

**Teacher Reference Document**  
**Hydrogen and its role in a sustainable transport system**

**Problem – How is it possible to provide, manage and maintain an efficient and sustainable transport system.**

<b>Technology lesson</b>	Hydrogen production and its role in an efficient and sustainable transport system.
<b>Geography lesson</b>	Hydrogen production and its role in an environmentally friendly transport system.
<b>Economics lesson</b>	Hydrogen production and its role in a cost effective transport system (Including opportunities for employment).
<b>Science lesson</b>	Hydrogen production and its use in fuel cells to power vehicles.

Technologies contributing to a sustainable transport system are currently being developed or are in different stages of market take up and deployment. Here, they are clustered in four technology areas covering all modes of transport:

This list of technology areas is not exhaustive but attempts to capture where action might be needed to provide high quality mobility services to European citizens and support the competitiveness of European industry while increasing resource efficiency.

<b>Information and Communication Technologies (ICTs) (9)</b>	<b>Fuels and energy technologies (7)</b>	<b>Materials and vehicle design (3)</b>	<b>Transport infrastructure and services (7)</b>
Traffic management	Biofuels	Use of lightweight or new materials for vehicles	Multimodal freight consolidation centres
Freight route planning and optimisation	Electrification and low carbon electricity	Downsizing of vehicles	Passenger terminals
Traveller information	Hydrogen and fuel cells	Aerodynamic design of vehicles	Construction materials
Route planning and optimisation	Hybrid vehicles		New infrastructure and service concepts such as bus rapid transit (BRT), personal rapid transit (PRT),
Ticketing and payment	Incremental improvements of conventional engines		Multimodal/on-demand services
Electronic communication between vehicles and between vehicles and infrastructure	Alternative propulsion for shipping, such as wind, solar-or nuclear energy based solutions		Pipelines
Technologies related to "virtual accessibility"	Propulsion for aviation		Intermodal integration
Teleworking etc.			
e-initiatives (e-Freight, e-Maritime, etc. )			

Glossary –

<i>integration</i>	when separate things are brought together	<i>freight</i>	goods transported in bulk by truck, train, ship, or aircraft
<i>optimisation</i>	the action of making the best or most effective use of a situation or resource	<i>e-freight</i>	replaces paper documents used in the air cargo industry with standardized electronic messages and regulated data exchange
<i>e-maritime</i>	replaces paper documents used in the maritime industry with standardized electronic messages and regulated data exchange	<i>data exchange</i>	allows data to be shared between different computer programs
<i>maritime</i>	connected with the sea	<i>route</i>	a way or course taken in getting from a starting point to a destination
<i>infrastructure</i>	the basic physical and organizational structures and facilities (e.g. buildings, roads, power supplies)	<i>virtual accessibility</i>	where something can be accessed from a different location
<i>teleworking</i>	working remotely	<i>biofuels</i>	a fuel derived immediately from living matter
<i>electrification</i>	the conversion of a machine or system to the use of electrical power	<i>low carbon energy</i>	power from technologies that produce lower amounts of carbon dioxide than fossil fuel power generation
<i>sustainable</i>	maintained at a certain rate or level	<i>efficient</i>	achieving maximum productivity with minimum wasted effort or expense

<i>cost effective</i>	<i>where the benefits and usage are worth at least what is paid for them</i>	<i>employment</i>	<i>paid work</i>
<i>opportunities</i>	<i>a time or set of circumstances that makes it possible to do something</i>	<i>hydrogen</i>	<i>a chemical element consisting of one proton and one electron</i>
<i>fuel cell</i>	<i>a device that generates electricity by a chemical reaction</i>	<i>hybrid vehicles</i>	<i>a vehicle which uses two or more distinct types of power</i>
<i>incremental</i>	<i>a small change</i>	<i>conventional</i>	<i>what is generally done</i>
<i>propulsion</i>	<i>the action of driving or pushing forwards</i>	<i>wind energy</i>	<i>the process by which wind is used to generate electricity</i>
<i>solar energy</i>	<i>turns sunlight energy into electricity to power homes and businesses</i>	<i>aviation</i>	<i>air transport</i>
<i>downsizing</i>	<i>making something smaller</i>	<i>nuclear energy</i>	<i>the energy released during nuclear fission or fusion, when used to generate electricity</i>

<i>aerodynamic</i>	<i>having a shape which reduces the drag from air moving past</i>	<i>bus rapid transport (BRT)</i>	<i>a high-quality bus-based transit system that is fast, comfortable, and cost-effective</i>
<i>personal rapid transport (PRT)</i>	<i>small automated vehicles operating on a network of specially built guideways</i>	<i>multimodal</i>	<i>several different modes of activity</i>

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Revision/Definition, Question and Flash card activity ideas - (it is advisable to laminate or print onto card)

- Cut out the word and definition in one piece and fold so students can test each other or self-test for revision.
- Cut out words and definitions separately and play 'concentration' style or matching games
- Display words and definitions in one piece around the classroom or learning environment. Challenge students to work in pairs to take it in turns to go and read one, return and tell their partner who writes down the definition (it may take several trips).