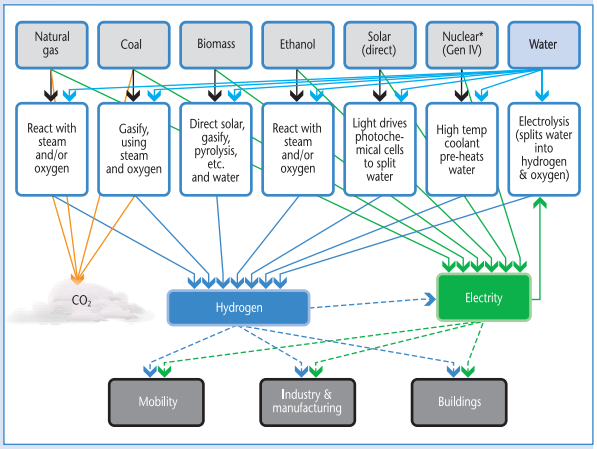
Facts and Trends
HYDROGEN

CONTEXT

- Like electricity, hydrogen is but a carrier of energy, not a source of primary energy. Generally, hydrogen would most likely complement electricity. For some uses, for example, in transport, the two carriers could compete with each other.
- Hydrogen can be produced, as electricity is, from a wide range of primary energy, including fossil fuels, renewables and nuclear. It could also be produced from electricity, although the efficiency of the electrolysis of water is prohibitively low with current technologies.

Hydrogen energy options



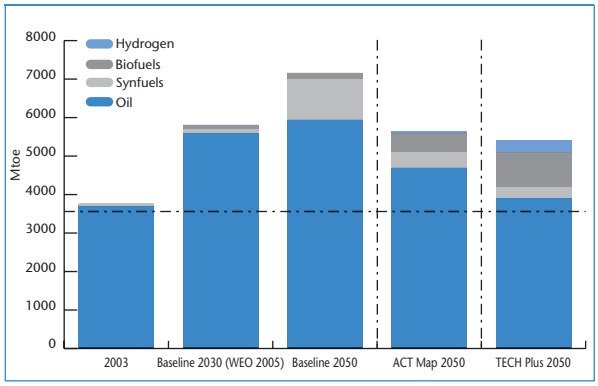
ISSUES

- At the point of use, hydrogen produces no CO_2. It emits only water vapor when used by fuel cells. In common with all combustion processes, burning hydrogen also produces NOx. Electricity produces no CO_2, water or NOx at the point of use.
- Today, hydrogen is produced mainly from natural gas without carbon capture and storage (CCS), raising issues of resource depletion, CO_2 emissions and security of supply, similar to other fossil fuels. In the future, production of hydrogen from renewables (e.g., solar photochemical cells), high temperature nuclear reactors, or coal with CCS could be a sustainable solution but will not be attainable on a wide scale before 2020 for coal and 2040 for other sources.
- The cost of hydrogen infrastructure remains very high. The challenge is to manufacture and use it cost-effectively and safely (hydrogen gas is explosive), taking care that the resultant impacts are acceptable. Hydrogen is more difficult to transport and store than fuels that are liquid or solid at room temperature.

THE WAY FORWARD

- According to the International Energy Agency's (IEA) *Energy Technology Perspectives 2006*, hydrogen will provide 6% of 2050 demand for liquid fuel and hydrogen in the TECH Plus scenario. This scenario is much more optimistic about the progress for new energy technologies than the other cases.
- Hydrogen could be a long-term solution beyond 2050, as a complementary energy carrier to electricity, if cost-effective production, transportation and end-use technologies can be developed.

World liquid fuel supply by scenario, 2003-2050



Source: International Energy Agency (IEA). *Energy Technology Perspectives*. 2006.

- Large scale production of electricity from hydrogen could be realized by the gasification of coal, with CCS used to capture CO_2. The hydrogen produced could either be burned by gas turbines or electro-chemically reacted by high temperature fuel cells (e.g., solid oxide fuel cells).
- A future carbon-free transportation system will have to involve at least one or all three end-use energy carriers that are zero-carbon: electricity, hydrogen, and/or bio-fuels.
- Vehicles are likely to provide the first new, large-scale demand for hydrogen. Reducing the adverse impacts from conventional fuel use in the transport sector is a priority. There are major challenges in mass producing the hydrogen, delivering and storing it and converting it into motive power (using either proton exchange membrane fuel cells or internal combustion engines).
- The use of hydrogen from low-carbon or zero-carbon sources in fuel-cell vehicles could practically decarbonize the transport sector in the long run. But a switch to hydrogen will require huge infrastructure investments. Although recent advances in hydrogen fuel-cell technologies have been impressive, they are still expensive.
- Hydrogen is an easier energy carrier to store than electricity, however future development of new batteries and other electricity storage technologies may overcome this weakness of electricity.
- The efficiency of the whole supply chain is a basic issue. Hydrogen will only develop if it is better than the alternative carriers; for example, in transport, if an improved battery is developed hydrogen will not be competitive.