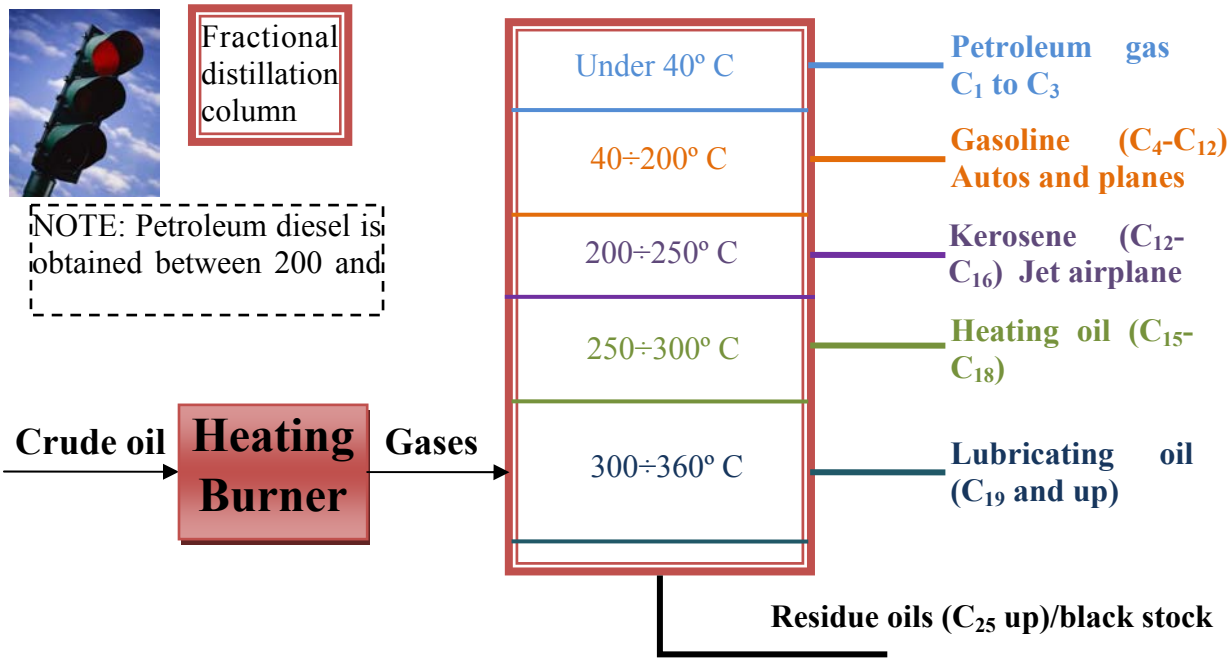


Fig.1 The petroleum refining process

Note: Probably you noticed the red traffic light on the left. It was added to illustrate the great danger these fuels represent for the environment.

a) Gasoline

Definition: Gasoline is, according to the Merriam-Webster Online Dictionary, a volatile flammable liquid hydrocarbon mixture used as a fuel especially for internal combustion engines and usually blended from several products of natural gas and petroleum.

Gasoline is most often produced by the fractional distillation of crude oil. This is done according to the different boiling points of the component hydrocarbons (with 5 to 12 carbon atoms per molecule). The result of the primary distillation process is called straight-run gasoline. The quantity of straight-run gasoline obtained is around 25% of the quantity of crude oil processed. This yield of gasoline might be doubled by converting higher or lower boiling point fractions into gasoline hydrocarbons.

Table 1 below presents the typical chemical compounds in gasoline:

General Name	Examples	Percentage
Aliphatic - straight chain	Heptanes	30-50
Aliphatic – branched	Isooctane	
Aliphatic – cyclic	Cyclopentane	20-30
Aromatic	ethyl benzene	20-30

Table 1: Typical Composition of Gasoline

Percentage Weight in 1kg Gasoline

1 kg of Gasoline contains 0.85 kg of Carbon BUT

1 kg of Carbon burnt

~3.7 kg of CO2

This means 3.7 * 0.85 = 3.145 kg CO_2 for each kg gasoline consumed. So the CO_2 swimming pool fill factor is very high. Hence the big red dot is well deserved by gasoline.

According to the Indian Oil Corporation Limited (in the PCRA Data Control Book):

What about one litre of gasoline?

Take notice that 1 kg of gasoline is not equivalent to one litre of gasoline! Specific density of natural gasoline is 711.22 kg/m^3, while the specific density of vehicle gasoline is around 737.22 kg/m3. Hence one considers that 0.73722 kg of gasoline correspond to 1l of gasoline, and one obtains that 1l of gasoline yields 3.145 * 0.73722 = 2.318 kg of carbon dioxide! (In line with the data presented in subsequent sections).

Gasoline quality can be improved by using benzenes to increase the octane number. But what is this octane number?

Definition: The *octane number* (ON) is the main criterion for determining the anti-knock quality of gasoline. It is determined through the comparison of gasoline with standard compounds, with a known octane number.

Highly branched Isooctane defines the 100 point on the octane rating scale, as it burns smoothly, with little knock. In contrast, heptane (a straight chain compound) was assigned the zero octane rating due to its very bad knocking properties.

The higher the value of the octane number, the higher is gasoline's resistance to knock. Straight-run gasoline usually has an octane number of around 70, and it undergoes several refining processes (including cracking and isomerisation) in order to achieve an octane rating above 90. Moreover, one can add anti-knock agents (e.g. Ferrocene, Toluene a. o.) to further reduce engine knocking and increase gasoline's octane rating.

b) Diesel fuels

Definition: Petroleum diesel, also called petro diesel, or fossil diesel to be used in diesel engines and produced from petroleum and is a hydrocarbon mixture, obtained in the fractional distillation of crude oil between 200° C and 350° C at atmospheric pressure.

It generally it contains 12 up to 18 carbon atoms in the molecule, and has densities between 850 – 890 kg/cm^3. It is used to fuel Diesel engines and is characterized by properties opposed to those of gasoline, i.e. the composing hydrocarbons have to easily oxidize and form peroxides and other incomplete oxidation products, so that auto-ignition produces easily.

Diesel vehicles emit significant quantities of both NO_x (Nitrogen Oxide) and particulate material. Sulphur content is the most important characteristic to be addressed in order to cut down PM (particulate matter i.e. any particles that can harm the environment) and NO_x emissions from diesel engines. What solutions do we have? On the one hand, ultra – low sulphur diesel (ULSD) is a standard for defining diesel fuel with substantially lowered sulphur contents. Since 2007, almost every diesel fuel used in Europe and North America is the ULSD type. On the other hand, diesel vehicles are equipped with anti particulate filters designed to allow compliance with the standard particulate emission limits (see the EURO norms in section II.3).

Note: Although CO_2 emissions per litre are higher than those for gasoline (see table 2) they compensate through the better fuel efficiency. Despite that we shall "award" diesel the same big red sign like in the case of gasoline.

Where does the word "diesel" come from?

It comes from the German inventor Rudolf Christian Karl Diesel (1858 – 1913) who in 1892 invented the diesel engine.

Rudolf Diesel originally designed the diesel engine to use coal dust as a fuel. He also experimented with various oils, including some vegetable oils, such as peanut oil, which was used to power the engines which he exhibited at the 1900 Paris Exposition 1900 and the 1911 World's Fair in Paris.

2.1.2 Electricity

Batteries

Electric vehicle batteries (EVBs) are rechargeable batteries used in all-electric vehicles (EVs) or in plug-in Hybrid-Electric Vehicles (PHEVs). The amount of electrical energy stored in any battery is measured in *ampere hours*, while energy is usually measured in *watt hours*.

Note: Significant improvement is continuously done in increasing battery energy density and in decreasing the cost per kWh. This trend's evolution is comparable to Moore's Law for computer hardware. Other main challenges with batteries are: the charge time, battery lifetime and efficiency, the number of recharges (cycles) and the speed of discharge.

Recent developments in the field of batteries

Li-ion, Li-poly and zinc-air batteries have proved energy densities high enough to deliver range (km run) and recharge times comparable to conventional vehicles. Current research includes the introduction of Iron nanophosphates that bring major improvements in performance due to their nanostructure.

Recently, a research team of Rice University (Houston, USA) created hybrid carbon nanotube metal oxide arrays as electrode material that may improve the performance of lithium-ion batteries, Science Daily announced. "Although the combination of these materials has been studied as a composite electrode by several research groups, it's the coaxial cable design of these materials that offers improved performance as electrodes for lithium batteries," said Pulickel Ajayan, leader of the research group. The same source mentions that the hybrid nanocables grown in a Rice-developed process could also eliminate the need for binders, materials used in current batteries that hold the elements together but hinder their conductivity.

More information:

Rice University AT http://www.sciencedaily.com/releases/2009/02/090209122554.htm

Charging

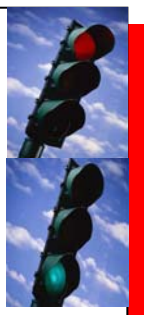
Batteries in electric cars must be periodically recharged. The most common way of charging these batteries is to use the electricity grid (at home or in on-road recharging points), that delivers power generated from a variety of energy resources (including coal, nuclear, etc.). Charging time is mainly limited by the capacity of the grid connection.

Recharging point for electric vehicles

In the Netherlands, 10 out of 11 electric grid operators joined forces to install electric vehicle recharging points all over the country. They will install free of charge an unknown number of such 1.5 meters terminals in the street, close to rail station and in parking lots.

Note: But what do we do here? In fact we might just move the pollution from our own car to some remote power plant. But we don't really eliminate it. Hence this source of energy receives from us the same red sign, just like conventional fuels, indicating the fuels most detrimental to the environment.

Home or remote renewable energy generators, such as roof top photovoltaic panels, micro-hydro stations or wind turbines, can also be used for charging. Eureka! Here are to notice the first good signs towards emptying our filthy swimming pools.



21.3 New - Alternative fuels

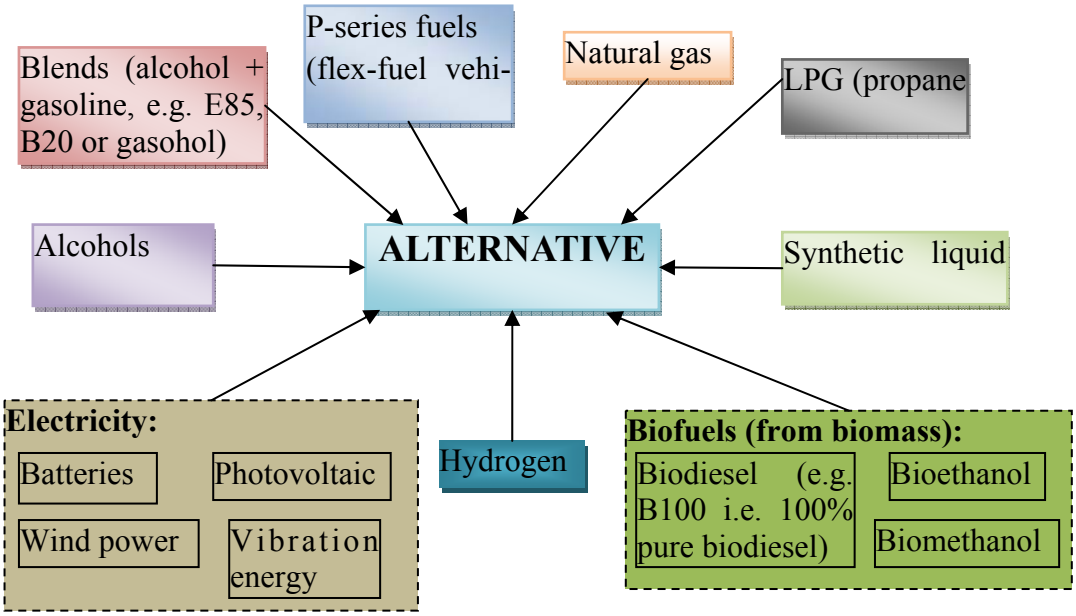
Definition: According to Webster's New Millennium Dictionary of English, an alternative fuel is a fuel other than gasoline or diesel for powering motor vehicles, often with improved energy efficiency and pollution reduction features.

The U.S. Department of Energy (DOE) adds fuels to their list of authorized alternative fuels if the fuel is substantially nonpetroleum and yields substantial energy security benefits, and if it offers substantial environmental benefits.

Note: Since 2000, the European Union has started addressing the issue of replacing conventional transport fuels (gasoline and diesel) with alternative fuels, in order to meet its commitments related to climate change (reduction of greenhouse gas emissions), to environment-friendly security of power supply and to promoting renewable energy sources.

Hence, the EU committed itself to replacing more than 20% of the conventional automotive fuels by alternative fuels until the year 2020, through its green paper: Towards a European Strategy for the Security of Energy Supply, issued in 2000. The alternatives seen as most promising by the Commission are: bio fuels (8%), natural gas (10%) and hydrogen (5%).

So emptying our swimming pools is also encouraged and enforced by the EU!!!



Fuels based on Gases

Natural Gas is a combustible gas that is found in deposits in deep Earth substrates. Natural gas is associated to petroleum deposits, the process of generation of the deposits being very similar.

In fact it is a by-product of oil drilling, although it can also be harvested from natural gas fields. On the other hand, natural gas consists mainly of methane (85-99%), but has a different chemical composition from methane.

Compressed and liquefied natural gas characteristics

Compressed natural gas (CNG) is inodorous, colourless and non-corrosive, greatly reducing the greenhouse gas emissions in comparison to gasoline-driven vehicles. It can be obtained at much lower costs than the conventional fuels. It is stored in high pressure containers, usually cylinders.

Liquefied natural gas (LNG) is another form of storing NG for use in transport vehicles. Liquefaction is obtained by cooling natural gas to -162 °C at atmospheric pressure. Storage and transport requires cryogenic tanks that are pretty expensive.

Note: According to NGVAmerica, typical Natural Gas Vehicles (NVGs) can reduce exhaust emissions as follows:

- Carbon monoxide (CO) by 70 percent
- Non-methane organic gas (NMOG) by 87 percent
- Nitrogen oxides (NO_x) by 87 percent
- Carbon dioxide (CO_2) by almost 20 percent below those of gasoline vehicles.

Wow!! This sounds interesting in our sustained search for discovering the best ways of achieving our goal: lower the impact on the environment of our own transportation. This means a yellow dot in our classification of fuels!

Natural Gas is lighter than air, so in the case of an accident it would dissipate towards the upper part of the atmosphere. Furthermore, it has a higher ignition temperature than gasoline. Hence the danger of creating fire or explosion hazards is lower.

On the other hand, NGV refuelling time is quite large, and natural gas pumps are still pretty uncommon and building new ones is very expensive. Hence promoting such vehicles worldwide would imply large infrastructure costs.

LNG Tank
(http://www.managenergy.net)

Liquefied petroleum gas – LPG

Definition: LPG - liquefied petroleum gas or LPG is a colourless hydrocarbon gaseous mixture, mainly containing propane and butane (i.e. 60% propane and 40 % butane or even 100% propane, or 100% butane).

It is produced by refining petroleum and stored under pressure to keep it in a liquid state. The boiling point of liquefied petroleum gas varies in the range −44°C and 0°C. LPG liquefies under moderate pressure, between 5 and 10 bars, and its special storage cylinders are made of heavy steel.

Note: LPG fuel (also called auto gas or auto propane) is used in internal-combustion engines, and burns with little air pollution and little solid residue.

Furthermore, it has a good octane rating: 108-110, and does not dilute lubricants. Auto gas has a lower energy density than both gasoline and diesel, so its equivalent fuel consumption is higher. LPG vehicles use a very similar engine technology to that for NGVs. Its advantage over natural gas is that it can be easily carried aboard the vehicle.

Most vehicles that run on unleaded petrol can be easily converted to run on auto gas and in most cases one can even use both of the fuels. But limited supply prevents any large-scale conversion to LPG fuel. This fuel deserves a yellow dot!

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Hydrogen

Definition: Hydrogen is one of the most interesting and maybe, in a way, the most promising renewable fuel in transportation. It could be easily produced through electrolysis, through the simple separation of Oxygen and Hydrogen in water (H_2O), making use of electricity from renewable sources.

Though, currently almost the whole quantity of Hydrogen is obtained from natural gas through a process called reformation. This produces CO2 emissions, but fewer emissions than just burning natural gas.

Note: Hydrogen usage, especially when it is produced with wind, solar, geothermal or hydro energy, or with other renewable energy systems, generates a zero-emission cycle. Hydrogen is a clean fuel that can replace gasoline, diesel fuels or gas, in the transportation sector. It has an octane rating of around 130, and hence enhanced efficiency. What dot should we appoint to it? A yellow dot would be appropriate although it tends to become green

Because hydrogen in gaseous state occupies a very large volume, in comparison to other fuels, hydrogen would be more useful as energy source in liquid state. Hydrogen can be transported over 350 km in vapour form, while in liquid form and in super-insulated tanks it can be transported over longer distance, up to 2000 km.

Hydrogen is used in fuel cells for producing electricity; the driving system of hydrogen vehicles is made up of an electrical engine without gearing. Hydrogen is also used in specially designed engines with internal combustion, and was successfully mixed with natural gas in gas buses, in order to increase efficiency and reduce emissions.

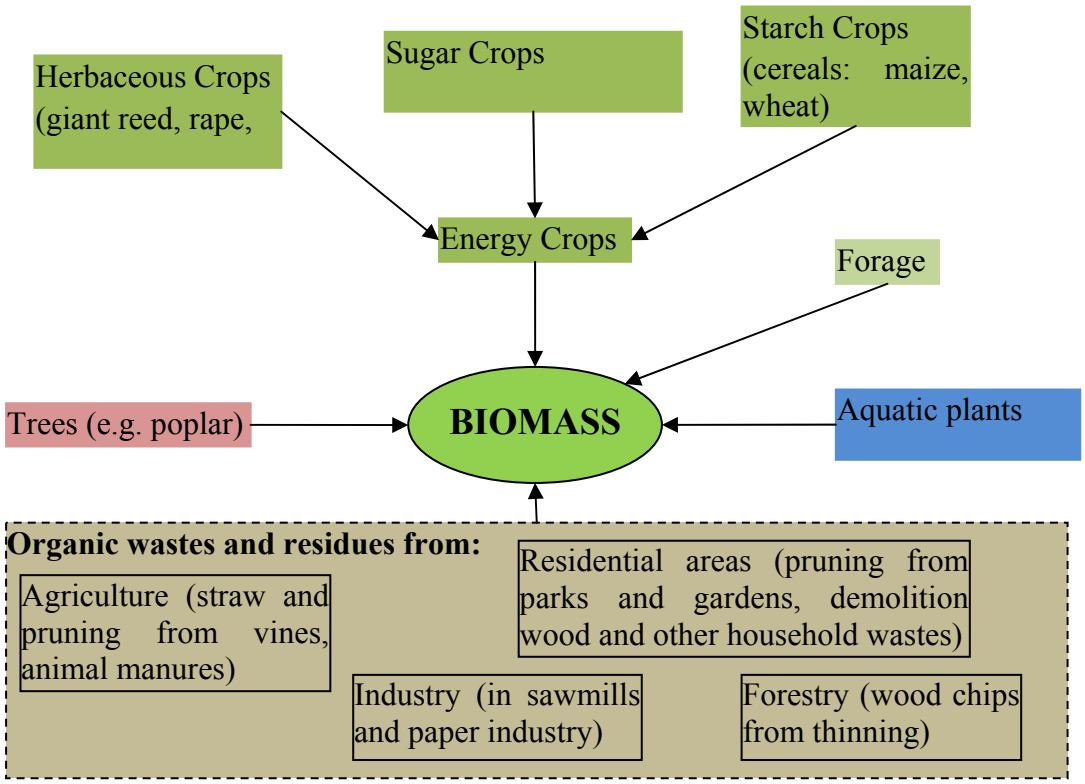
The Hydrogen fuel cell uses Hydrogen as fuel and Oxygen as oxidant. Other fuels include Hydrocarbons and alcohols. Other oxidants are air, chlorine and chlorine dioxide.

Starting with the ‘90s, automobile manufacturers put an emphasis on developing hydrogen-driven systems. Buses in public transportation, based on hydrogen fuel cells, proved to have reliability comparable with Diesel fuel buses, over a three year operation cycle, and the lifetime of the combustion cells is continuously improved.

Hydrogen scooter (U.S. EERE Dept.)

b) Bio fuels

Definition: According to the English Collins Dictionary, a **bio fuel** is a gaseous, liquid, or solid substance of biological origin that is used as a fuel.
Biomass can be seen as solar energy stored in the chemical bonds of the organic material. It is the source for bio fuels.



Note: Advantages of bio fuels:

- Cleaner (lower emissions of carbon dioxide and other pollutants)
- Renewable (i.e. based on CO_2-consumer plants that can be re-grown)
- new markets for agriculture, especially attractive for new member states
- biodegradability
- can be used with existing technologies
- it has assigned a red dot smaller than the one for conventional fuels

Disadvantages:

- higher costs than conventional fossil fuels
- limited availability of land for energy crops
- natural hazards can destroy the crops
- increased corrosiveness
- might contribute to increasing food prices
- in some cases the CO_2 emissions produced in growing, harvesting, transport and processing the crop wipe out the benefits of using bio fuels

Specific information related to biogas, biodiesel, bio ethanol and bio methanol.

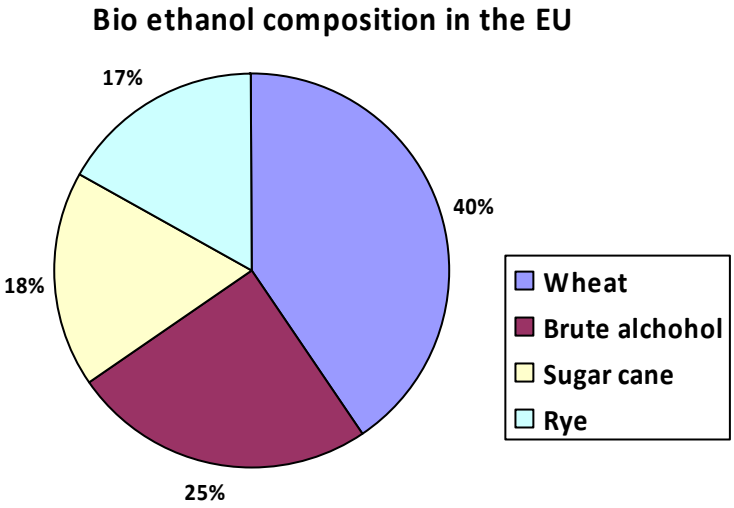
Biogas is a fuel gas produced from biomass.
Biogas produced by anaerobic fermentation of manure, municipal waste or energy crops, contains 30-60% methane and the rest is mainly carbon dioxide. But, it can be purified to natural gas quality, and hence be used as vehicle fuel. On the other hand biogas can also be produced through gasification of wood or other biomass. It contains mainly nitrogen, hydrogen and CO. Hence biogas can also be used for production of another alternative fuel: Hydrogen.

Biogas ((http://www.managenergy.net))

Biodiesel is a methyl-ester obtained from oil crops (rapeseed, sunflower, soy or palm) or animal fats. Hence it is a natural lubricant and ensures longer engine life, but caution should be taken as it can damage rubber parts (especially in pure state). Biodiesel can completely replace diesel fuel (B100 – pure biodiesel), or it can be mixed with petroleum diesel in any percentage (e.g. B25 is 25% biodiesel and 75% petroleum).

Rape oil crop used for biodiesel (http://www.managenergy.net)

Bio ethanol is ethanol produced from biomass.
Bio ethanol can be produced through fermentation and distillation of sugar crops (e.g. sugar cane in Brazil) and cereals (e.g. maize in the U.S.A.). What about the EU?



Grassland, agricultural waste and waste wood can also be used in bio ethanol production. It is usually used as gasoline additive (e.g. 10% ethanol and 90% gasoline – so-called gasohol), reducing ozone levels partly responsible for urban smog. Richer E85 (i.e. 85% ethanol and 15% gasoline) can be used in Flexible Fuel Vehicles (FFVs). It is said that combustion of ethanol produces 90% less carbon dioxide than gasoline. It has a very good octane rating of 129. Bio-ETBE is ETBE (ethyl-tertio-butyl-ether) produced from bio ethanol, and is used to increase the octane number of gasoline.

Bio methanol is methanol produced from syngas (synthesis gas, a mix of CO and hydrogen), that can be obtained through biomass gasification. It has a high octane rating (around 123) and can be applied to spark ignition (Otto) engines and fuel cells. It can also be used as gasoline additive (up to 10-20%) without needing changes in engine or infrastructure.

Bioethanol factory (http://www.managenergy.net)

Note: A report of the European Agency for Environment shows that the European Union (EU) might not be able to cover from its own production, more than a third of the bio fuels needed to achieve the objective for 2020 regarding the fuels in transport, i.e. 10% of the fuels to be bio fuels. There are already discussions in the European Commission about reducing its initial provision to 4%

SUSTAINABILITY

75% increase in food price increase (World Bank report) →

Standard of sustainable bio fuels production (12 main areas including:
Greenhouse gases reduction, rural-social development, food security, environment conservation and efficiency)

Fears might appear also with regard to the paper and timber industries, as they are also dependent on wood, although in biomass production, one usually uses trees with short lifecycle (e.g. poplar) planted in special crops.

Feasibility: Producing bio fuels implies releasing some amount of CO_2 emissions. So, is it worthy to produce it? Is there a real saving in the emissions? Or is it just a transfer of pollution from one region to another?

Note: Taking all that into consideration, in our dot notation, bio fuels will receive a yellow dot.

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More on the issue of bio fuels sustainability

According to a much discussed report by Donald Mitchel of the World Bank (Policy Research Working Paper, 4682, July 2008), bio fuels have caused a rise in food prices of around 75% worldwide. Accordingly, the EU tries to avoid such secondary effects by introducing some strict social and environmental sustainability criteria for bio fuel production.

Wheat crop for bioethanol (http://www.managenergy.net)

The Roundtable on Sustainable Bio fuels, an international initiative concerned with ensuring the sustainability of bio fuels production and processing, released in August 2008, the first draft of a generic standard for sustainable bio fuels production. It was circulated around the world until April 2009 for consultation, and soon RBS is going to release the final version of the standard that is concerned with 12 issues including: greenhouse gases reduction, rural-social development, food security, environment conservation and efficiency.

More information:
http://www-wds.worldbank.org/external/default/WDSContentServer/IW3P/IB/2008/07/28/000020439_20080728103002/Rendered/PDF/WP4682.pdf

c) Other Renewable Energy Sources

Note: These sources of energy could really help us in our trying to empty the swimming pools of CO_2 emissions that we produce. They clearly deserve a green dot, although they are feasible at the moment only as auxiliary power, not as the main fuel. But that's not bad at all! At least the emissions go lower!!!

Solar energy

Definition: Solar energy is considered to be a renewable energy as it is available as long the Sun exists, i.e. as long as life on Earth exists. Sunlight can be converted into thermal energy (solar-thermal modules) or into electrical energy (photovoltaic modules).

Note: The Sun is the main source of energy for Earth, and in fact it is the source of life.

Photovoltaic panels can be used as auxiliary energy sources in many transportation sectors: satellites and spacecrafts (in the inner solar system), airplanes (e.g. in unmanned aerial vehicles), road vehicles (usually installed on the roof), electric boats (especially on inland waterways), and railroad vehicles (trams but also trains, see EU project: PVTrain).

At present, stand-alone solar vehicles are not practical on a day-to-day basis, because the conversion efficiency is still not very high. Hence one can only talk about demonstration vehicles and engineering exercises. But vehicles with photovoltaic devices as auxiliary power units are already on the market. For example a solar car roof usually delivers enough power to ventilate the car in full sun, reducing the temperature inside (improving driver comfort during the rise or keeping a cool ambient when the car is parked on a sunny spot).

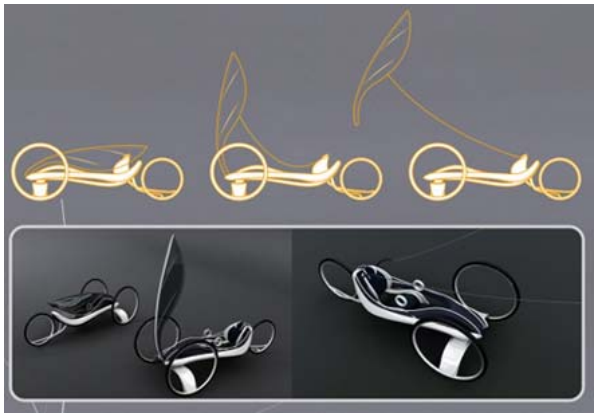
Wind power

Definition: Wind's kinetic energy can be converted into mechanical or electrical energy, by using wind turbines.

Wind energy has been traditionally used in marine and river transportation. All kinds of sailing ships are wind-powered vessels. Wind power is also used in wind surfing.

Vehicles such as automobiles, trucks, and trains usually move at moderate to high speeds especially on speedways and motorways. This leads to high opposite head wind speeds that cause "wind drag" detrimental to the overall efficiency of the vehicle. Hence it becomes more and interesting to make use of this detrimental and otherwise wasted energy and convert it, through wind turbines, kites or even sails mounted on the moving vehicle (see pictures below), into a beneficial source of energy for transportation.

Kite Car - designers: Tsun-Ho Wang, Min-Gyu Jung & Sung-Je Do



The Ventomobile, constructed by Stuttgart University's InVentus student team. (Credit: Tobias

More information:

Speed record wind-powered Greenbird AT http://www.greenbird.co.uk/

Greenbird - How does it work - Part aeroplane, part sailboat, part Formula One car AT http://www.greenbird.co.uk/about-the-greenbird/how-it-works

d) Human Power

Note: Technology is useful and its development is needed, but we shouldn't abuse it! We shouldn't forget about the simple and healthy means of transport making use of human power: some of them are older (walking, cycling), some of them are newer (roller skates, skateboards). And each of them brings important benefits both for you and our beloved Earth. One can have nice morning and/or evening walks, short cycling trips to the beautiful surroundings of the home city/village. But one can make use of the bicycle or even roller skates in standard situations: going to school (instead of being brought to school by car), go shopping (in the local shops), and pay your friends a visit (for doing homework together).

This is compliant to the KISS principle!! And furthermore you'll sure reduce the level of CO_2 emissions you produce, as this is the only source of energy with a full green dot!

Beware of the following facts:

Importance of walking in Neil Armstrong's words: "That's one small step for [a] man, one giant leap for mankind."

The great Tour de France and its icon, Lance Armstrong. You can be part of the cycling phenomenon too. (letour.fr)

All students love roller skating and/or skateboarding. Try putting them into use in standard situations.

2.2 Consumption

Definition: Fuel efficiency is the efficiency of converting the chemical potential energy contained in a fuel into kinetic energy. In the case of transportation, the term commonly refers to the energy efficiency of each vehicle model.

In Europe fuel efficiency or consumption (range) is measured in terms of the volume of fuel needed to travel for 100 km, i.e. in "litres per 100 kilometres" (l/100 km).

Others use the distance that can be travelled with a unit amount of fuel i.e. in the USA and UK, mileage is measured in "miles per gallon" (mpg), while in Asia one uses the "kilometres per litre" (kmpl) unit of measure. One can also compute the individual passenger-range (i.e. vehicle range / passenger capacity).

The **thermal efficiency** (mechanical work obtained / heat-content of the fuel) of petroleum engines has constantly improved in recent decades, but this did not automatically transform into fuel economy, because people tend to buy bigger and heavier cars.

2.3 How to reduce pollution

EU on greenhouse gas emissions

Probably you heard lots of times the terms Euro III, Euro IV and so on. But did you know what exactly did they stand for? Table 2 below will give you an insight into these EU norms.

EU norms	CO	NO_x	HC + NO_x	PM
Euro III (2000)	640	500	560	50
Euro IV (2005)	500	250	300	25
Euro V (2009) (proposal)	500	200	250	5

Table 2: Evolution of the European Standard related to Diesel vehicle pollutant emissions
HC = hydrocarbon; PM – particulate matter

In 2007 the EU made a firm commitment to reduce with at least 20 % the greenhouse gas emissions by 2020 in comparison to the 1990. In 2008, the European Environment Agency (EEA) released a report related to the European Community greenhouse gas emissions between 1990 and 2006. The data showed that by 2006 the emissions from the EU 27 fell by only 7.7% from the base level of 1990.

Note: The same report showed the rate of change between 2005 and 2006, i.e. –0.8% in EU-15 and just –0.3% in EU-27. This is because of some increase in CO_2 emissions in the new member countries in sectors such as public electricity and heat production or road transportation (increased number of cars and import of older second-hand polluting

Road transport emissions continued to rise, in 2006 being released 6.5 million tonnes CO_2-equivalents more than in 2005 at EU-27 level, while the increase at EU-15 level was lower: +2.1 million tonnes. This is supposed to take place because of the increased use of diesel for freight and passenger transport. Two other transport sectors currently not covered by the Kyoto Protocol, the aviation and international shipping industries, had largely increased by 5 and 10 million tonnes of CO_2 respectively.

More information:
Annual European Community Greenhouse gas inventory 1990–2006 released in 2008 AT http://reports.eea.europa.eu/technical_report_2008_6/en

The greenhouse gas emissions calculator – a tool developed by the Australian Department of the Environment, Water, Heritage and the Arts. It takes the fuel consumption rating (L/100 km), offers the possibility to choose the type of fuel between: petrol (gasoline), diesel and LPG, and asks for the number of km travelled in a year. The tool computes the annual tailpipe CO_2 emissions, considering that 1 litre burned gasoline yields 2.3 kilograms of CO_2, 1 litre burned diesel fuel yields 2.7 kg of CO_2, and that 1 litre burned LPG produces 1.6 kg of CO_2.

More information:
Tool: Greenhouse gas emissions calculator AT http://www.environment.gov.au/settlements/transport/fuelguide/environment.html

Table 3 below presents a comparison of the different energy conversion factors. Greenhouse gas conversion factors are used to indicate the carbon dioxide emissions caused by the use of energy. These factors are used to convert energy consumed in kWh to kg of carbon dioxide. Third column of the table also presents the Lower Heating Value (LHV), also known as net calorific value.

Energy Source	% hydrogen (weight)	LHV (kWh/kg)	kg CO_2 per kWh	Kg CO_2 per litre	Kg CO2 per tonne
Natural Gas	Methane: 25%	-	0.185	-	-
LPG	Propane: 18,2 %	6,98	0.214	1.495	-
Diesel	13,5%	10,52	0.250	2.630	-
Gasoline	13,5%	11,77	0.240	2.315	-
Industrial coal	-	7.44	0.330	-	2,457
Wood pellets	-	5.28	0.025	-	132
Grid electricity	-	-	0.537	-	-

Table 3: Comparison of energy conversion factors

Note: Diesel engines tend to be far more fuel-efficient than gasoline engines.

More information:

Carbon Trust leaflet on energy and carbon conversion (December 2008) AT http://www.carbontrust.co.uk/publications/publicationdetail.htm?productid=CTL018

Note: The UK Government offers a tool for computing the individual CO_2 emissions. The calculator focuses on the following three major fields where individual actions lead directly to CO_2 emissions: Household heating, hot water and lighting; Appliances and gadgets; and Personal transport. You are invited to use this calculator on the following link.

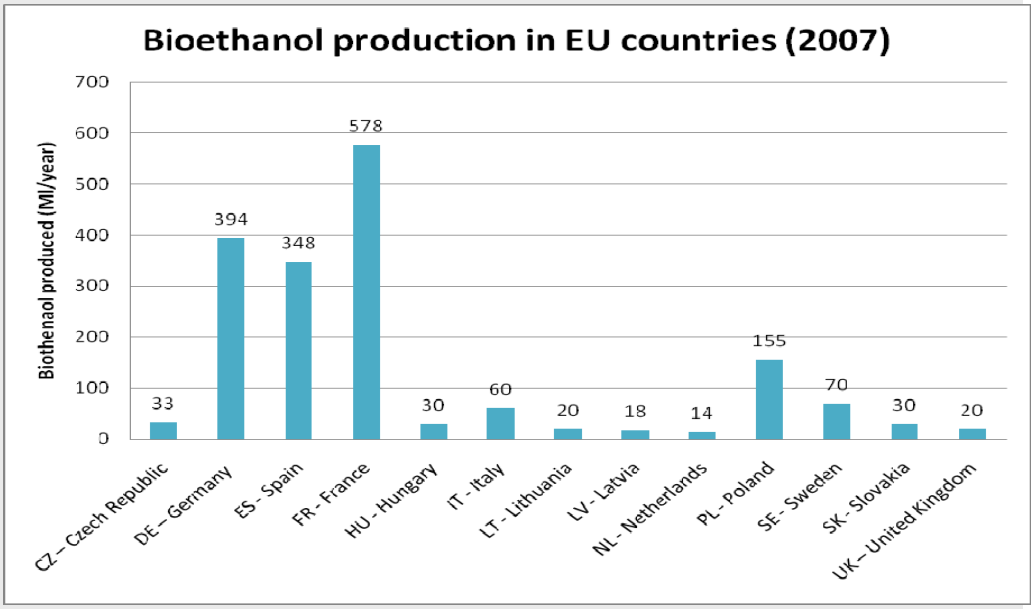
More information:

Act on CO2 Calculator - including personal transport (UK government) AT http://actonco2.direct.gov.uk/index.html

2.4 Case study

a) Production of bio ethanol in the UE

Bio ethanol is the most produced bio fuel product worldwide with over 50,000 Ml in 2007.
The annual production of bio ethanol in the EU and Switzerland is shown in table 3 below. Figures are given in Ml/year and refer to the year 2007.



If the EU is today the fourth producer of fuel-bio ethanol in the world behind the United States, Brazil and China, its production is however much lower than the first two (by a factor of more than 10). In 2007, the production of fuel-ethanol amounted to 1,770 Ml (including new member states), i.e. an increase of 13% compared to 2006.

These statistics include the production of fuel-ethanol purchased and put up for sale on the European market by the European Commission within the frame of the Community wine market regulation. Under the new Common Agricultural Policy (CAP), the European Commission is indeed bound to purchase and store vineyard overproduction. She then takes the decision to convert a portion of this wine alcohol into ethanol and resells it on the fuel market.
Reference: http://www.biofuels-platform.ch/en/infos/eu-bioethanol.php

b) Transportation ship fuelled partially with solar energy (premiere)

The first goods transportation ship in the world, which is partially supplied by solar panels, was launched in Japan. The ship can transport up to 6,400 automobiles. These 328 PV panels amount for 1.7 million dollars, delivering 40kW and covering only 0.2% of the energy needs of the ship. It is an important step forward and gradually other ships will follow this example, in order to reduce the carbon dioxide pollution and the dependency on gasoline.

From the port of Kobe (Japan), Toyota automobiles are sent worldwide. The new ship supplied partially from solar photovoltaic panels will contribute to this process. Source: Physorg

The company that uses the ship is Nippon Yusen and it is the biggest naval transport company in Japan. The investment was made before the economical crisis stroke. Marine transportation industry produced between 1.5% and 4.5% of the annual carbon dioxide emissions. Hence, this industry is under pressure to reduce its impact on the environment. Also, Japan is very low on resources and especially on gasoline, and that motivates Japan more than other countries, to find renewable energy sources. Reference: http://www.physorg.com/

c) Public transportation with solar energy in London

Designer Varun Singh created a modern public transportation system supplied with solar energy, and called Direct Order Transportation (D.O.T). Two-seat futuristic vehicles might be taken from any public parking, to transport citizens to their desired destination.

Ecological automobiles would be supplied from solar rechargeable lithium batteries, through mounting of solar panels on their roofs. The vehicles conceived by Varun Singh combine public transport with personal transport, allowing the citizens to quickly reach their destination, without the agglomeration in the classical public transportation system and at the same time being environmental friendly.

Reference: http:green-report.ro

2. 5 Tips on fuels

Fuel saving tips for you and your friends

- It's cool to use your own power! Walking, cycling or skating is trendy and healthy! Do this as often as possible!
- Go shopping by bicycle or roller skates!
- Use your personal car as rarely as possible! Think about car –sharing! Think about using public transportation! You'll save 450 grams of carbon dioxide for each 1.6 kilometres that you travel by other means than your car!!
- Use solar cells to power outdoor small size models (cars, robots, ships etc.) wherever you are: at home, in high school, in university, in a research institute.
- Don't keep these information and tips just for yourselves. Share them your parents, relatives, and friends. Let the whole world know about your new discoveries! You have the chance to be the teacher of your parents (if they seem to forget about the environment)!!!
- Don't forget the following tips when you'll start using your own car!!!!

Tips on using alternative fuels (for you and your parents)

- Use fuels with better properties!! Use fuels and fuel blends with increased octane numbers!
- Petroleum is going exhaust! Reduce world's reliance upon petroleum car fuels! Make use of alternative fuels!
- Be responsible! Be friendlier with the environment! Turn to alternative fuels with lower emissions!!
- Maintenance is also important with alternative fuels!! For example, inadequate ventilation when using LPG can result in an increased production of toxic Carbon Monoxide (CO).
- Be cautious when using bio fuels, pay attention to the bio fuels label in order to be sure you get a good-quality fuel!

Safety tips for alternative fuels (for you and your parents)

- Always keep the fire extinguisher in your luggage rack!!!
- Methanol and hence bio methanol is poisonous for humans! So keep it away from skin and eyes!
- Inspect and requalify your propane cylinders every ten years!
- Never smoke while handling an LPG cylinder!
- Don't overfill when using gaseous fuels! They'll need space to expand when temperatures rise!!!
- Check for gas leaks on a regular basis!!!
- Most automakers do not warranty their engines for using blends with more than 5% biodiesel. So make sure the fuel you purchase is safe for your engine by checking fuel compliance!

2.6 Questions

1. How are alternative fuels defined?

……..

2. What types of fuels are used in transport?

……..

3. Who invented the Diesel engine and in which year?

……

4. The quantity of electricity stored in batteries is measured in Ah or in Watt h?

……

5. What is EU's commitment regarding replacing the conventional fuels with alternative ones?

……

6. Hydrogen can be used as an alternative fuel in transport?

……

7. What about the renewable sources?

……..

8. What type of renewable energy is used by the means of transport in the pictures below?

9. A student lives at around 1km away from school (by car or public transportation). By walking or cycling the distance might be reduced with 25% and on the other hand one can save time, especially under heavy traffic conditions (at peak hours).

Suppose that during the last years, the student was brought to school by car by his parents, but this year he decided to make the daily trip to school by walking or cycling.

a) Knowing that when using a car, for each 1.6km travelled one releases 450 g of CO_2 in the atmosphere, and that the number of school days in a year is 180, compute the quantity of CO_2 emissions avoided during one year.

b) What will be the reduction in CO_2 emission for the case in which at least 100 students in the school will do the same, considering the distance to be travelled would be the same?

c) What will be the fuel and money savings in this case, considering the fuel consumption to be around 7l/100km, and the price for 1l of fuel would be around 1euro?

Glossary

Alternative fuels – any materials or substances that can be used as a fuel, other than conventional fuels, also known as non-conventional fuels

Bio fuels - any fuel that is obtained from a renewable biological resource, especially from biomass; Bio fuels include ethanol, biodiesel and methanol

Fuel cells – electrochemical cells in which the energy of a reaction between a fuel, such as liquid hydrogen, and an oxidant, such as liquid oxygen, is converted directly and continuously into electrical energy

Greenhouse gas – a gas that contributes to the warming of the Earth's atmosphere by reflecting radiation from the Earth's surface, e.g. carbon dioxide, ozone, or water vapour

Key Points

- Main alternative fuels are: natural gas, LPG, hydrogen, bio fuels, electricity and alcohols
- Sustainability of bio fuels became an important issue lately, and hence guidelines are under discussion and they will be part of the Standard of sustainable bio fuels production
- It's cool to use your own power! Walking, cycling or skating is trendy and healthy! Do this as often as possible!
- Use your personal car as rarely as possible! Think about car –sharing! Think about using public transportation! You'll save 450 grams of carbon dioxide for each 1.6 kilometres that you travel by other means than your car!!
- Don't forget the tips when you'll start using your own car!!!!

Web links

Citymobil Project: *www.citymobil-project.eu*
CIVITAS Projects: *www.civitas-initiative.org*
Cooperative Vehicle Infrastructure Systems Project: *www.cvisproject.org*
NICHES Project: *www.niches-transport.org*
SMARTFREIGHT Project: *www.smartfreight.info/index.html*
Co-ordinating Urban Pricing Integrated Demonstrations Thematic Network: *www.transport-pricing.net/cupid.html*
OPTIPARK Project: *www.optipark.eu*

Chapter 3 Alternative Transport

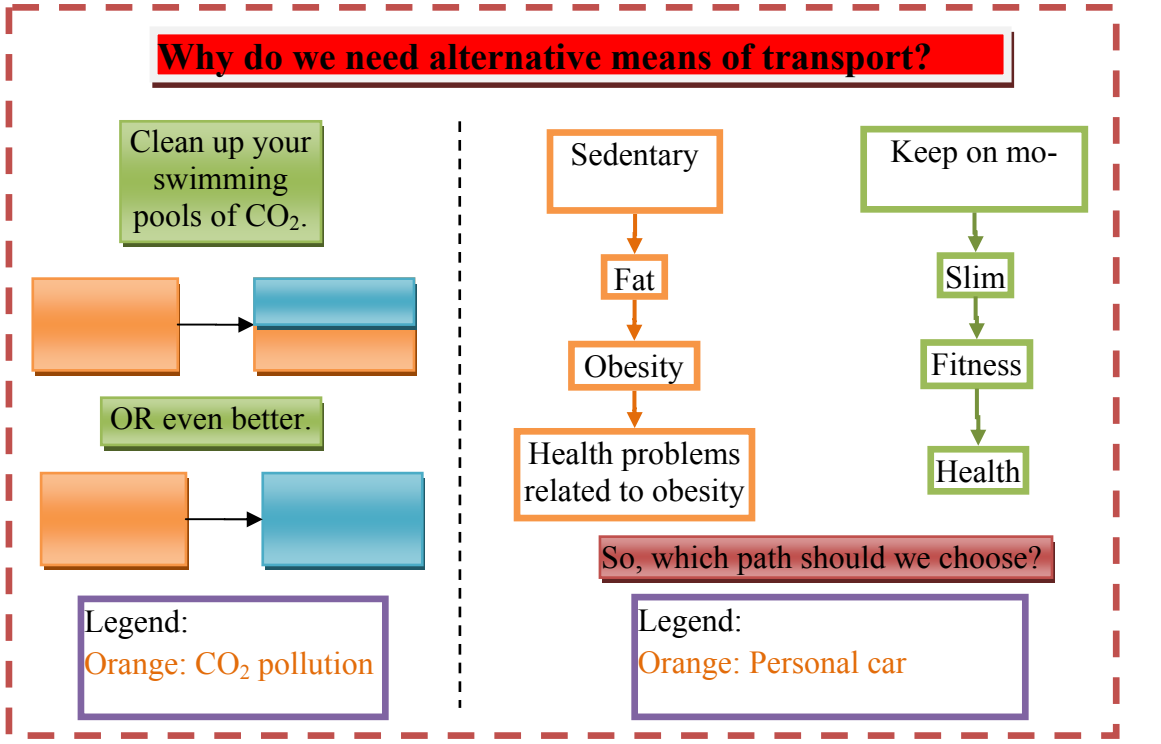
3.1 Context

Learning objectives: in this chapter you'll learn:

- Which means of transport can keep you fit
- That using public transport is more environment-friendly than using a car
- Which are the alternative or greener vehicles
- About the long journey of some products to the supermarket shelf
- How to safely use your bicycle, your skateboard or your rollerblades

But first of all, what do we mean by alternative transport?

Definition: Alternative transport: any mean of transport that imply a decrease in the use of petrol and diesel fuels. In fact, it usually means any means of transport other than personal cars running on conventional fuels.



Now, what do we mean by a sedentary way of living in the framework of this handbook?

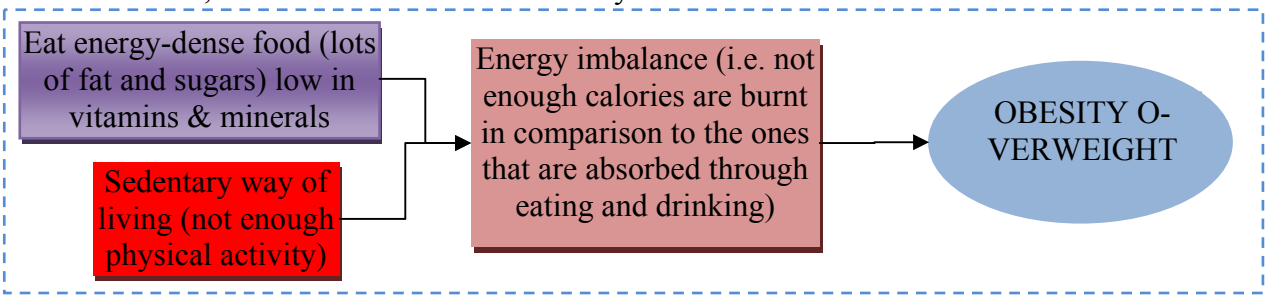
Definition: A sedentary way of living: making almost no physical effort, using your personal car in any situation, whatever the distance you have to travel, whatever alternatives you have.
Obesity is the state of weighting more than 20% over the ideal normal weight, that is computed taking into consideration one person's height, age, sex, and build.

Note: Overweight increases a risk of developing certain health problems such as diabetes, hypertension and heart problems (stroke, infarction), cancer, gallstones, osteoarthritis, breathing problems while asleep, etc. The first three are major illnesses leading to death.

So, which path should we choose? We will start our journey in the world of alternative transport with the healthiest means of transport…

3.2 Means of transport that keep one fit

Note: How important is keeping your body healthy?
Health is extremely important. In fact, it's the most important thing. One cannot enjoy life as much when health problems appear. Illness brings discomfort. Illness costs a lot of time and money. If the illness is very severe it can even decrease your lifespan. Hence, we should take care of our body. We should treat it as best we can.



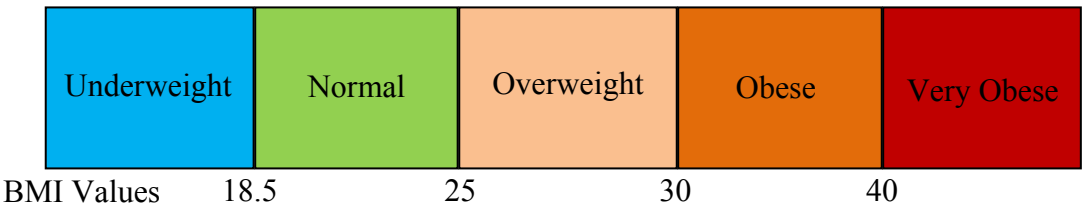
What are the causes of obesity and being overweight?
FACT: Effects of childhood obesity increase chances of premature death and disability in adulthood. So, think twice when asking your parents to come by car to take you from school. You are playing with your health and at the same with the environment. You are doing it at your own risk.

Now, how is obesity defined worldwide?

Definition: The Body Mass Index (BMI) indicates the nutritional status in humans. It is defined as follows:

$$BMI = \frac{weight}{(height)^2}\left[\frac{kg}{m^2}\right]$$

For adults (both males and females), interpretation of the BMI is the following:



See Adult BMI chart link below

Note: Recent studies of the World Health Organization (WHO) showed that even in the case of high-school children, the interpretation is pretty much the same (with errors below 0.5%).

See the BMI graphs for children at References.

Is this method of defining obesity the most appropriate one?
First of all, it should be considered as a rough guide because it may not identify the same degree of being overweight in different individuals (e.g. athletes and generally people with heavy muscle weight have high BMI values, but are not fat). Hence, one should be careful when consider-

ing this BMI-based classification, because it can be misleading. Secondly, there is evidence that the risk of occurrence of chronic diseases increases gradually from a BMI value of 21.

Statistical data about overweight and obesity:
WHOs latest data show that globally, in 2005, there were around 1.6 million overweight adults (over 15 years old) at least 40 million adults were obese. They also project the following figures for 2015~2.3 billion adults will be overweight and more than 70 million will be obese.

Note:

How can you keep your body healthy?

1)Move for health. Do physical activity.

2) One adult should have physical activity of moderate intensity, for at least 30 minutes each day.
But **school students should have at least 60 minutes** each day, in order to ensure their healthy development. This would offer you important physical, mental and social health benefits.
WHO fact: More than 1 million people die each year because of physical inactivity. So, the conclusion is clear: we should all be active persons. If we do not do special physical training (e.g. jogging, swimming or fitness), the least we can do is to walk to school or our job, to cycle to a local market, to make use of the means of transport that will be presented in this section. These will also decrease the amount of greenhouse gas emissions. In fact you can obtain clear water in your swimming pool.

3) Healthy eating (to be discussed in section 3.5)

4) Do not become dependent of cigarettes, drugs or alcohol

References

WHO obesity fact sheet AT http://www.who.int/mediacentre/factsheets/fs311/en/index.html
Adult BMI AT http://www.diethealthclub.com/do-you-know-if-you-are-fat-for-your-height.html
Children BMI (girls) AT http://www.who.int/growthref/bmifa_girls_z_5_19_labels.pdf
Children BMI (boys) AT http://www.who.int/growthref/bmifa_girls_z_5_19_labels.pdf
WHO AnthroPlus Software AT http://www.who.int/growthref/tools/en/
WHOs Move for health initiative AT http://www.who.int/moveforhealth/en/

3.2.1 Walking

Note:
God let the birds fly, He let the fish swim. He let people WALK.
Walking is moving on foot, going on foot for exercise or pleasure.
Hippocrates said "Walking is man's best medicine". Was he right?

Well, there's already so much research worldwide to show that walking is good for the human being. Thus, walking proves to be the oldest and simplest way to keeping physically fit. One of its greatest advantages is that one can walk almost anywhere and at any time.

Maybe you remember the moment in which you made your first step and all the fuss made by the others around you. Right then, walking was very important, wasn't it? But what happened along the way? You probably stopped walking so much. Did you? We have news for you. It is still very important.

Note: Remember the recommended 60 minutes of physical activity that ensures the healthy growth of young people.

"Above all do not lose your desire to walk. Every day I walk myself into a state of well being and walk away from every illness. I have walked myself into my best thoughts and I know of no thought so burdensome that one cannot walk away from it. But by sitting still, and the more one sits still, the closer one comes to feeling ill... if one keeps on walking everything will be alright." Soren Kierkegaard, Danish philosopher.

Unfortunately, inactivity has been engineered into our lives: from elevators to remote controls, from automobiles to the disappearance of footpaths, from telephone to e-services. Technology is driving all of us to unhealthy physical and psychological states. It even drives us to unhealthy social behaviour.

Cosa dovremmo fare?

Thomas Jefferson disse: "Di tutti gli esercizi, camminare è il migliore"

A volte si possono perfino risparmiare tempo

Camminare tutti i giorni!

Usate le scale invece di ascensori e scale mobili!
Andate a piedi a trovare gli amici!
Camminate nei parchi!
Andate a piedi al mercato!

Camminare in vacanza!

Organizzate delle visite a piedi delle città che visitate!
Salite sulle montagne a piedi, non in auto!
Andate a piedi fino ad una grotta!
Andate a piedi a visitare le meraviglie della natura!

Camminando si usano circa 200 mu-

Journalist Paul Scott Mowrer stated so beautifully the benefits of walking holidays: "There is nothing like walking to get the feel of a country. A fine landscape is like a piece of music; it must be taken at the right tempo. Even a bicycle goes too fast."
French philosopher Jean Jacques Rousseau in his Confessions: "I can only meditate when I am walking. When I stop, I cease to think; my mind works only with my legs." Indeed, walking simply recharges your batteries after tension and stress have squeezed you of all your power and energy. It brings a pleasant tyredness and a calm, clear mind.
We will end this section with the words of the famous English novelist Charles Dickens: "The sum of the whole is this: walk and be happy; walk and be healthy. The best way to lengthen out our days is to walk steadily and with a purpose."

References

International Walk to School Month AT http://www.iwalktoschool.org/
Medical Vision on Walking AT http://www.medicinenet.com/walking/article.htm
Walking Holidays AT http://www.walking.org/c/holidays/walking

3.2.2 Roller skating. Inline skating

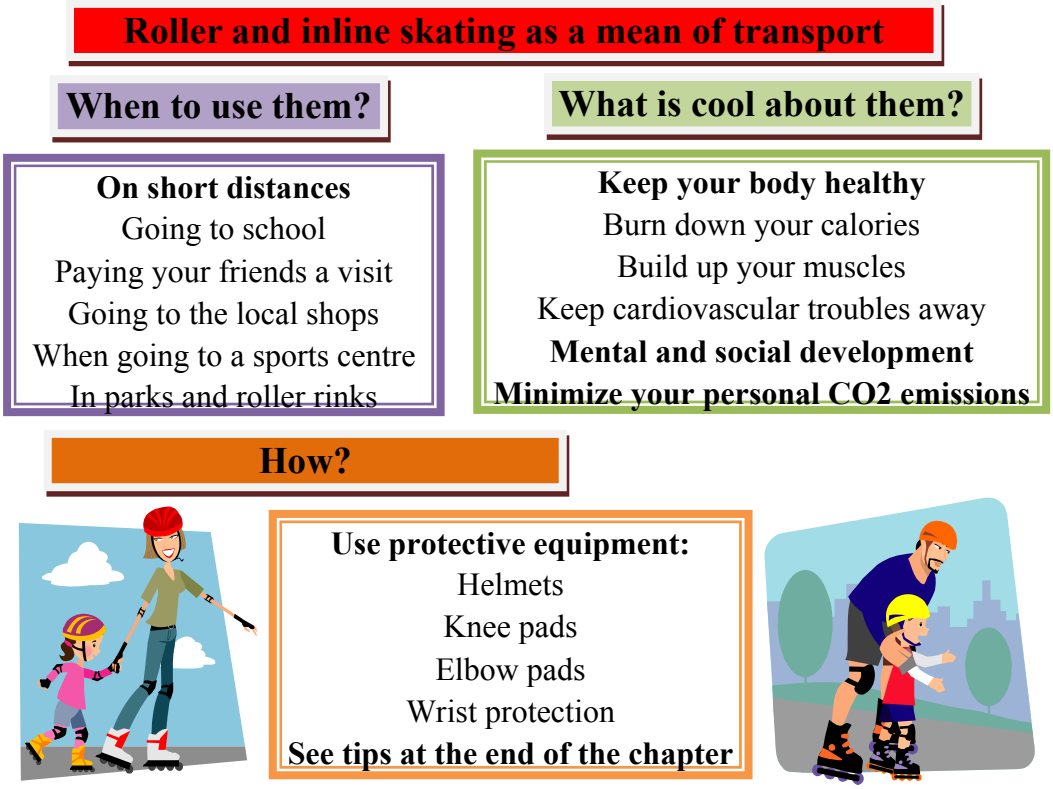
Definition: According to the Merriam-Webster Online Dictionary, a roller skate is a shoe with a set of wheels attached for skating over a flat surface.

The beginnings: The first recorded use of roller skates was found in 1743 in a London stage performance. In 1760, Belgian John Joseph Merlin demonstrated a primitive inline skate: wooden sole with metal wheels. He is considered to be the Father of inline skating.

Roller skates vs. Inline skates

Quad skate (Roller skate)		**Inline skates (Rollerblades)**
Four wheels: Two on Front Two on the rear		Three, four or five wheels placed on a straight line

Roller and inline skating are excellent recreational activities. The figure below shows you why. But what about using them in standard situations?



Roller and inline skates can even be used on the job. Think about the benefits it can bring to young people that work in supermarkets. Furthermore, there are more and more reports about the police making use of skates.

3.2.3 Skateboard

Definition: According the Oxford Advanced Learner's Dictionary a skateboard is a narrow board about 50cm long, with roller-skate wheels fixed to it. The board (i.e. deck) is rectangular and usually made of plywood.

The modern skateboard originated in California in the late 1950s, and is usually put into motion by pushing one foot in the ground while the other remains on the deck. When on a downward slope all you have to do is just stand on the skateboard, as gravity will provide the ignition.

Note: Skateboarding is mainly perceived as a recreational activity or an extreme sport. It teaches perseverance and confidence. It is fun and helps one keep in good shape. But at the same time it can be more dangerous than roller- or inline-skating, if not done properly.

Intelligent Energy Europe

The Skateboard – a mean of transportation?

The **long board** is a skateboard with a longer deck (between 90 and 150 cm) and with larger and softer wheels. They **are meant for** downhill, cruising and **transportation**. Cracks, bumps and rocks are less dangerous than in the case of a normal skateboard, making it more appropriate for use on streets.

Many youngsters picked up skateboarding just for transportation. One could go to school or to meet the friends on a long board.

But, steering and stopping a skateboard is not an easy task. Hence, it can become a danger both to you and to the others. Furthermore, skateboarding is illegal on the streets and footpaths of many countries. There is much debate worldwide about this issue and its social implications.

References

Skateboarding – a social problem? AT http://www.nytimes.com/1989/10/17/world/oslo-journal-in-ibsen-s-land-skateboard-is-a-social-problem.html

3.2.4 Cycling

Definition: John Howard, U.S. Olympic cyclist once said: "The bicycle is a curious vehicle. Its passenger is its engine." A bicycle is a vehicle with a light metal frame, two wire-spoke wheels one behind the other. It is steered by a rider sitting on a saddle, through handlebars, brakes, and two pedals.

Why should you cycle?

It is good for your body
Burns down the calories. Makes you fit.
Builds up your muscles.
Keeps the doctor away.

It is good for you
Keeps you away from long waiting times due to traffic jams.
Clears your mind! Reduces stress.
It brings you new friends. It's cool.

"I thought of that while riding my bike." – *Albert Einstein*, on the theory of relativity

It is good for the environment.
Cleans up your swimming pool. ☺

It is good for the city.
It can help shorten the traffic jams if more and more people would cycle.

"When the spirits are low, when the day appears dark, when work becomes monotonous, when hope hardly seems worth having, just mount a bicycle and go out for a spin down the road, without thought on anything but the ride you are taking." – ***Sir Arthur Conan Doyle***, January 18, 1896, Scientific American Magazine.

What types of bicycles are there on the market for you?

Road bicycles – fast and lightweight – sports (hobby) and utility (shopping etc.) bikes
Touring bicycles – robust, comfortable and capable of carrying heavy loads
Mountain bikes – for off-road cycling (with wide, knobby tyres)
Tandem bicycles – for two persons sitting one behind the other

Biking Safety

Protect yourself:
Helmets / Knee pads
Elbow pads / Wrist protection
Properly maintain your bike
Pay attention to the traffic:

Please take into consideration the tips on cycling at the end of this chapter

Cycling as a mean of transportation

On short distances (below 3km)
Going to school
Visiting your friends
Shopping in the local markets
Going to a sports centre
In parks and in cycling centers
Saving time in the city

On medium distances (3km-25km)
Trips to the recreational resorts around the city.
Reaching places that are not covered by public transportation.
Trips to other cities and villages around the city you live in.
Tourist tours by bicycle.

It is cheap, nonpolluting, small and silent.

Problem: In many countries the infrastructure is far from offering the best conditions for cycling.

3.3 Public transportation vs. cars

Definition: Public transportation refers to the different fleets of passenger vehicles for mass transportation, which can be accessed by the public usually through buying a ticket. They run on well-established routes and usually using well-defined schedules. The picture below presents the main types of vehicles belonging to public transportation.

Public Transportation

City traffic: Buses, Subways,





Long Distance: Trains, Ships,





On the other hand, public transportation does not include taxis, limousines (e.g. to the airport), or industrial buses (taking employees to their working sites).

Using public transportation instead of driving your personal car

Helps us clear the swimming pools of CO_2:

Increased fuel efficiency (full bus six times more efficient than a single commuter car; trains are even more efficient)

A single person who commutes via public transportation instead of driving alone will save over 750 litres of petrol in one year.

Using one mean of public transport instead of tens or hundreds of cars.

Public transportation is more likely to use less pol-

Other community advantages:

Lower noise pollution.

Green spaces could replace garages and parking lots.

Makes it more pleasant to walk, skate or cycle.

Lower number of cars, means less congestion and traffic jams. Hence, public road transport could become faster and more reliable.

Personal benefits of using public transport:

More safety (i.e. professional drivers, lower risks of accidents)

Save money (i.e. no costs with parking, fuels, car parts and insurances)

Saves you time (subways, but also others because of the lower number of cars)

No accidents for you. No headaches. No stress. No police visits. No service visits.

Keeps away the stress with traffic and parking problems. Hence clears your mind.

You'll need to walk in cleaner air. That will keep you fitter and healthier.

Keeps you fresh. One can rest during the trips instead of paying attention to the traffic.

It's good for the mind. Gives you the opportunity to read a book or listed to your music.

We've seen the many benefits of using public transportation. But of course the situation is not always ideal. Nothing is perfect. So there are also some potential problems with it:

When to bike instead of driving?

Strikes in the public transport sector

When you can't reach certain areas by public transport and you are in a hurry.

Save time when having to change too many means of public transport!

When to drive a car?

Going shopping for the whole week – carrying lots of goods (especially heavy ones)

Emergency cases

(Transport to hospital)

Note: Do you really need to fly?

Of all the public transportation vehicles available, the airplane is the worst. It has the highest impact on the environment and the highest influence on climate change. Are we really prepared to pay these high costs? Fly by plane only if really necessary. Take the direct path when available; it is better than changing planes. Avoid flying short distances; think about taking the train. Besides protecting the environment, it is more comfortable and safer.

Note: Now let's see… how do you travel to school? By car? Think again. Do you really need to have your parents or big brothers/sisters take you to and from school? Do you want to keep them from their jobs or studies? Or do you want them to be model employees or students so that you can be proud of them? Act accordingly: use the school buses. If there are no school buses, try the local public means of transport, while you lobby for the introduction of school buses for your high school or college. But of course it would be better to bike, skate or walk to school.

References:

Environmental aspects AT http://www.cas.usf.edu/philosophy/mass/Stephanie.html

3.4 Alternative vehicles

Definition: In this handbook, an alternative vehicle is any vehicle that uses alternative fuels and renewable sources of energy to completely or partly replace conventional fuels (petrol and diesel).

Note: Both public transportation operators and car owners should consider alternative vehicles. This will certainly reduce the emissions of greenhouse gases (especially CO_2) – see the data on the alternative fuels in the previous chapter. Besides that, this will also relax the petroleum market. But more important, it will protect the health of Earth that we overlooked too much lately.

We will discuss here only the following alternative road vehicles: electrical, hybrid, hydrogen and solar cars and buses. But of course there are alternatives to petroleum-based fuels in all the other types of transport: vehicles on rails and waterways (ships), airplanes and space shuttles.

3.4.1 Electrical cars and buses

Definition: **The electric vehicle (EV)** is a vehicle using an electric motor driven by the electricity stored in electric batteries.

Note: The main components specific to electric vehicles are the following: the traction electric motor, an electronic control module (ECM), the electric battery pack with its management system and its smart charger. Most EVs use built-in regenerative braking systems, that recover the kinetic energy of the vehicle when braking (i.e. when the accelerator pedal is released and especially when the brake foot pedal is pushed down). The energy recovered is directed back to the battery pack for storage. This leads to improved fuel efficiency.

History: Electricity and automotive vehicle development were two of the most important technological revolutions of the twentieth century. In the early 1900s, there were almost twice as

many electrical vehicles (EVs) as petrol ones, and there were more than 100 EV manufacturers. However, in 1920 they virtually disappeared because of the rapid development of petrol vehicles which appeared to be more convenient.

Note: But history teaches humanity a lesson: Not all that seems most convenient at a certain moment is the best solution in the long run. So mankind has to continuously change and adapt its attitude according to new contexts. Since the oil crisis in the 1970s, research in EV technology was once again strongly encouraged. The climate change concerns in the last decades has brought an additional boost for EVs and of course for the other new alternative transport technologies.

Electric vehicles

Advantages

Increased energy efficiency (~ 46%) in comparison to conventional vehicles (~ 20%).

Full use of regenerative braking systems. Rooftop solar panels can also contribute.

Very quiet operation. Lower vibrations and lower noise pollution.

No greenhouse gas emissions. **BUT** remember that such emissions still appear in many places where electricity is produced, in spite of the renewable energy sources revolution.

You can have your own small PV array for charging your batteries. This ensures you that you are really emptying your CO_2 swimming pool.

Handling and operation of commercial EVs is not very different from traditional vehicles.

Disadvantages

High prices

Shorter driving range

Less developed infrastructure for fuelling during your trips.

Longer recharging time

Electric vehicles today

Daimler-Chrysler, Ford and General Motors focus on the lead-acid technology; Honda and Toyota on nickel metal-hydride batteries; Nissan's main focus is on Li-ion batteries. Recently Renault launched its own EV program, involving the French electric grid operator. So all major car manufacturers go electric!

Note: Of course electric vehicles still cannot compete with petrol vehicles, but with more intensive research in the field, a continuous shift in electricity production towards clean technologies and with increased pressure from the EU to decrease greenhouse gas emissions, they may win a larger share in the market.

Many cities already use electric-powered buses, trolleys or subways. The ***Yosemite National Park*** in California started using two electric buses with batteries in September 1995. They are almost silent, and silence is so much appreciated in such places in which people go to relax and escape the overcrowded landscapes of the city. Eventually, all the buses in Yosemite will be electric.

References

S. Dhameja – "Electric Vehicle Battery Systems", 2002, Newnes – Butterworth-Heinemann

3.4.2 Hybrid vehicles

Definition: Hybrid vehicles are those vehicles that use more than one source of energy for propulsion. More precisely, hybrid-electric vehicles (HEVs) refer to the vehicles that combine a conventional internal combustion engine on petrol or diesel with the electric car technology (electric motor with regenerative braking and storage batteries). But, there are also hybrids that use fuel cells instead of electric motors.

History: The first hybrid was built in the early 1900s by the German Dr. Ferdinand Porsche. It used a series configuration: an internal combustion engine spinning a generator that provided power to the electric motors located in the front-wheel hubs (i.e. with no transmission system).

Note: Just like in the case of electric cars, hybrid vehicles are once again in the news and on the roads. They were revived to maximise the fuel efficiency of petroleum-based engines.

Hybrid vehicles

Hybrid configurations

Serial – combustion engine in series with the electric motor(s)

Parallel – both energy sources can

Hybrid levels

Mild (electric motor and battery assist the gasoline/diesel engine)

Full (the two propulsion systems can work both separately and together)

Plug-in (the combustion engine is a back-up to the main electric motor

Actual main manufacturers

Toyota, Honda, Lexus and Ford

Advantages

Fuel savings of around 30% in the city.

Greater operating efficiency through using the energy captured by the regenerative braking.

Cleaner operation, lower emissions.

Tax incentives in some countries.

Increased mileage compared to electric

Disadvantages

EVs and hybrids are so quite that they could threaten the safety of pedestrians, cyclists or skaters.

Increased complexity and pricing.

Recycling the batteries is not so easy.

Still might move some pollution to the

References:

How Hybrid Vehicles work (U.S. Environmental Protection Agency) AT
http://www.fueleconomy.gov/feg/hybridAnimation/hybrid/hybridoverview.html

3.4.3 Hydrogen vehicles

Definition: A hydrogen vehicle is any vehicles that use fuel cells and hydrogen as a fuel.

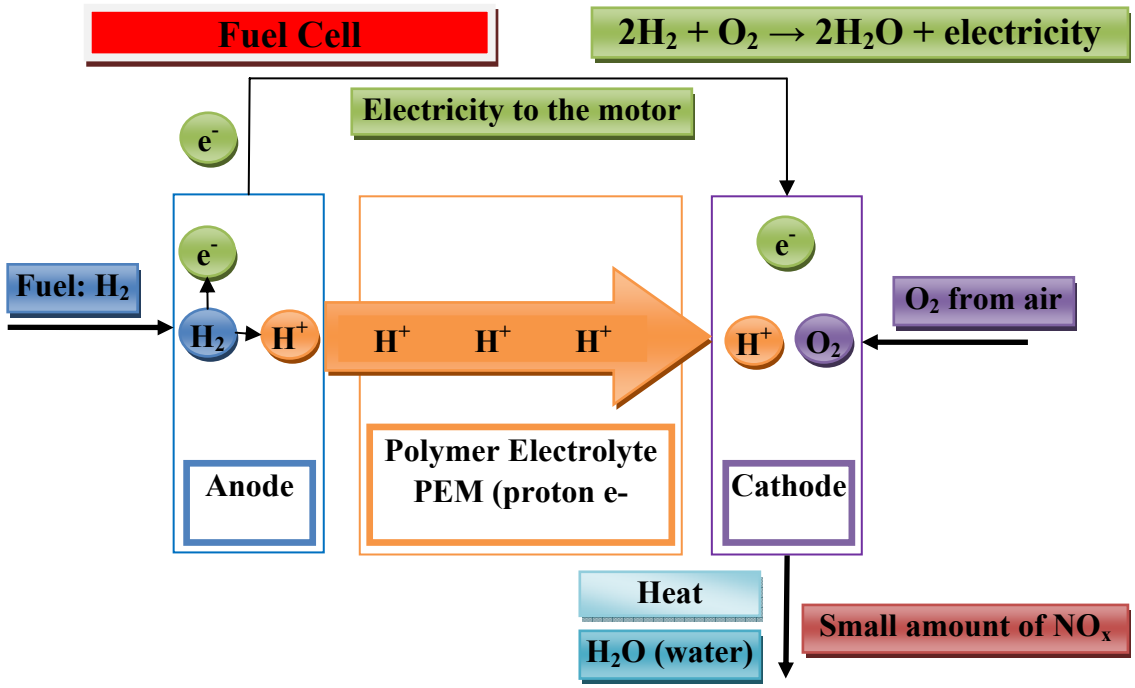
Hydrogen vehicles

Encouraging	Problems
Fuel efficiency: 40 – 60%	High cost
No carbon emissions when electricity is produced in a fuel cell.	Durability of fuel cells
Lots of research is put into making these vehicles competitive.	H_2 storage & refueling infrastructure
EU Parliament has recently adopted a regulation on type-approval of hydrogen powered motor	Weather (inner membrane has to stay moist for the cell to work)
	Moving some greenhouse gas emissions to other areas (hydrogen production is usu-

Actual main manufacturers (testing)

Definition: A fuel cell is an electrochemical cell that converts the chemical energy of the hydrogen oxidation reaction into electricity. See how a proton exchange membrane (PEM) fuel cell (usually used in vehicles) works in next figure.

History: In 1800, British scientists William Nicholson and Anthony Carlisle discovered ***electrolysis*** (i.e. the process in which electricity decomposes water into hydrogen and oxygen). In 1839, Sir William Grove demonstrated that it is possible to reverse the electrolysis of water and obtain electricity. He called his invention the ***"gas battery"*** – the first fuel cell.



References:

EU Parliament regulation on type-approval of hydrogen powered motor vehicles AT http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P6-TA-2008-0395+0+DOC+XML+V0//EN

3.4.4 Solar power in road transportation

Let's see how solar power (one of the cleanest types of energy) can be used in transportation…

Solar cars and buses

Full solar cars

Those vehicles that use the directly-attached solar panels to supply the electricity needed to move the car around. At the moment car manufacturers experiment with such solutions. There are also many demonstrative developments in universities participating

Potential problem

Partially solar cars

Many car manufacturers have started using solar panels on the rooftop of their cars. They are not intended to move the car, but to supply air conditioning, the on-board computer or any

Indirect solar cars

These are in fact electric battery vehicles that are supplied with electricity from special solar power plants. Of course you might install PV modules on the rooftop of your house or in your courtyard just for charging electric batteries.

Solar buses in the University

The Naresuan University in Thailand started using solar buses on the campus in 2003. In fact they fall in the category of indirect solar vehicles, as they are mini-buses (up to 20 passengers) with electric batteries that are recharged at a small solar power plant in the university.

Solar World No.1 at exhibition

Solar World No.1 is one of the many one-seated prototypes developed for competitions such as the World Solar Challenge. This car is the creation of a team of **students** and professors in the University of Applied Sciences Bochum. The design uses 6m^2 of solar cells to power an electric motor built into the front wheel rim. It weights only 200 kg and reaches a top speed of 120 km/h.

Of course, solar power can also be used in other means of road transportation, not just for cars and buses. Follow the links for solar rickshaw and solar bicycle.

References:

Solar World No.1 AT http://www.hochschule-bochum.de/en/solarcar.html
Solar World No.1 AT http://www.solarworldno1.de/ENG/index.php?seite=racer
Solar Rickshaw: http://afp.google.com/article/ALeqM5gre7O8J9E84olLfX0NLk7uw2ECVA
Solar Bicycle: http://www.thedesignblog.org/entry/cycle-sol-modish-solar-powered-bicycle-pedals-in-effortlessly/

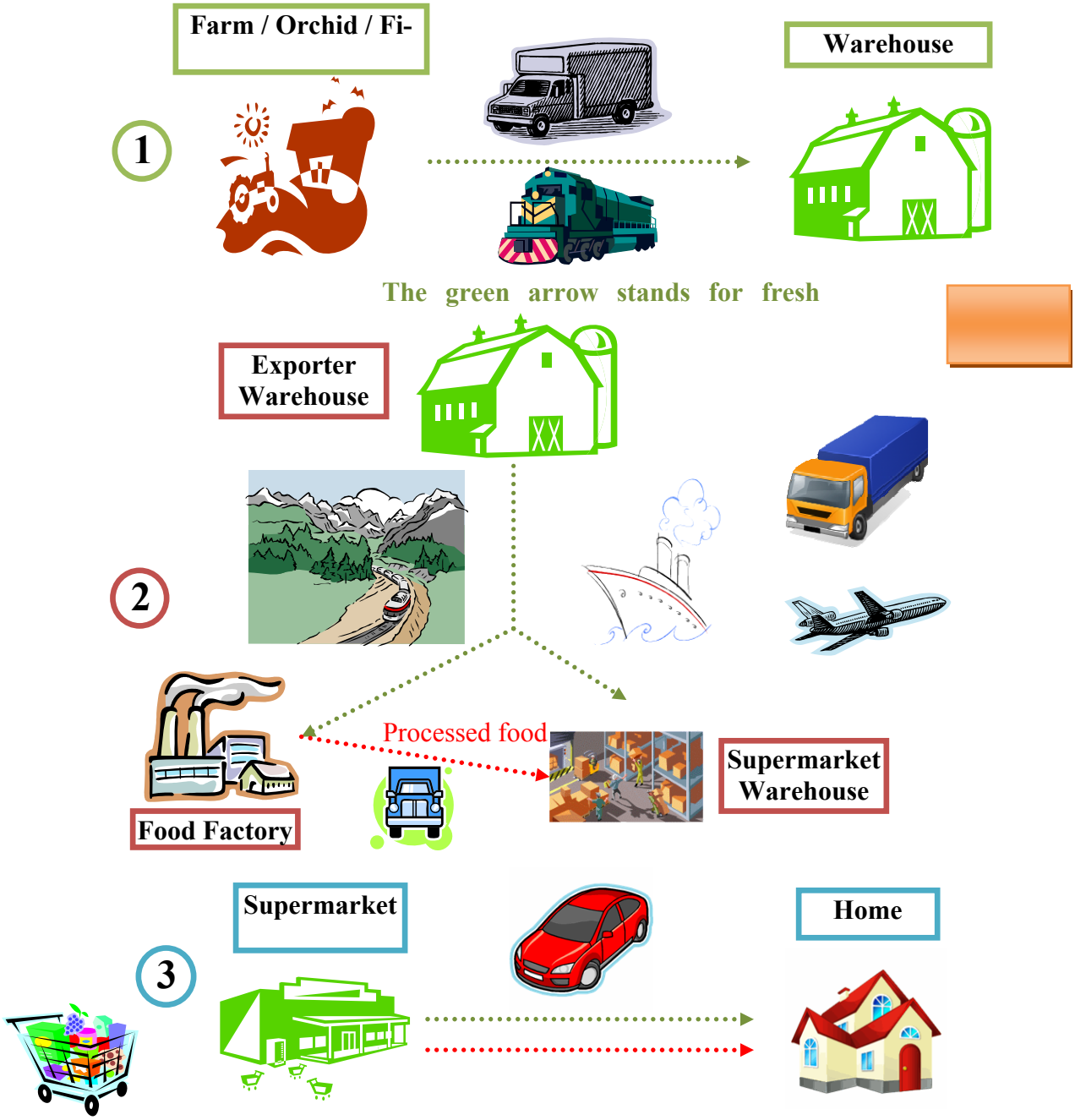
3.5 A story about a long journey

Note: One important issue in the food sustainability debate is that the food industry has a substantial contribution to greenhouse gas emissions. The main sources for the emissions are: agricultural activities; food processing in factories; transportation and refrigeration of the raw materials and of the food products throughout the supply chain. The emphasis of this section will be on how to reduce the gas emissions due to transportation involved in getting the food from the farms to your home.

3.5.1 From the farm or factory to the supermarket shelf

Our "long journey scenario" is actually made up of three separate journeys:

- The journey of the raw food to the warehouse of the exporter.
- The international journey of the raw food to the supermarket warehouse
- The journey of the food to your home.



Note: Well, there's something **wrong** in this whole chain isn't there? By buying your food provisions from the supermarket you are, in fact, filling up even more swimming pools of CO_2 than one could expect at first sight.

CO_2 emissions along this chain

Airplane freight emissions
0.6 (long dist.) to 1.85 (domestic) kg CO_2/tonne km

Rail freight emissions
21 g CO_2 per tonne km

Ship freight emissions
Under 20 g per tonne km

Road freight emissions
Light goods vehicles
Gasoline (<1.25 tonnes) 448.8 kg CO_2 per tonne km
Diesel & GPL (<3.5 tonnes) 271.8 kg CO_2 per tonne km
Heavy goods vehicles
The higher the tonnage the lower

Farms, Warehouses, Factories, Supermarkets
Motorised vehicles
Refrigeration

Personal cars
Use alternative vehicles, public transportation!
See next section for the

Data taken form the reference below

Reference:

2008 Guidelines to Defra's GHG Conversion Factors: Methodology Paper for Transport Emission Factors, © Queen's Printer and Controller of HMSO 2008, www.defra.gov.uk AT http://www.defra.gov.uk/environment/business/reporting/pdf/passenger-transport.pdf

3.5.2 Buy locally, buy by bike

Buy locally!

Reducing the CO_2 emissions above
Buy less processed food. Reduce emissions from the food factory (e.g. from packaging).
Eat less meat (80% of agriculture emissions is related to raising livestock).
Lower energy consumption with storing frozen food and with keeping certain products fresh.
Fewer airplane freight flights.

How should I buy locally?
Cycle to the local markets. **Walk** there. Shopping on a daily basis by car is even worth than buying products from the other side of the world.
Buy local fruits and vegetables when they ripen. Buying summer food in winter is not good for the environment.

Advantages for the community
Protect local agriculture. Support your national economy.
Protect the countryside.
Discourage industrial agriculture.
Lower the pressure of the fuel crisis.
Fewer household wastes through more ra-

Personal & family advantages
Become more active.
Eat fresher vegetables and fruits.
The body develops better.
Avoid all traffic problems.
Save time.
Last but not least, save money (fuel

3.5.3 Exercise where does my shopping come from?

One of the major weekly problems for a family is the procurement of the food needed for .daily meals. Robert's family has to options: either to buy from the nearest supermarket (i.e. out of the city, 3 km away from their home), or from the local market, that could be reached in just a few minutes by walking or cycling. For the last 5 years, since the supermarket opened, Robert's family frequently (i.e. twice a week) do their shopping in the supermarket.
The knowledge acquired after taking this course produced some changes in Robert's attitude towards this issue. So he convinced his parents to forget about the supermarket and adopt the second option they had ignored during the last years: buying from the local market nearby their house. Moreover, Robert started to become actively involves in this family activity.
What did this new strategy mean for Robert and his family? Obviously, they made important steps towards clearing those swimming pools full of CO_2:

1. They had the chance to consume ***fresher*** vegetables and fruits usually produced locally not brought from far, far away. This also brought health benefits to them.
2. They usually bought what was only necessary for a day or two. Hence, they avoided long-term storage and refrigeration of the food they ate. This added up in their fight to reduce CO_2 emissions. Moreover this short-term food planning also meant less household waste. Another added value for the environment.
3. By not using the car for shopping, they achieved ***fuel savings***, they protected their personal car against additional wear, and they diminished their chances of being involved in a car accident, But most important of all they ***reduced the CO2 emissions*** released into the atmosphere, Also keep in mind the huge emissions linked to the supermarkets,

Starting from point 3 and considering that when using a car for one km the quantity of CO_2 released is ~280 g, that the average fuel consumption of their car is 7.2 l/100km, that the average price for 1l of fuel is around 1.1 Euro and that there are 52 weeks in a year, please compute the quantity of fuel that Robert's family used in those five years, when they did their shopping in the supermarket. What were the costs? What about the CO_2 emissions?

Key:
1. Compute the number of kilometres travelled in 5 years:
3km * 2 (times) * 52 (weeks) * 5 (years) = 1560km
2. Compute the quantity of fuel used: 1560km * 7.2l / 100km = 112.47 l of fuel used in 5 years
3. Costs: 112.476 l * 1.1 Euro/l = 123.72 Euro
4. CO_2 emissions: 280 g * 1560km = 436.8 kg of CO_2

By shopping locally all that quantity of fuel will be saved in the following five years. This also means money savings for the family and lower emissions into the atmosphere, i.e. a benefit for the whole community, for the whole world. Should we follow this example? Definitely YES. It's not that much, but if you don't do it, than who will? Who will save the planet? All great things are done with very small steps. So be part of the wave. Show that you care.
Now, think about what the fuel and emissions savings would be if YOU will adopt this attitude?

Key: You should make the appropriate modifications to the parameters in the hypothesis (no. of weekly trips to the supermarket, distance to the supermarket, and fuel consumption for your car).

Collect the data from all your colleagues to see what it would mean if all of you would adopt this attitude. Try involving the teachers too. Develop posters about the highest savings possible in your class; about those of you who already got this attitude; and of course one showing the

Intelligent Energy Europe

amazing results that would be obtained by the whole class. Stick them all over the school. You could even initiate small working sessions with the other classes in your school. Taking it step by step, you'll soon be able to make the computation for the whole school.

3.6 Case studies

3.6.1 PERS - Pedestrian Environment Review System (Software)

UK's Transport Research Laboratory developed a software system for the Borough of Bromley (one of the 33 Boroughs of Greater London). The software package was meant to systematically review pedestrian environments within the Borough. The idea was to develop a process that could be used to identify pedestrians' problems and difficulties and to bring to light the opportunities to improve pedestrian accessibility. In particular the system was supposed to help the local authority prioritise the work to be done and efficiently target investment.

PERS, which comes with a very useful and detailed handbook, allows reviewers to evaluate the performance of different parameters of pedestrian facilities, such as width, surface quality and environmental quality, by rating them on a given fixed scale. Scores are then automatically weighted by the software to give an indication on the overall performance of the facility.

Of course, the software offers the possibility to audit and compare the performance of different facilities in terms of their overall quality or in terms of any of the individual criteria. Hence, PERS v2 is a powerful software product that is flexible enough to allow easy capture and structure of traditional pedestrian issues such as town centre access, safe routes to school and the establishment of residential areas.

References:

What is PERS: http://www.tfl.gov.uk/assets/downloads/businessandpartners/what-is-PERS.pdf

3.6.2 VIANOVA Project

Whoever leaves his car frequently in the garage provides benefits not only to the environment, but also to himself/herself. Regular physical exercises contributes to our well being. In this sense transportation policy enforces illness prevention. VIANOVA, with partners from all seven Alpine countries, is a project that aims to reduce car traffic and at the same time to encourage non-motorised and sustainable means of transport based on physical activities (cycling & walking). A multidisciplinary approach (land use planning - mobility – health) will combine measures that fit perfectly to create a beneficial and improved Alpine space.

Demonstrations will be implemented on three different levels:

a) Improvement of the objective situation regarding public spaces for physical activities (air quality, infrastructure, barriers, organisation, and intermodality)

b) Improving the perception of public space for walking and cycling

c) User motivation for sustainable modal choice.

VIANOVA main topics are:

•Walking
• Intermodality
• Cycling
• Mobility for 50+

Reference: http://www.eu-vianova.net/index.php

3.6.3 Passport to Health

The Lytchett Matravers Primary School in Dorset, UK, launched their "Passport to Health" scheme during the "Walk to School Week" in October 2004. They reported that they reduced car trips to school by 18% and increased walking by 14%.
How does it work? The scheme offers regular rewards and incentives that encouraged over half the school to walk to and from school each day. In fact, all pupils receive a passport, which is stamped each time they walk to and from school. Additionally, the school has marked out a "walking route" around the playground, so pupils travelling to school by bus can also participate in the scheme by walking a certain distance within the playground.
Children can choose from a number of different rewards, depending on how often they have walked to and from school and the number of points they have collected on their passports. Lytchett Matravers Parish Council has funded the rewards for the school's incentive scheme. All Parish Councils have funding under Section 137 of The Local Government Act which states that £5 per elector can be spent towards community projects, such as walking incentive schemes.

Reference:
http://www.iwalktoschool.org/downloads/Lytchett_Matravers_IWALK.pdf

3.7 Tips

General safety tips during walking, skating, skateboarding and cycling:

- Be an active and responsible traffic participant. Don't let your head drop. Keep it up. Pay attention to everybody else on the road. Notice what each of them will to do next. Obey all the rules of the road. By doing all this you won't be involved in any accidents.
- Don't be passive. Listening can prove to be very important in traffic. You can't see with your back. So, don't wear headphones so that you can hear what's coming from behind.
- An hour before you go out, drink a large glass of water. During the trip, drink some water from time to time. On long trips, consider using sports drinks containing the salts that your body needs.

- Wear hats when walking in the middle of hot sunny days, they will protect you from the burning heat of the sun.
- Wear protective equipment (helmets, knee and elbow pads, and wrist guards) whenever you skate, skateboard or cycle. They will surely prevent serious injuries in case of falling.
- Keep your roller / inline skate, skateboard and/or bicycle in good shape. Proper maintenance is important for any machine, be it a computer, a car or a roller skate.
- Practice falling on a soft surface. Many injuries occur because of the lack of knowledge about falling techniques. Learn from others. Take some lessons.
- Traffic needs no additional menace on the roads and sidewalks. If you can't skate, skateboard or ride a bike safely, don't venture into traffic. Why not practice until you can do it safely? .
- When purchasing your inline-skates or your skateboard, select soft wheels. They are less affected by road bumps than the fast harder wheels. And once again we come to the question: do we really need so much speed?
- How to fall when skating? Keep your hands out in front of you, bend your knees as much as possible and sit back on your thighs.
- Skaters shouldn't venture into traffic unless they have mastered the skills of skating forward, turning and stopping and unless they can maintain a high level of control. Keep in mind that even a small hill can induce high speeds.
- Keep in mind that in certain countries there are areas in which it is forbidden to skateboard (e.g. Norway). Check the law before you go.
- Make a safety check before going out with your skateboard.
- Don't ever think of skateboarding with a massive schoolbag on your back. You'd better think about walking or using a bike. If this is not feasible: use public transportation.

Tips on the protective equipment for skating, skateboarding and cycling:

Helmets

- They help prevent head injuries in the event of a fall. See this Australian poster: http://www.transport.qld.gov.au/resources/file/eb2e17462d9628c/Skateboards_metrolite.pdf
- To be effective, helmets must appropriately fit on the head. They must be buckled, with the front of the helmet coming down to just a finger's width above the eyebrows.

Knee Pads

- Knees are usually the first point of impact in the event of a fall. So you definitively have to wear a pair of knee pads. By redistributing the force of a fall, they also minimise the risks associated to elbows & wrists. One should securely fasten the knee pads around the leg.

Elbow Pads

- They provide good protection for the elbow during a sideways fall.

Wrist Guards

- Should contain hard plastic which allows the skater to slide on the footpath during a fall.

Bicycle Maintenance Tips

- The minimal set of tools a biker needs contains: screwdrivers, Allen keys, spanners, and a pump, tyre levers, cleaning rags, an old toothbrush, lubricants and a puncture repair kit.
- Every morning check the condition of your tyres and their air pressure.

Weekly maintenance:

- Lubricate exposed moving parts of the bike, such as the chain and gear mechanisms taking care not to get any on wheel rims or brake blocks.

Monthly:

- Ensure wheels are properly fastened and in line with the frame.

- Check brake blocks for wear and ensure they contact squarely with the rim, not the tyre. Replace worn or frayed brake cables and adjust brakes levers so that they do not contact the handlebars when braking hard.
- Check if gears work correctly and if cables move freely. Clean the chain with a rag soaked in degreaser and then re-oil.
- Check for looseness in the handlebar and stem and tighten when necessary.
- Pedals should spin freely so check the pedal axles for looseness and tighten them.
- Inspect the frame for any damage. Make sure the seat is fixed tightly and its height is correct.

How to change a bicycle tyre?

a) Removing the old tyre

- Remove the wheel from the bike. Simply flip one of the quick-release levers on the axles, If you have an older bike, you should loosen one of the axle nuts holding the wheel in place,
- Completely deflate the tyre.
- Slowly pry the tyre away from the rim – be careful not to pinch the inner tube. Then you can remove the tyre and the inner tube from the rim.

b) Installing the new tyre

- Take a new tyre and slip one edge of it all the way around the rim.
- Insert the inner tube completely inside the new tyre, making sure to line up the inner tube valve with the valve hole in the rim. You might very slightly inflate the tube to make it easier.
- Push as much of the second edge of the tyre onto the rim as possible. Gently roll the tyre into place over the rim edge. Work slowly and avoid snapping the tyre into place as this might pinch the tube causing air leaks.
- Inflate the tyre to the recommended pressure written on the side of the tyre, and replace the wheel on the bike. More detailed procedure with pictures AT http://www.wikihow.com/Replace-a-Bicycle-Tire
- Carry a spare set of inner tubes with you. Hence you can change the ***punctured*** tube on the spot (using the procedure above) and mend the punctures when you get home.

Tips for choosing most environment-friendly car

- First of all, remember that we all should use the personal cars as rarely as possible. But, when we have to use a car, which one should we choose?
- Size matters? Yes, it does! Smaller is cooler, while bigger is shameful and not desirable for the environment and for your pockets.
- Powerful? Think again. Do we really need so much power? Do we really need so much speed? Do we really need so many accidents?
- Consider carefully the requirements you really need, You don't need a Ferrari or an SUV to drive in the city centre,
- The first thing we have to study is how much fuel does the car consume? Lower the fuel consumption, lower the CO_2 emissions,
- Purchase alternative vehicles instead of petrol or diesel ones. They are much cleaner and much cheaper to run. Moreover in some countries there are tax incentives and other state contributions for those who wish to purchase alternative vehicles,
- Use green cars. In many countries, you could drive them even in the areas of the city centre that are closed to ordinary cars.

3.8 Questions & Exercises

1. What does BMI stand for?

2. Compute your BMI and find out your nutritional status according to the BMI charts.
(Teachers should set as an example by computing their BMI before asking the students to do it)

3. Compute the BMI of your parents and compare with the BMI charts.
(Encourage each of your friends and relatives to make the same computation, help them do it or just do it for them)

4. How many muscles are used during walking?

5. How good are the conditions for walking in your community?
To define how well prepared are the walkways in your city/village, please use the online application (http://www.rwjf.org/files/newsroom/interactives/walkability/walk_app.html) or the printed checklist (http://www.walktoschool.org/downloads/checklist-walkability.pdf) developed in the Walk to School initiative.
Further info: http://www.walktoschool.org/eventideas/checklists.cfm

6. How good are the conditions for biking in your community?
To define how well prepared are the bikeways in your city/village, please use the online application (http://www.rwjf.org/files/newsroom/interactives/sprawl/bike_app.jsp) or the printed checklist (http://www.walktoschool.org/downloads/checklist-bikability.pdf) developed in the Walk to School initiative.

7. Create posters and flyers promoting Cleaner Transportation and walking/cycling messages.

8. Ask your physical education teachers to teach you warm-ups and stretches useful for walking, cycling and skating.

9. Write press articles and public service announcements to promote Cleaner Transportation. Write essays or keep a diary or blog about your experiences walking, biking or skating. It's very good to learn from the experiences of others.

10. Study historical locations in your community by walking to them. Visit the historical sites in your county by cycling to them. Of course you might think about doing this in groups. Finally deliver short reports to the class, to your school magazine etc.

11. What would be better: flying or taking a train?

12. Considering that a single person who commutes via public transportation instead of driving alone will save over 750 liters of petrol in one year, how many liters of petrol would be saved in a year if 10 of you would use public transportation instead of the personal car to travel to school? What if each of the ten additionally influences another 10 people in using public transport when going to school, university or job?

13. The first fuel cell was invented by Sir William Grove in:
a. 1839; b. 1899; c. 1932.

Key points

- Walk, cycle, skate. This will give a boost to your health and prevent obesity. Remember the Walk to School initiative. Furthermore this also means a great benefit for the environment through the decrease in CO_2 emissions. Clean up the swimming pools full of CO_2.
- Use public transportation whenever possible. This will protect communities from traffic jams, it provides a safer environment for walking and cycling, and of course it decreases greenhouse gas emissions.
- Electric, hybrid and fuel cell cars are becoming more and more competitive alternatives to traditional cars. Think about that when deciding what car you'll drive.
- Solar energy has begun to be embedded in different means of transport. Think about using it when charging your batteries for your electric or hybrid cars.
- Buying local is very good but going everyday to the market by car could be even worse than buying goods from Thailand.

Chapter 4 Sustainable Transport

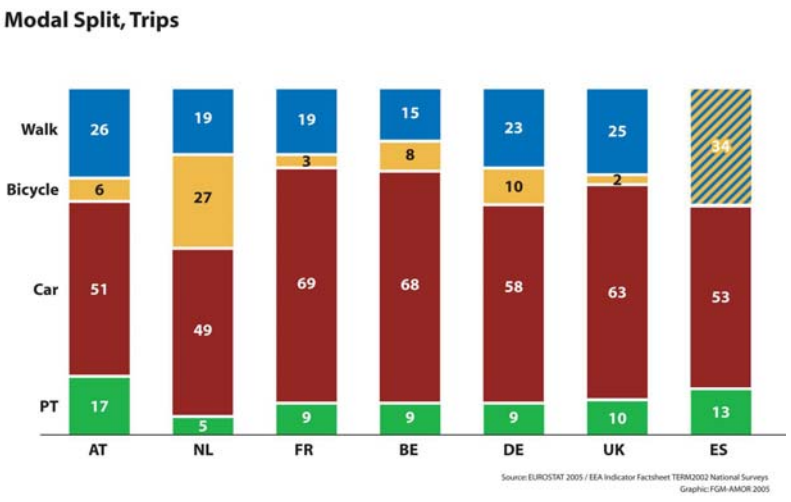
4.1 Organizational and behavioural means towards Sustainable Transport

The way of moving around in urban areas has changed in recent years. In the past, people moved by cycling, walking, trams and buses because very few people had cars. At present, due to the higher purchasing power of people and to lifestyle changes focused on comfort, as well as the growth of cities and the need for travelling longer distances, the numbers of trips in private vehicles has greatly increased.

This evolution of urban mobility has in most cases resulted in worsening traffic conditions, leading to a growing number of traffic jams which cause increased polluting emissions in urban areas. According to ADEME[1] (France), individual urban travel represents 24% of the energy consumption of the total land transport. Private cars account for 87% of the energy balance of urban mobility, whereas public transport consumes barely 7%. In Brussels, vehicles of the STIB/MIVB (buses, trams and metros) consume only 8% of the energy balance of urban mobility yet account for 30% of total urban travel.

Note: Nowadays, cities are designed for vehicles where pedestrians are largely forgotten in the mobility system. It is quite common to have cities where shops, schools and parks are far from densely populated areas and require a car to reach them. Here traffic dominates the streets making them difficult to cross and walking and cycling are unsafe and unpleasant. Public transport is infrequent and hard to get to and air pollution is a visible, pungent health hazard.

Have a look at the typical European modal transport breakdown, and you can see how the car dominates:



Source: Competence project (IEE Programme)

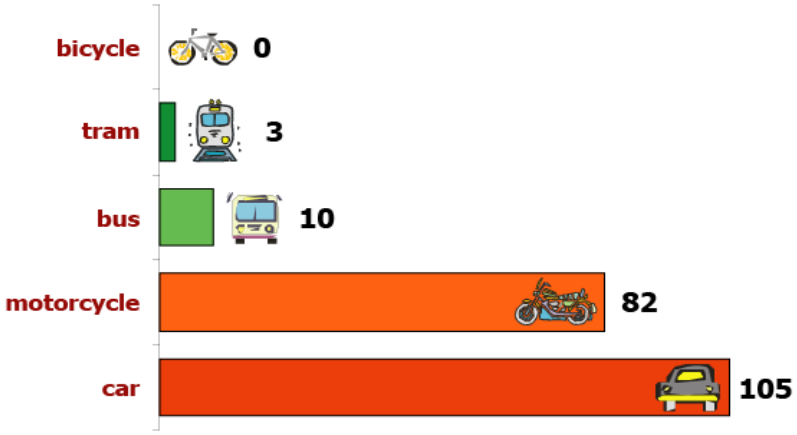
1 ADEME is the French Environment and Energy Management Agency

Note: A city should be made for people and it should be a place where it is pleasant and safe to walk to shops, parks and schools, where streets are safe to cycle on, to cross the road, or even for children to play on, where work is not far away or is easily reached by bus or light rail, where buses move quickly in bus lanes and get priority at traffic lights.
To get a more sustainable city it is necessary to act in two main directions:

- To change the behaviour of citizens and
- To change the planning and organisation of urban spaces

Sustainable transport systems make a positive contribution to the environmental, social and economic sustainability of the communities they serve. Conventional transport systems have significant impacts on the environment, accounting for between 20% and 25% of world energy consumption and carbon dioxide emissions. Greenhouse gas emissions from transport are increasing at a faster rate than any other energy using sector.

Environment impacts by means of transport



Source: Competence project (IEE Programme)

This improvement in the quality of urban life can be achieved through the implementation of a Sustainable Urban Mobility Plan that in many cases could imply a serious rethink of the Urban Environment and Design

Sustainable Urban Mobility Plan. What is that?

Definition: A Sustainable Urban Mobility Plan is a set of actions aimed at introducing more sustainable forms of travel, such as walking, cycling and public transport within a city, i.e. ways of transport to make compatible economic growth, social cohesion and environmental protection, ensuring thus a better quality of life for citizens. The measures implemented are a mixture of physical changes and information with the aim to reach a better life environment with reduced traffic volumes and emissions, increased accessibility and safety.

Note: The three main measures for a Sustainable Urban Mobility Plan are:

- the reduction of the private car
- the creation of an adequate urban transportation network,
- the promotion of cycling and walking

Control and reduction of private car use.

Note: Basic pillars of a Sustainable Urban Mobility Plan are the reduction of traffic in the city and making cities free of motor dependence.

Here are some of the measures that could be put in place to achieve this.

- A low prices or free parking policy can promote excessive use of private vehicles for urban travel. In some places or in the street, parking is usually free (workplace, shopping mall), and external costs (emissions, noise, accidents, congestion) are not "internalised", as drivers support only a small ratio of the costs incurred.
  The priority should therefore be making the use of cars in cities more expensive. The goal is not to increase road tax indiscriminately, but to implement a series of specific charges to alter motorists' behavior and promote economic efficiency and common well being. To achieve this goal is necessary to:

  - increase charges for parking in the streets and parking for non-residents;
  - persuade companies to offer less free parking at their facilities;
  - implement tolls to enter urban centers, congested roads, etc.

For example, in London, after the implementation of the congestion charge and public transport development, the number of cars traveling through the center has fallen by 30% in few years.

- Moreover, there are more and more cities that are introducing "odd-even traffic restrictions". This consists of allowing the use of cars in alternate days according to the number of plate (or registration number). For example such a system was implemented in Beijing, one of the most congested cities in the world, just before the 2008 Olympics games, to reduce air pollution. And it worked.

- Another way to reduce private car use is to promote share journeys. People working together who live close to each other can share a car to drive to the work place. In this way, if we suppose a five seats car fully occupied, we will achieve an 80% saving both from economical and environmental perspectives.
  In many countries, there are firms offering the possibility to use a car when you need it without having to own it (this is known as car sharing). In 1997 there were less than 50.000 users worldwide whereas in 2006 there were almost 350.000 users[2] of such schemes. The personal advantages of car sharing are clear: users save time and money not owning a car.

2. Source: IDAE (Spanish Institute for Energy Saving and Diversification

They will always drive a nearly new car and have the possibility to select a car type according to their requirements. In terms of global advantages, car sharing is a crucial element of multimodality and contributes to reducing some negative impacts of car traffic such as pollution, energy waste and the misuse of urban space. Car sharing not only reduces mileage but also the number of cars in inner city areas - an aspect often neglected in the sustainability debate.

This system has direct and indirect benefits. For example, 4 to 10 private vehicles are replaced by one car sharing vehicle in Europe. Users tend to develop more rational mobility behavior and switch to sustainable modes (such as walking, cycling and public transport) for a higher portion of their trips. Car sharing can have very positive results[3] :

- The overall kilometers travelled by car per year falls by 17%.
- The mileage travelled by private vehicle is reduced by 72%.
- The distance covered by public transport is increased by 35%.
- There is a 70% increase in mileage covered by other systems of movement (bicycle, walking, etc).

When talking about car sharing in modern terms, Switzerland must be considered as a pioneer country. The first such scheme was established in Zurich as a citizens driven initiative. Other similar organisations have since been set up in other Swiss cities. When the two biggest providers merged in 1997, de facto a national car sharing scheme with some 17,000 users was created. This company is the largest in Europe with circa 76,000 users in 2007. Just to give an example: in Zurich alone there are 365 such cars at 163 locations for 18,000 customers.

According to a study conducted by AISA (Association des importeurs suisses d'automobilies), car sharing in Switzerland (1,750 vehicles) saves 1,200 t of CO_2 compared to the average amount of CO_2 emitted by an equivalent amount of new private vehicles.

Public transport.

Note: Another vital step is the development of public transport, offering alternatives to the users of private vehicles, which must go hand in hand with any measure aimed at restricting car use.

Public transport constitutes the key to the problems of urban congestion. It also contributes to increased quality of urban life and the environment, and it makes it possible to free up scarce urban space.

The following figures support this reasoning:

- in the Paris region, for example, a public bus of the transport company RATP which is 25% full, consumes 25 goe / passenger-km, while a car with 1.25 occupants consumes 60 goe / passenger-km ;
- as to greenhouse gases, a bus emits only one third of the CO_2 per passenger and kilometer than that of a private car;
- with regard to air pollutants, the bus delivers 25 times less CO in the atmosphere than a petrol-powered car and one quarter of the particles emitted by a diesel-powered car.

3 Source: IDAE

Obviously, these ratios would be even more unfavorable compared to a private car during rush hour, since the bus would be close to 100% full.
These findings are not unique to the Paris region. They can be extended to almost all European urban areas having a dense public transport network. Generally speaking, the higher the occupancy rate of public transport vehicles, the lower the relative energy efficiency of private cars.
The following easy calculations show further evidence:

Note: In displacement from home to work, a private car takes from 10 to 30 times more space than public transport, and five times more than a bicycle.
For example 75 people can be moved by 60 cars…or by one bus.

(Pictures from www.transportlearning.net)

To promote public transport, its operators must offer multiple solutions from door to door services that are efficient enough to compete with private transport. In other words, operators must offer a wide range of mobility services. The bottom line is that the effectiveness and efficiency of any public transport network depends on how easy it is to use. Consequently, the services offered must be coherent and well integrated and the network must offer both physical and operational continuity.
To meet this challenge, the following points should be well considered for *making public transport more attractive and efficient.*

Photo credit: Ricardo Silva

- Interconnecting networks and modes.

Private transport has the advantage that one vehicle can seamlessly transport its occupants from A to B. But this is not the case for traditional public transport. As a result, public transport looses a lot of attractiveness by imposing transfers (and waiting-time) at interchanges. To limit the impact of fragmented journeys, it is crucial to adopt a network approach to make sure that the different services involved allow a smooth journey.
In this respect several elements should be taken into account:
-reducing unnecessary transshipment between different modes and routes;
-integrating schedules and planning services in order to reduce waiting times;
-providing "on-demand" transport service where it is needed,
The last point means creating a system of buses and minibuses on demand. This system is designed as a solution to cover the needs of remote areas or time slots in which traditional public transport is not economically viable. In this case the bus may deviate from its regular route only if users required the service or a mini bus (or even taxi) is used on demand of the beneficiaries.

- Improving interchange points.

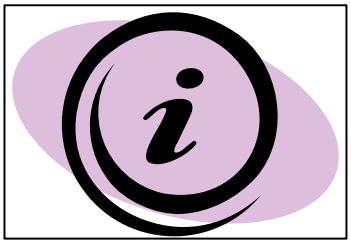
The time spent during a changeover in public transport is perceived as wasted time, and it feels twice as long as

an equivalent period spent on board. Passengers perceive transshipments as interruptions of displacement due to the uncertainty caused in the duration and success of the operation.
Moreover, virtually all travel involves a change, if we include walking from home to the nearest public transport stop. A large percentage of passengers move through transfer points, and the quality of these points is a decisive factor when people define their transportation options.

- Integrated tariff systems (ITS)

In many cases, in a journey that is comprised of several individual trips, it is necessary to buy multiple tickets. Having to buy multiple tickets for the same displacement has a deterrent effect, since this may involve a lot of time in queues. Furthermore, when multiple payments are made, travellers are much more aware of the cost of displacement than people driving their own car, creating a subjective feeling that public transport is more expensive than it actually is.
If integrated fares are set for all public transport networks in the same area, instead of applying different rates by mode or operator, public transport becomes easier to use and more accessible for travelers.

- Providing integrated information.



Often there are several possibilities to go from point A to point B on public transport, and each of these possibilities implies different modes and operators. Often, when you are seeking information for intermodal travel, travellers should consult different sources of information. Since it is virtually impossible to compare alternatives, it is extremely difficult to select the best option.
People should be informed how to use public transport, how to read timetables and, last but not least, where to find such information. Information is an integral and essential part of every public transport system.

Information about public transport should be clear and comprehensive, letting users know everything they need to know. It must be available quickly and at all points of the network.
Nowadays, there are new technologies that provide real-time information at bus stops, so that passengers know the exact waiting time.

- Lanes for buses and high occupancy vehicles.

The reservation of exclusive lanes for buses and high occupancy vehicles has a dual effect: on the one hand, it improves the travel times of public transport, making it more competitive. But it has also a psychological effect on private car users who see the fluidity of the public transport system from the traffic jam and then they are more willing to change their transport methods.
These kind of actions normally require broader structural changes in cities and a large amount of inversion, concerning with urban planning projects.

Here are some examples of measures relating to public transport implemented in different cities of the world, and their results:

-Extension of the metro network (+10 km/year)
-Reorganisation of the bus network and implementation of bus corridors
-Improvement of interchange stations
-Fare integration
-Results: +60% of public transport use

-Implementation of Bus Rapid Transit network (41 km in 2002, 388 km in 2015)
-Reorganisation of bus network (trunk lines, feeder lines)
-Car traffic restriction
-Results: -32% in travel time, -40% in air pollutants and -93% in number of accidents

-Implementation of 100 km of bus corridors
-Provision of park & ride parking with fares integrated with public transport
-Results: Bus speed 30 to 50% higher than car speed, +30% in bus use (+38% in peak hours) and 65% of new customers in the park & ride parks

-Increase of public transport supply
-Improved quality (new buses, frequency, night services)
-New fares policy
-Results: + 50% in public transport use between 1999 and 2004

Cases selected by Competence project: www.transportlearning.net

Promotion of cycling and walking - young people's challenge!

Note: Cycling has a major role in any Sustainable Urban Transport Plan. It helps reduce congestion and local air pollution, as well as emissions causing climate change. 23% of car trips are less than 2 miles, a distance that could be easily cycled in less than 15 minutes. If people choose to make some of those trips by bike, we could have a considerable impact on local congestion and pollution

As well as the above, cycling has the following advantages:
-Save energy because you do not consume fuels
-Improve environment (no pollution, no noise)

-Save urban space
-Save costs
-Promote health and wellbeing
-Make your travel more enjoyable
-Reduce time losses, maybe even increase overall speed.

But on the other hand, there are barriers that impede the development of this type of transport, such as:
-Parking prohibition at cycling paths is rarely enforced
-Lack of dedicated infrastructure, bottlenecks and sudden breaks in cycle lanes
-Traffic regulations for cyclists and routing often unclear
-Neither fish nor fowl: cyclists are sometimes considered with motorists, sometimes with pedestrians
-Lack of understanding on cyclists' issues within city councils and police
(See the comprehensive barrier check list below)

There are several possible improvements to be made to overcome the above mentioned barriers:

- One of the most important improvements is constructing routes for cyclists along crowded and dangerous roads. This network of bike paths should link downtown to the suburbs - in this way many people living in the periphery will avoid car driving.
  A good example is Aalborg (Denmark). This city has bike paths and bike routes connecting downtown with the suburbs and now a "cycle motorway" is going to be built. Improvements in travel time and cyclists' safety are expected from this measure. In the long-term perspective this will have a positive impact on modal choice in favour of cycling for students and other residents who travel in this corridor. The route will be from the city centre to the university and the aim is to increase cycling by 5% (and the rate is already relatively high).

- There are many people who would like to enjoy the bike but they cannot have one because the available space at home is limited, as a bike at home could become a nuisance. Bike sharing is the solution!
  Bike sharing has been proven to encourage further cycling in a variety of towns and cities throughout Europe and there is a growing number of bike sharing schemes in operation. From Velib' in Paris to Bicing in Barcelona, there's no doubt about it: bike sharing schemes across Europe are getting more people on bikes. Some such as Velib' in Paris are funded through cross subsidies from public space advertising incomes, whilst others such as Bicing in Barcelona receive direct public funding.
  Generally, city councils and private firms have fleets of bicycles and lend these to citizens, giving them the chance to enjoy the bike without having to buy it. It is a great advantage because the bike is parked in a dedicated public street parking space and the user does not need to perform maintenance on them. They have just to pay an annual cheap fee.

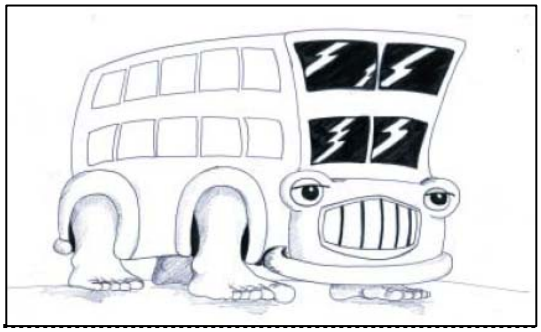
- Another problem presented by the use of bicycles is related to the unavailability of space to park them. Moreover people do not want to leave their bike parked next to a lamppost or a bus stop for fear of having it stolen or damaged. For this reason, and to promote cycling in cities, the construction of safe parking for bikes is required. An example can be seen in Saragossa where there are two underground parks which storage bikes for free, automatically and intelligently, the park get bikes and returns them to the street.

- Currently more and more cars have route guidance systems. Via the internet, car drivers and public transport users can also simulate their trip with all kinds of models. For cyclists, systems like this are available, but they do not give information about the safest cycling route. Therefore, another measure that promotes the use of bikes is to provide bikers with information about safer bike paths to plan their own routes.
The city of Gent (Belgium) is developing its own cycling model. In Gent there are route guidance systems but these systems do not always give information on the safe route. Therefore, a new guidance system will be elaborated to inform bikers not only about the fastest routes, but also about the safest ones. The aim of this measure is to increase the number of bicycles by 5% and to decrease accidents by 40%.[6]

Note: **Walking** is the most natural mode of transport and the one that has the smallest impact on the environment. Walking doesn't require any special equipment, does not produce any additional polluting waste and the only fuel you will need is a healthy meal. Moreover it is safe.

Walking should be encouraged since childhood, so children become aware of the environment and get used to it.

Below the "walking bus"[7],an activity which could be developed at schools, is explained.
A walking bus is a concept designed to encourage children to walk to school thus helping them keep fit and benefiting the environment by the reduced use of cars. The walking bus is a simple idea which any parent, teacher or interested party can set up. The basic idea is that a group of children walk to school together with accompanying adults to ensure their safety. This is an opportunity for fresh air, exercise and a chat with friends and reduces the number of vehicles at the school gates which pose safety and environmental problems.
There are basically two kinds of walking bus. The first is simply parents walking their children to school in a group. This is the easiest to set up as all you need to do is arrange a small group to meet at a certain place and time and walk to school. The idea tends to quickly catch on and you'll probably find that you soon have many more people joining in.



6. Case study selected from the CIVITAS European initiative
7. For more information about the "walking bus" visit: www.thewalkingbus.co.uk/

The alternative walking bus is a volunteer-led bus with volunteers from within the community to accompany the children. This takes a little more work to set up as police checks and training are required but you could always start a parent-led walking bus in the meantime.
For those children who live too far from the school to walk, consider finding a local car park where parents could drop their children to meet the walking bus so that at least they can walk some of the way.

Barriers for walking and cycling.

The principal barriers which impede progress in increasing walking and cycling in cities across Europe are well known[8] and can be summarised in the table below
Do these obstacles affect your city and in which way?
Would you like to have them solved and be able to freely drive around your city?

Active learning exercise

Have a look at the list, detect which barriers concern your ambient living and assess how much they apply to you, by giving a mark (Legend: Strong, Medium or Low barrier)
Extend the list if you overcome any kind of other barriers!!
Finally you could send the check list, accompanied by a little report or letter, to your city council in order to propose a solution or, at least, to make your wish evident.

Pedestrian and cycling Barrier Check List

	BARRIERS	Level of barrier (Strong – Medium – Low)
1	Safety and Security Concerns	
	Unsafe routes for cycling/walking	
	Lack of definite regulations on cycling	
	Fear of theft or criminal damage to bicycles	
2	Inadequate Information	
	Lack of information on how to reach destination safely	
	Lack of information about walking/cycling routes	
	Lack of convenient signage on walking/cycling routes	
	Ineffectiveness of promotional campaigns	
	Lack of information about walking and cycling facilities	
	Lack of skills to promote walking and cycling amongst businesses and citizens	
	Insufficient communication between city departments and citizens	
3	Inadequate Urban Environment and Design	
	Lack of penetrability of city areas to walking and cycling	
	Low level of importance of pedestrian use in the city centres	
	Unattractiveness and low level of quality of urban environment for walking and cycling	
	Climatic and topographical barriers	

8. The ASTUTE project (Advancing Sustainable Transport in Urban areas to promote Energy efficiency) was a three-year project, funded by the European Commission, Intelligent Energy Executive Agency (IEEA) 2006-9, working in six urban areas - Budapest, Dublin, Granada, Graz, London and Syracuse - and focusing on behavioural change through the use of 'soft measures' (education, training and publicity).

	BARRIERS	Level of barrier (Strong – Medium – Low)
4	Lack of Infrastructure and Support	
	Lack of integrating existing networks	
	Ineligible or lack of parking facilities in the city reduces the modal share	
	Inadequate public transportation accessibility	
	Lack of cycle tracks	
	Lack of facilities of bike using (loaning, storage and repair facilities	
	Lack of maintenance of the infrastructure	
5	Poor Public Perception and Lack of Awareness	
	Lack of public interest	
	Public approach of walking/cycling	
	Low attractiveness of bicycle for longer journeys (e.g. commuters)	
	Cultural barriers against cycling	
6	Accessibility and Health Issues	
	Low level of environmental and health awareness among citizens	
	Lack of competence of citizens / organizations and lack of power to enforce their interests	
	Exclusion of people reduced mobility / minority / elderly / residents living areas difficult to access	
	Low fitness levels among citizens	
7	Lack of Public Sector Support	
	Transport policy prioritising private car/public transport	
	Lack of co-ordination between city departments and NGOs responsible for walking and cycling	
	Lack of appreciation of the value of marketing campaigns	
	Lack of integrated planning of cycling and walking/pedestrian traffic	
	Purchasing and keeping political support behind project	
8	Lack of Private Sector Support	
	Lack of financial incentives to develop a travel plan for employees / school	
	Lack of skills to implement actions for sustainable transport	
	Insensitivity of companies towards employee transport preferences	
	Inadequate resources and knowledge by employers to implement travel plan	
	Inadequate facilities of walking/cycling in the workplaces (cycle park, changing room, shower)	
	Inadequate incentives by employers to encourage walking/cycling to the workplace	
9	Congestion and Air Pollution	
	Unbalanced level of utilization on public transport vehicles	
	Level of car traffic and air pollution	
	Reduced accessibility for businesses due to congestion	
10	Lack of Education and Training	
	Lack of cycling and bicycle maintenance skills	
	Children inadequate road safety skills	

Watch the videos!!
A video collection of 10 case studies, one on each barrier, is available in many European languages on the ASTUTE project web site. http://www.astute-eu.org/

Best Practices.... to learn from the experience....
More and more cities, schools, enterprises or simple group of people around the world have already taken action in order to change the transport paradigm and build up a better place to live: greener, safer, more enjoyable and more fun.
Some best practices leading the way in travel behaviour change are described below.

Launching green connections for schools"
Links to Schools (UK)
is a Sustrans project (under UK's "A joint undertaking for a sustainable transport" initiative: http://www.sustrans.org.uk), with the primary aim of connecting young people to their schools by way of traffic-free and traffic-calmed walking and cycling routes, creating a safe and attractive environment to give parents the confidence to allow their children to travel to school by foot and bike.

Funded by the Department for Transport (UK) Sustrans' Links to Schools project began in October 2004 with the majority of projects being completed between spring and autumn 2005 creating 147 links connecting over 300 schools to their communities, enabling up to 200,000 pupils to walk or cycle to school.
These Links come in a variety of forms, from new cycle routes to pedestrian crossings, all providing the safe routes that young people need to cycle and walk to school.

"Travel Plans equals Travel Smart"
TravelSmart (Australia)
is an initiative of the Victorian Government (in Australia) that aims to reduce people's dependency on cars and encourage them to choose sustainable travel alternatives, such as walking, cycling or using public transport.
The TravelSmart methodology involves developing and implementing travel plans to encourage a sustainable transport shift. Travel plans can be used in a variety of settings from primary school to university campus, corporate workplace to community centre or precinct. They are also delivered in partnership with a wide variety of organisations including councils, schools, universities and workplaces..

Since 2002, TravelSmart has been successful in delivering travel behaviour change projects across Victoria. Travel plans have been established in over 100 schools and 110 workplaces; working with tertiary institutions to change student and staff travel behaviour; and involving over 88,000 households in large-scale community-based projects. Projects have already connected 700,000 Victorians.
Travel planning is increasingly being used by governments in the UK, New Zealand and other Australian states to create more travel choices for people.
Website: http://www.travelsmart.vic.gov.au/

"Free cars quarter"

Ecological Model Quarter Vauban (in Freiburg, Germany)
The project has been implemented from 1998 to 2007 in the Municipality Freiburg (about 200.000 inhabitants).
The Vauban Quarter, about 5000 inhabitants in an area of about 42 ha, is an acknowledged example for large projects with an integrated approach, including ecological solutions for the most relevant sectors (mixed use structure, transport, energy, social aspects etc.) and especially for the participation process, which involves inhabitants in the "Forum Vauban".
This urban quarter proved to be very successful in avoiding car trips. Many families live car free and a car sharing service is also available. Cars are used for only about 10 % of trips, while the share of bicycles is more than 50 %.
For more information see: http://www.vauban.de/info/abstract.html

"Integration of cycling with public transport"

Demonstration and information campaigns (Malmo, Sweden)

A package of measures boosting a cleaner mobility has been implemented in Malmo from 2006 to 2008,
Objectives were:

- ✦ To implement new solutions for improving safety and comfort at crossroads;
- ✦ To improve safety, security and comfort on two selected bicycle lanes;
- ✦ To produce a 3d-demonstration of a high security parking facility for bicycles;

To produce an inspirational handbook for municipalities who want to integrate bicycle parking facilities with major public transport hubs.

Implementation Status.

26 radar detectors for bicycle priority were installed in 2006 and adjusted in 2007. A concept for a high standard demonstration bicycle lane has been produced. In May 2007 a large bicycle information campaign was undertaken and was observed by 50 % (approx 130,000 people) of Malmö citizens. A survey shows that over 10,000 people have changed their travelling habits thanks to the campaign. A bike garage handbook and 3d-models were presented in late 2008.
Best practice posted on the Eltis web site: http://www.eltis.org/case_study

"Addressing pre-requisites for cycling and walking"

Extension of the infrastructure for cycling and walking (San Sebastian – Spain)

A number of measures are on-going with the overall objective of addressing the pre-requisites for cycling and walking in urban transport, such as growing cycling networks and increased bicycle parking spaces.

Implementation status

Up to April 2009, 5 additional kilometres have been created. In 2010, 6 additional kilometres will be completed and the last 4 kilometres are planned for 2011.

The new pedestrian zone Paseo Riberas de Loiola (next to the Urumea river) with 1,225 metre has been recently inaugurated.

The city will put out a tender to select a suitable operator of the bicycle parking. This operator will also be responsible for providing the additional services and for data collection on the number of users.

An underground bicycle parking area at the railway station and close to the new station for long distance buses will be operational in 2011.

The programme of financial incentives to condominiums that are willing to rehabilitate their building to create indoor bicycle parking will be promoted in the summer of 2010.

"Go where you want, when you want, without fumes or noise"

Bicycle sharing and dedicated bicycle lanes in Saragossa (Spain)

Zaragoza's new public transport system is called Bizi. It was set up by a council initiative in 2008 and is in its full implementing phase.

bizi Zaragoza

Bizi is a public service that combines a low price bicycle renting with several parking stations across the city. After a year of starting, a total of 700 bicycles and 70 parking allow citizen journeys around the city.

The system to use the service is as simple as riding a bicycle:

- Get the travel card via the internet by subscribing the annual quote;
- take out a bicycle from any Bizi station,
- use it for your journey and

return it to the station closest to your destination.

Each station will have bicycles that are ready to use and free spaces for returning them.

At the same time, the city will create dedicated bicycle lanes that guarantee interconnection among the key points of city, such as the River Ebro, rail and bus station, the historical centre. The roll-up process linking all quarters and parks is in progress.

Weblinks

European Union co-financed initiatives:

http:/www.civitas-initiative.org (Cleaner and better transport in cities)
http:/www.eltis.org (web portal on urban transport and mobility)
http:/www.transportlearning.net (Competence EU project)
http://www.astute-eu.org/index.php

UK's leading sustainable transport charity:

http:/www.sustrans.org.uk

4.2 Sustainable driving

Learning Objective

- In this section you will learn how to reduce fuel consumption when driving a car

Introduction

As we saw in the previous chapters, the best way to save fuel and reduce environmentally harmful emissions is not driving at all.

Walking and riding a bicycle are zero-emission ways of transport, whereas public transport is much less environmentally harmful than cars.

But in case you really need to drive and don't have any alternative options, you can drive in a greener way, reducing emissions and fuel consumption (and saving money at the same time).

As we said in chapters 2 and 3, the type of car and fuel used can lead to significant fuel savings, nevertheless the way you drive can lead to even more significant savings: an environmentally friendly driving style uses up to 25% less fuel than an aggressive, careless one.

In particular, short trips (shorter than 5km) should be avoided, since they generally do not allow the engine to reach its peak operating temperature, especially in cold weather. That means fuel consumption and exhaust emissions will be significantly higher than usual. For such short distances you don't really need to use a car.

Tips and hints on sustainable driving

Before driving

1. Take care of your car.

Maintain proper engine tune-up to keep your vehicle running efficiently. Follow the manufacturer's maintenance schedule and have your car checked whenever there's an anomaly.

Make sure you check the pressure of your tyres regularly (every 2 weeks or at least once a month). Tyre-pressure must be checked when tyres are cold. An under-inflated tyre can increase fuel consumption by 3%, and it will wear out faster too. The correct tyre-pressures can be found in the manufacturer's manual and remember that two different tyre pressures are recommended: one for driving unloaded and one for driving fully loaded.

Change oil and filters (oil and air) according to the manufacturer's instructions and choose a good quality oil, with a viscosity grade as recommended in the owner's manual.

2. Avoid unnecessary loads

Don't leave unnecessary loads in the boot (especially heavy ones). Weight is one the most important factors in fuel consumption. A 50 kg extra load will lead to an extra 2% fuel consumption.

3. Don't reduce aerodynamics

All vehicles are put through thorough testing in wind tunnels to optimize their aerodynamic per-

formance. Additional parts to the basic vehicle such as roof-boxes, ski- or bike-carriers etc, will significantly increase the car's fuel consumption - up to 38%, depending on the speed and on the shape of the object.

So remove roof-boxes, ski- or bike-carriers when you don't need them. A ski-carrier can greatly decrease the aerodynamics so that consumption is noticeably increased, especially at a high speed. At a speed of 120km/h, it can cause at least a 20% increase in fuel consumption (about € 200 per year).

Author: Frank C. Müller

4. Plan Ahead.

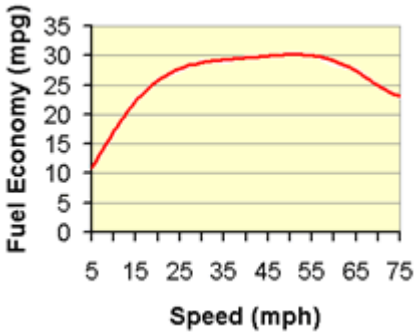
Planning is also important: use the latest road maps to plan your route and avoid prolonging your journey due to a wrong turning. Avoid highly congested roads and bear in mind that the most direct route is not always the best. Using bypass roads is much better than crossing towns, since traffic lights, intersections and pedestrian traffic mean multiple stops and starts and extra fuel consumption.

Plan your refueling and do it on your route. If the filling station is not on your way, don't go there just for a few litres, but fill up your tank completely. To avoid evaporation, fill the tank possibly during the cooler hours and replace worn out gas-tank caps.

When driving

1. Drive smoothly and slow down.

Smooth acceleration from a stop, and braking softly reduce fuel consumption, whereas fast starts and hard braking waste fuel and lead to faster wear of some of the car components, such as brakes and tyres.



Maintain a safety distance between vehicles and anticipate traffic conditions to allow for more time to brake and accelerate gradually. Pay attention to traffic lights, stops, traffic jams, bends and pedestrians. Slow down gently in advance, without braking at the very last second. The risk of accidents will also decrease!

Don't drive too fast. Fuel consumption increases considerably at a higher speed. For example, increasing your highway cruising speed from 90km/h to 120km/h raises fuel consumption by as much as 20% and in a short trip you will not save so much time.

Driving with your engine at low revolutions also considerably decreases the noise produced by your vehicle: engine noise from a car when driving at 4,000 rpm (revolutions per minute) equals the engine noise of 32 cars at 2,000 rpm!

2. Don't rev up the engine.

Even though it might sound cool, revving up the engine will just lead to a significant waste of fuel!

3. Use the right gear.

Proper use of gears can produce huge fuel savings (up to 15%!). Change up to a higher gear as soon as possible (2,500 rpm for petrol cars and 2,000 rpm for diesel cars).

For example, a car running steadily at 60 km/h in third gear will use up 25% more fuel than one running in fifth gear.

Intelligent Energy Europe

Driving steadily in the highest gear with a low engine rpm rate is the most energy efficient way to drive.

4. Air conditioning.

Minimise the use of heating and cooling. A car which would normally use 11 litres of fuel, will end up using 13.3 litres when air conditioning is on. Keeping the car much warmer or cooler than the air outside isn't just a waste of fuel, it is not good for your health either!

At a low speed, keep your windows open to cool down the car. In most cases this will be sufficient.

However, don't drive with your windows open when your speed is above 80 km/h. Driving with open windows at highway speeds increases aerodynamic drag on the vehicle and fuel consumption.

Park your car in a covered space or in the shade to keep it at a more comfortable temperature.

Apart from heating and air conditioning, avoid reckless use of other electric devices in the car, such as big HI-FI systems, mobile phone chargers etc.

5. Don't idle.

A car idling achieves 0 km per litre! The fuel consumption of a modern engine during idling is about 0.5 litres per hour, depending on the type of engine, while for older cars it is much more. So don't keep your engine on if you don't have to drive.

Once a vehicle is running, the best way to warm it up is to drive it. Even in a cold winter day, a modern computer-controlled, fuel-injected engine will need no more than 30 seconds of idling before driving away. Remember that, when starting a modern fuel-injected engine, you should not press the accelerator pedal. The electronic engine management system provides a correct start. Pressing the accelerator only 'confuses' the system, which makes starting harder and increases fuel consumption and exhaust emissions.

Besides that, more than just the engine needs warming up: the wheel bearings, steering, suspensions, transmissions and tyres do so too and that can happen only when the vehicle is moving. For a typical vehicle, it takes at least five kilometres of driving to warm up these components.

Turn off the engine during long waiting at traffic lights, when loading and unloading the boot, while waiting for somebody, at drive-ins etc. When driving a modern car and expecting to stop for more than 20 seconds, it already makes sense to switch off the engine, whereas with an older car (15 or more years old) it's better to switch the engine off when stopping longer than a minute.

6 How to drive up-hill

When driving up-hill, still use the highest gear possible, even if you have to press down the accelerator pedal. Reduce pressure on the pedal just before the top. When driving downhill, take advantage of the car's momentum and don't press the accelerator pedal, yet don't shift into neutral, since on steep or long slopes this is very dangerous! Always respect speed limits and safety rules!

7 Driving on bends

Slow down in advance, so you will not need to brake roughly. This way, the highest possible gear can be used. Using full acceleration with short, sharp pressure on the brakes, and then high revolutions to speed up again around a bend is not only a waste of fuel, but it also reduces road-holding. Heavy use of the brakes causes transfer of weight on the axle, which can very easily result in malfunctioning and so frequently leads to an accident.

8 Make use of in-car devices

Make use of in-car devices, when available, such as revolution-counters, cruise-control systems and trip-computers.

A revolution-counter will help you switch to the proper gear.

An on-board computer (or an older and less reliable econometer) can provide you with immediate feedback on fuel consumption , whereby you will be able to fine-tune your driving style.

A cruise-control system makes it easy for you to keep a steady speed and to avoid fines for unperceived acceleration. It's particularly good on plain highways, yet it can be not as efficient as an experienced driver in other situations.

9 Just park your car

Don't drive around the lot hoping to find a better parking space. Take the shortest route to a free space and walk from there. Circling doesn't just waste gas, it usually turns out to be slower than simply parking somewhere a little less convenient and then walking.

Exercise

Try driving the same car, along the same route and at the same times of the day first as you normally do, then fully applying the sustainable driving tips (in both cases respect rules and safety!) and compare fuel consumption.

To calculate fuel consumption you can use your on-board computer or you can fill in the tank before the experiment and after the experiment to estimate your fuel consumption.

References

Ecodriving IEE project http://www.ecodrive.org

Ford Driving Skills for Life https://www.drivingskillsforlife.com

U.K. Direct.gov http://www.direct.gov.uk

U.S Environmental Protection Agency http://www.epa.gov

4.3 School Mobility/Transport Plan

Learning Objectives

In this section you will learn

- what a school mobility/transport plan is
- how to set one up in your school

Introduction

One of the best ways for students to reduce their environmental impact, especially from transport, is to look at the ways they travel to and from school. This is the most common travel that students do - for hundreds of days every year they are coming and going to school.

Some of the trends in how students travel to and from schools are of major concern. In many parts of Europe for example, more and more students are travelling in cars, alone with the driver (a parent). Figure 4.1 shows some statistics on this in the UK[1].

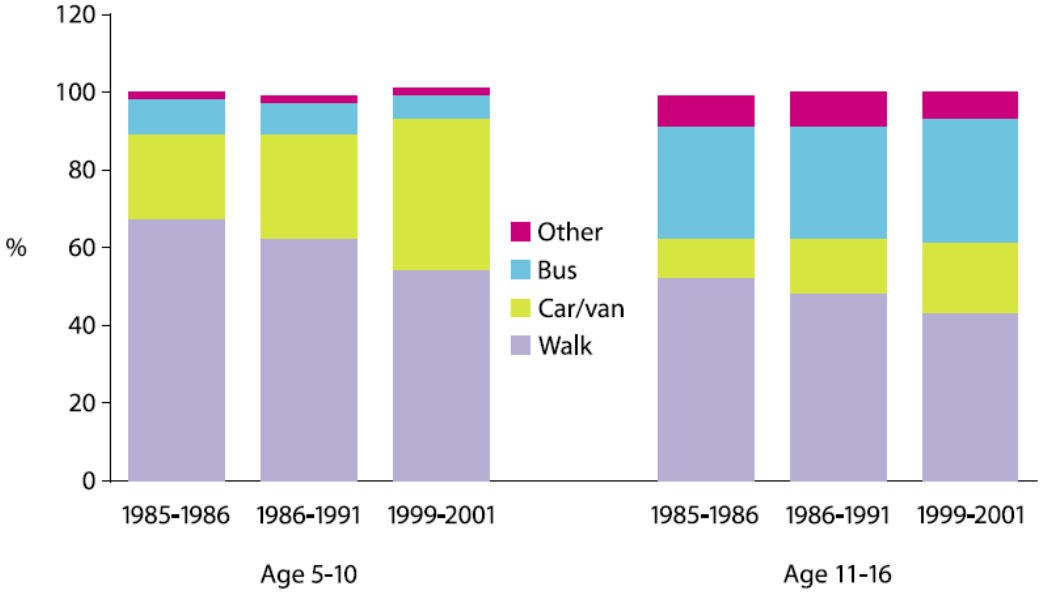


Figure 4.1: Children's ways of travel to and from school in the UK

From this you can see the growth in the green area from the 1980s to the 2000s. The rate is especially high in very young children (as one would expect), but it's also still growing rapidly for older kids. Also look at the indigo section (walking) and how much it is decreasing – even though this is the healthiest and most environmentally friendly option.

1 UK Department for Education and Skills Travelling to School: an action plan 2003 DfES Publications, UK

Exercise

Find out the statistics for children's ways of going to school in your country. This will be available from some government body like the Ministry of Education or Transport, or perhaps the national body that produces statistics in your country. Find out the European average and figure out how your country compares.

However, while it's important that every family decides the best way for its children to travel, a lot can also be done by the school – and the kids themselves. And the best approach for any school is to develop a Transport Mobility Plan for all the children and staff of the school. Such a plan has many advantages over individual and once off behavioural changes. And the schoolchildren in the school (you) can play a major role in the development and implementation of such a plan.

What is a School Mobility/Transport Plan?

Definition: A School Mobility/Transport Plan is a systematic and ongoing way of improving the mobility habits and actions of the staff and students of a school to:

- ensure a reduced impact on the environment
- provide health benefits to all involved, and
- reduce traffic.

Such a plan must be developed and though out properly by all the stakeholders involved, both inside and outside the school, such as:

- Students
- Staff
- School Management Board
- Educational Authorities
- Environmental groups
- Parents
- Local Authorities
- Transport Providers

Local Residents

While the plan will be mainly developed by the staff and students of the school, the other stakeholders (parents especially) must be consulted and their approval and support could be vital for success.

The plan will comprise four stages involving

1. **planning** the scheme,
2. carrying out or **doing** actions to implement it,
3. **checking** it regularly to see if it is working and
4. **acting** to make any changes necessary for improvement.

Then starting all over again, in an ever improving cycle!

This process is shown in Figure 2[2]

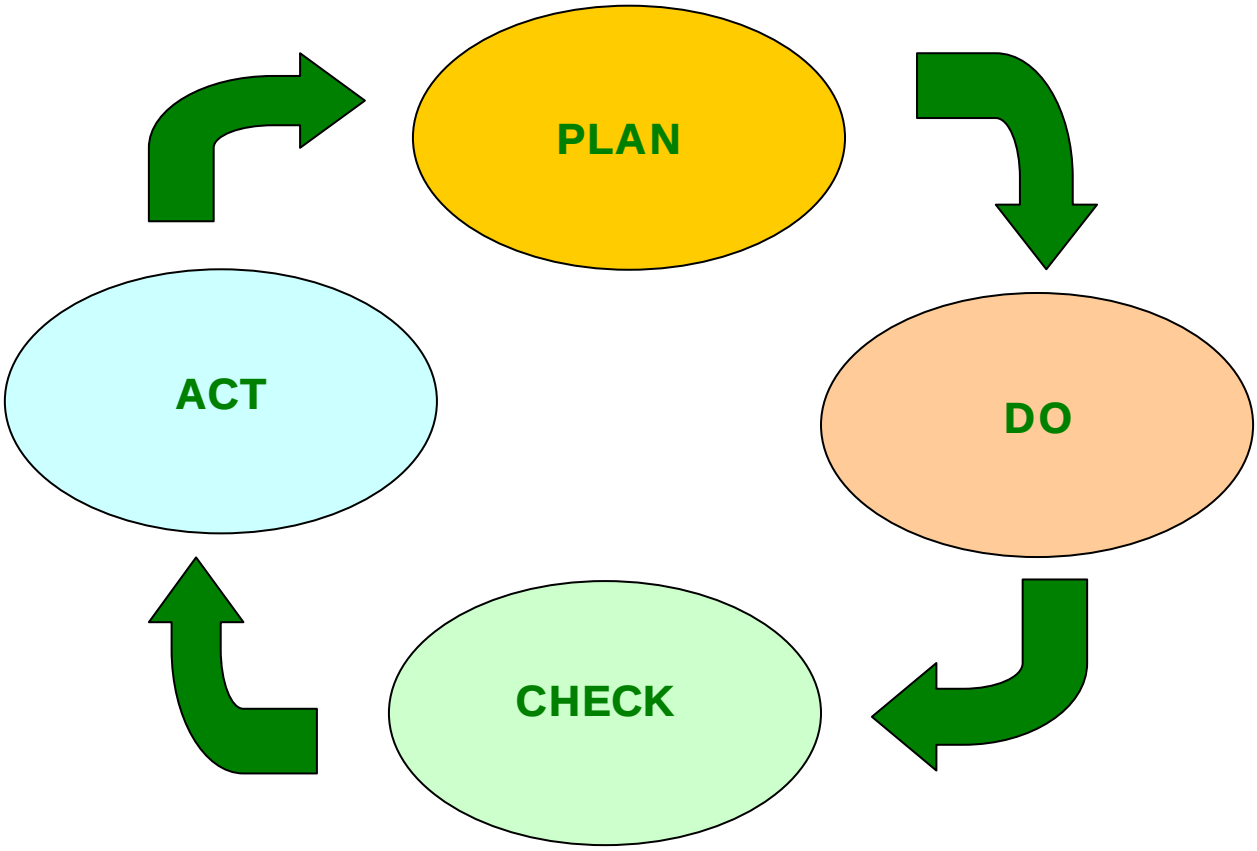


Figure 2: Elements of a School Mobility/Transport Plan

Exercise

Are there any environmental programmes for schools in your region? Find out! Is there an environmental group helping schools improve what they are doing? Contact them and get some information to begin the process in your school.

Benefits of a School Mobility/Transport Plan

There are many benefits of such a plan, to the school, its students, the parents, the local community – everybody benefits!

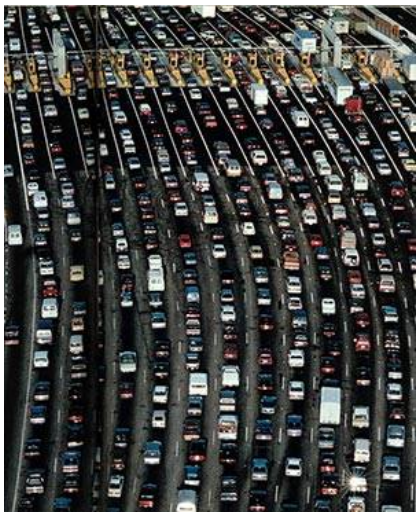
Environmental Benefits

Less pollution due to cars

Less global warming due to emissions

More environmental awareness among the students and parents

2 This is similar to the Energy Management Plan that can be seen in Chapter 4 of the Industry Handbook of this series



Health benefits

Students get exercise and get healthier

Parents have less stress, stuck in traffic, looking for parking etc.

Less traffic fumes from cars

Less chance of getting knocked down near the school!

Financial Benefits

Less costs for petrol, cars

Less time stuck in traffic (and time is money!)

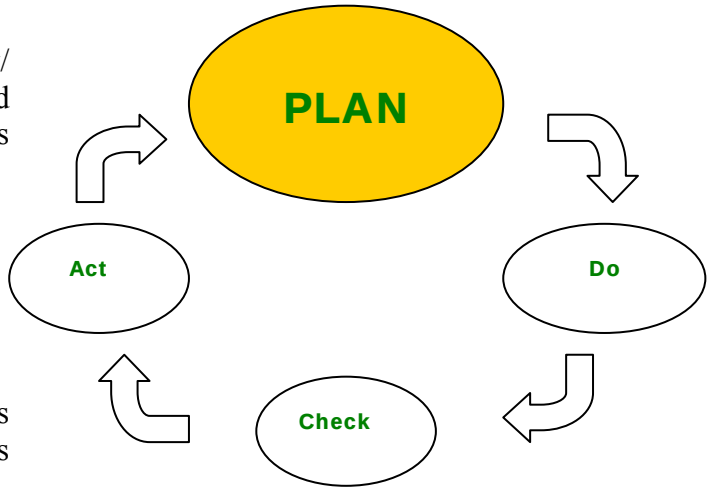
Local benefits

Less traffic jams around the school

Less problems for local people, trying to move about

Stage 1: Forming a Plan

This stage of the School Mobility/ Transport Plan is to set the ball rolling and begin the process. There are usually 4 steps in this stage:



Create a team

The first step is to form a good team to develop the plan. This should involve teachers and students to begin with.

A mixture of students, from different years would be good, but some senior students are definitely required.

Find a group of 5 or 6 committed people – 2 teachers and 4 students, say, to begin. It can always be changed or increased later.

Make a Policy

Next step is to make a school policy to commit to improving the mobility of school staff and students and reduce their impact on the environment. This could be a simple, one page document stating:

- Some details of the school
- Commitment of the school to the environment
- Commitment of the school to develop a School Mobility/Transport Plan
- Commitment of the school to carry out and continue to improve such a plan

The policy should be typed up on a page of school headed paper and this should be framed and put in the front hall of the school for everybody to see: staff, students and visitors. It should be signed by the school principal and the head of the board of governors to show the commitment of the top people in the school to act. All the children in the school should be told about it and it should be explained to them.

Do a Survey

The next step in the process is to carry out a survey of the current situation in the school, so that it can be improved upon. This can be done in different ways, but one good way is to find out an overview of the current travel behaviour of the staff and students, look at ways that this could be improved, and then make recommendations about what should be done.

This list of actions or recommendations will then form the basis of the School Mobility/ Transport Plan and they will be acted upon, to improve the current situation.

Exercise: Survey of School Transport

Exercise Step 1: Write a questionnaire about how the kids in your school travel.

This could have between 10 and 20 questions and could cover issues like:

- What age are you
- How far you live from the school
- Which area
- How do you get to and from school (walk, bus, cycle, car, train etc.)
- If it's a car, what kind of car
- Are you alone in the car with your parent (any other kids too)
- How long does it take
- Are there any other ways you could do it
- Have you ever tried walking and cycling
- Would you do this? Alone? With others?
- Would your parents go with you? Some of the way?
- What's the main reason you don't walk? How could this change?
- What's the main reason you don't cycle? How could this change?
- What's the main reason you don't get the bus? How could this change?

And so on. The idea is to get a picture of what is happening in your school. Get enough students to do this (all if possible, but that might be too many in a big school) so that you can get a good picture of the overall school performance.

From this you can also calculate the emissions from all the kids in your school. How could you do this? *Hint: check the rest of this Handbook and you will find out how it could be done. So much emissions from one car, how many cars are used in the school? Same for buses. Calculate the distance by the emissions per km by the numbers and you have it. It will be bigger than you think!*

Now find out how many kids there are in your city/region/country and you can calculate the CO_2 footprint for all the schools in your city/region/country.

Exercise Step 2: Assess the findings

What proportion of pupils walk / cycle / take a bus / drive with their parent / drive alone / etc? Are these proportions similar to the national statistics? If they are different, why?

Using pins with coloured heads (red = car; blue = bus; green = walk or cycle, etc.) mark the

starting point for each pupils journey on a map of the locality. Any pattern?
Take a sample of those travelling y car and mark the routes they follow on the map. Again, is there any pattern?

Exercise Step 3: Look at options

Now look at the best options being used by some of the kids. Could others do this? What would it take?
Are there safe and good alternative ways to get to school? List them.
What else would be needed – list these too (do you need better facilities for bikes? Would more public transport help? Think of other things).
Some things you can do yourselves, for others you will need the help of others. How can you go about this?

Exercise Step 4: Make recommendations

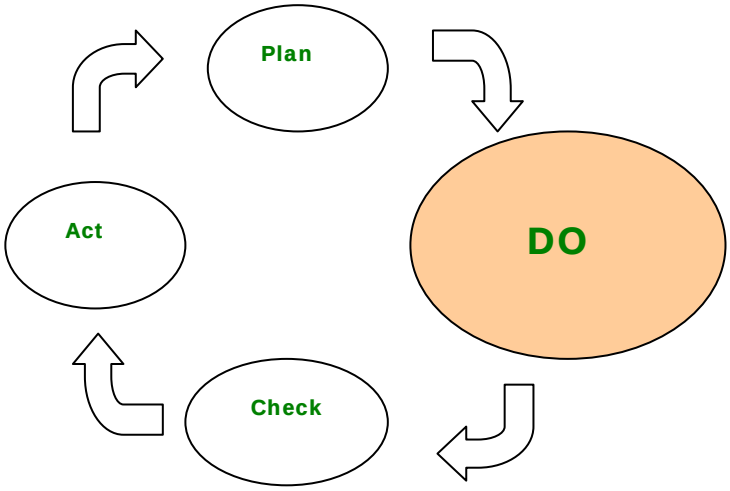
Now make a list of things that can be done to improve things. Set targets and allocate responsibilities (who will do what and when?).
Start with 5 or 6 targets for the first year and list the different actions to achieve them. Try work with those in the first year without being too ambitious.
Here is an example of on such target and some actions used to achieve it.

Target 4: More car sharing. Specifically 25% increase on current level				
Action	**Who**	**When**	**Funding/ Resource**	**Outcome**
1. Print leaflet for all students going alone in cars	Transport Team and secretary	October 09	Paper, toner	Inform all students and parents about car sharing
2. Get list of all students in same area travelling by car and issue it	Form teacher and car committee	November 09	None	Students know who they can share it
3. Talk to parents at PTA meeting	Teachers	December 09	None	Inform all parents again
4. Provide access near school for car sharers – all other cars not allowed in (except special needs)	Principal and Governing Body – caretaker to enforce	January 10	None	Encourage car sharing
5. Good transport list on project website – everybody car sharing put on list	Webmaster, transport team	October 09 onwards	None	Encourage car sharing
6. special access to bus/taxi lane for car sharers	Principal and Governing Body to lobby local authority	November 09	None	Encourage car sharing

Figure 3: list of actions and responsibilities for one target in mobility/transport plan

Stage 2: Doing the plan

There are many options of what to do in your plan. When you start don't be too ambitious – set realistic targets, especially the first year.



What the plan should contain

There are many modes of transport, but at least three main options should be considered for use or improvement by your school

A. Walk/Cycle – what are the options here, how could they be improved, do kids have bikes? Is it safe to walk? Can we organise a 'walking bus', or a "group cycle" where children walk or cycle in an organised/supervised group? How far would be viable? Are there facilities in the school? Is it safe to cycle – should there be training? Would road safety training be needed for cycling, walking? Who would give this?

What about cycle lanes, do you have these? Could the local authority provide them? Find out.

Woodford Halse Church of England Primary School, Northamptonshire[3]

Pupils and parents have developed a bike train. The train runs to a pupil-devised timetable. About 14 children use the service on a regular basis. Three or four adults accompany the train through the village. Lunchboxes and backpacks are carried in trailers. The county council has provided all riders with tabards. A team of parent volunteers co-ordinates the cycle train and it has received some sponsorship from local businesses

School run by bike

The State school Claire-vivre in Evere organises a school run by bike.

Clair-vivre is a state school with approximately 880 pupils aged between 3 and 12.

The school has 36 classrooms, spread across 3 sites and covering a distance of ± 600m. The school run by bike is being organised there for the 7th consecutive year, involving over 70 children and parents. It is an initiative by the school parents' association and has been organised and run since the outset entirely by volunteer parents.

In year one, the school located a sufficient number of parents to set up a route. Out of about forty requests the school was able to handle a dozen or so chil-

3 Dipartimento per l'istruzione del Regno Unito Andare a scuola: un piano d'azione per il 2003 – Pubblicazioni del DfES

From 2001, the Office of the Deputy Mayor in charge of Mobility in Evere agreed to hire and pay for 4 qualified supervisors and provide them with equipment. These supervisors handled an ongoing 10 return trips a week over 2 routes. In 2002, the Brussels Capital Region boosted this initiative by giving each child registered in the scheme a fluorescent top and a safety helmet.

In 2003, the Borough of Schaerbeek also made a contribution to the project by allocating 5 escorts, making it possible to open another 3 routes. In 2004, the Borough of Evere hired a further 2 escorts.

From 2003 to 2007, the town of Evere was awarded the "Golden Bicycle" town on five consecutive occasions (for having the best urban cycling policy) for the Brussels-Capital Region

Source: http://www.stib.be/temoignage-ecole-getuigenis.html?l=en&news_rid=/STIB-MIVB/INTERNET/ACTUS/STATIC/WEB_Article_1_1201795096893.xml

B. Bus/Train/Tram – what are the options here? Are there buses? If not, why not? Which routes, areas are served? How much do they cost? Find out – especially form students who use the bus. Where is the nearest train/tram stop to your school? How far is it to walk from there?

Raise awareness and let people know, especially those on the bus/train/tram routes.

Following a 'Best Value' review of transport services, North Somerset Council has put in place service level agreements with seven schools that run their own home-to-school transport services. The council provides each school with a fully maintained 17 seater minibus, covers running costs and plans routes. The buses are available during the day for school trips, swimming runs and taking children home from after school clubs. Schools employ the drivers who are support staff undertaking other duties during the school day.

Beahviour on the buses has improved as the drivers command respect - they can report any incidents immediately to the head teacher – and parents like having the same driver and vehicle every day. Best of all the scheme has saved

C. Car share - Car is the worst option to travel, but if it is necessary, at least people should share. It's also fairly easy to share. Find out which kids come from the same area and make it happen. Maybe this is being done already by some parents – learn how it works.

Some further information on car sharing here:
http://www.energysavingsecrets.co.uk/CarSharingAndClubs.html

What can be done and by whom?

Have a think about this. Different people can do different things. Ask the questions:

What I can do? Lead by example, make an effort, walk or cycle or get the bus, get my parents to car share.

What can my parents do? Get me a bike, walk some of the way to school with me, car share, or bring me to the bus.

What can the school do? More facilities? Teachers becoming involved? Staggering school times with other schools?

What can the authorities do? Safer routes? Traffic Calming near the school? Slower speed limits near the school? Better signs? Traffic lights?

Find out and figure out how it can be done.

Nottingham Emmanuel School, a voluntary aided secondary school with a wide catchment area, opened in September 2002 with 180 year 7 students. The school is in a green setting next to the river Trent in the centre of the Nottingham conurbation. The senior management team, governing body and school council are committed to sustainable travel.

Working in partnership, the school and local authorities improved routes for pedestrians and cyclists before the school opened. A roundabout on one of the main routes to the school was remodelled so that cyclists have two lanes while cars have one, and prominent signs were installed warning motorists of the cycles routes. A double lane dual carriageway leading off the roundabout has been reduced to single lane to provide a safe drop-off point for buses and cars around half a mile from the school.

The school's work with local authorities, parents and children has achieved a non-car travel rate of 81 percent – 17 percent cycling, 32 per cent walking and 32 per cent using public transport. Parents who bring their children by car are not allowed on to the school site at the start of end of the school day. Instead, they must drop them off at one of three 'drop and go' sites around half a mile from the school, from which the children walk.

Raise awareness in the school

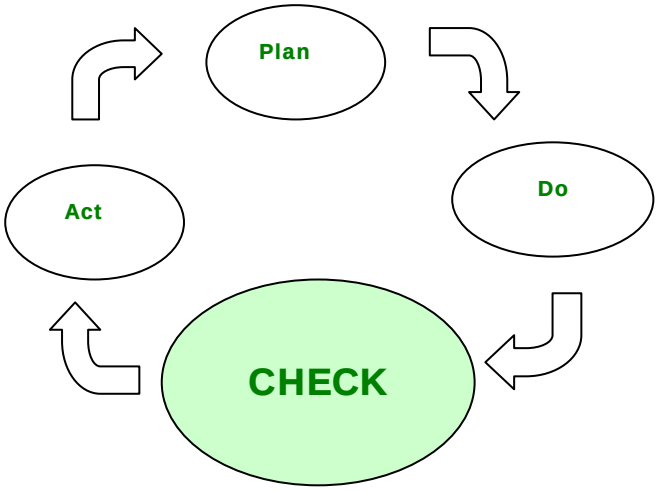
This is an important part of the process. Everybody is part of the problem so everybody is part of the solution. And everyone must be involved.

What are the best ways to do this? Check it out. A website? Posters? Talks to students? Games? Meetings? Brochures? Letters to parents? Texting? Blogs? Twitter? All the above?

Use methods already in place for other things like sports, classes, subjects etc. But be innovative too.

Stage 3: Check how it's going

After doing all the actions and all the work, now it is time to take a step back and have a look. This is important to see how well the plan is going and if the targets have been achieved.



If they have, good, make sure they are improved upon in any way possible. Make the initial target a bit harder and be more ambitious.

If not, what else can be done to achieve them. Should other targets be considered?

One obvious way to check how things are going is to carry out the same survey the following year and compare the results. This will give a very good idea of the progress happening.

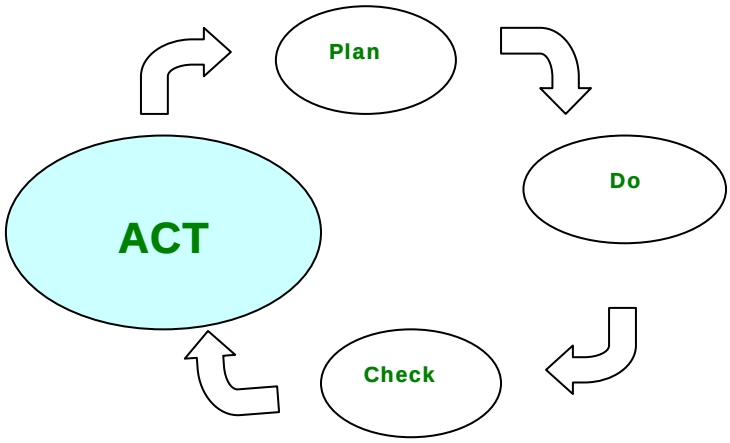
Stage 4: Act to improve it

This is the final stage in the plan.

Based upon the results of the new survey, change targets, actions, roles and responsibilities.

Perhaps more outside bodies need to be involved.

Start the whole process again for another year.



Key Points

The key points about this section are that it is both vital and possible to set up a School Mobility/Transport Plan in your school. Students are an essential part of this plan and everybody can play a part. Make a Plan, follow it and let everyone know about it and your success!

If you get involved in setting up or maintaining such a plan in your school, you can make a huge difference, for yourself, your fellow students, the school, the neighbourhood, the parents and the planet!

Intelligent Energy Europe

Web Links:

Civitas Project: http://www.civitas-initiative.org/measure_sheet.phtml?lan=en&id=575
Theatre show for teachers: http://www.quantumtheatre.co.uk/ourshows9.html
Some resources from an IEE project: http://www.schoolway.net/index.phtml?id=1073&ID1=1073&sprache=en
Green schools Ireland transport initiative.
http://www.greenschoolsireland.org/index.aspx?Site_ID=1&Item_ID=209
etream project: http://etream.team-red.net
ELTIS mobility portal: http://www.eltis.org/
EU resource on transport: http://www.managenergy.net/transport.html

Questions:

1. How many stages in a School Mobility/Transport Plan?
2. Name them.
3. How can you assess the current status of transport in your school?
4. Give three examples of transport best practice in schools.
5. What's the best way to travel to school?
6. What's the worst?
7. Who should be involved in any School Mobility/Transport Plan?