What is clean technology?

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Introduction

A company is considered to be part of the clean technology (commonly referred to as "cleantech") **industry if it produces any knowledge-based product or service that improves operation, performance, productivity or efficiency, while reducing costs, inputs, energy consumption, waste or pollution.**

Clean technology includes various areas such as wind power, solar power, biomass, hydropower, clean fuels, engines and many devices and appliances that are now more energy efficient. It is a means to create electricity and fuels with a smaller environmental footprint.

In other words, **clean technology aims to optimize the use of natural resources – typically energy – and economic value, and in doing so, reduce ecological impact**.

Overview of clean technologies

Agribusiness

Agrichemical (or *agrochemical*) is a generic term for the various chemical products used in agriculture. In most cases, agrichemical refers to the broad range of pesticides, herbicides, and fungicides, but it may also include synthetic fertilizers, hormones and other chemical growth agents, and concentrated stores of raw animal manure.

Green manure is a type of cover crop grown primarily to add nutrients and organic matter to the soil. Green manure usually performs multiple functions that include soil improvement and soil protection.

Organic farming is a form of agriculture, which avoids or largely excludes the use of synthetic fertilizers and pesticides, plant growth regulators, and livestock feed additives. As far as possible, organic farmers rely on crop rotation, crop residues, animal manures and mechanical cultivation to maintain soil productivity and tilth, to supply plant nutrients, and to control weeds, insects and other pests.

Air quality management

Air pollution control aims to reducing emissions of air pollutants into the atmosphere. Many technologies are applied toward this purpose and the technology for the collection and treatment of pollutants such as dust collector and exhaust gas desulphurization and denitrification equipment.

Carbon capture and storage (or *carbon capture and sequestration*) technologies involve the separation of CO_2 from the exhaust stream from the burning of fossil fuels, and its long-term storage, either in depleted oil and gas fields, under the ocean or elsewhere.

Clean coal is the name attributed to coal chemically washed of minerals and impurities, sometimes gasified, burned and the resulting flue gases treated with steam, with the purpose of almost completely eradicating sulphur dioxide and re-burned so as to make the carbon dioxide in the flue gas economically recoverable.

Ecoforestry

Anaerobic digestion is the harnessed and contained, naturally occurring process of anaerobic decomposition. An anaerobic digester is an industrial system that harnesses this natural process to treat waste, produce biogas that can be used to power electricity generators, provide heat and produce soil-improving material.

Composting is the process of producing compost through aerobic decomposition of biodegradable organic matter. The decomposition is performed primarily by aerobes, although larger creatures such as ants, nematodes, and oligochaete worms also contribute. This decomposition occurs naturally in all but the most hostile environments, such as within landfills or in extremely arid deserts, which prevent the microbes and other decomposers from thriving.

Remediation generally means providing a remedy. In this context, the term refers to the removal of pollution or contaminants from environmental media such as soil, groundwater, sediment, or surface water for the general protection of human health and the environment or from a brownfield site intended for redevelopment.

Electric vehicles

A **hydrogen vehicle** is a vehicle, such as an automobile or aircraft, which uses hydrogen as its primary source of power for locomotion. These vehicles generally use the hydrogen in one of two methods: combustion or fuel cell conversion. In combustion, the hydrogen is "burned" in engines in fundamentally the same method as traditional gasoline cars. In fuel-cell conversion, the hydrogen is turned into electricity through fuel cells, which then power electric motors.

A **plug-in hybrid electric vehicle** is a hybrid car, which has additional battery capacity and the ability to be recharged from an external electrical outlet. The vehicle can be used for short trips of moderate speed without needing the internal combustion engine component of the vehicle, thereby saving fuel costs.

Energy-related technologies

Advanced energy-related materials. Materials development for improved functional, physical and mechanical properties sustainable under severe environments is a key to make real use of advanced energy systems.

Cogeneration (sometimes referred to as ***combined heat and power*** or *CHP*) is the use of a heat engine or a power station to simultaneously generate both electricity and useful heat. Conventional power plants emit the heat created as a byproduct of electricity generation into the environment through cooling towers, as flue gas, or by other means. CHP captures the byproduct heat for domestic or industrial heating purposes, either very close to the plant, or – especially in Scandinavia and Eastern Europe – for distribution through pipes to heat local housing (district heating).

Distributed generation is a new trend in the generation of heat and electrical power. The *Distributed Energy Resources* concept permits "consumers" who are generating heat or electricity for their own needs (like in hydrogen stations and micro-generation) to send surplus electrical power back into the power grid or share excess heat via a distributed heating grid.

Energy intelligence is related to the technical, economic, and political capabilities and programs of countries to engage in development, utilization, and commerce of basic and advanced energy technologies. This includes the location and extent of foreign energy resources and their allocation; foreign government energy policies, plans, and programs; new and improved foreign energy supply, demand, production, distribution, and utilization.

Generation efficiency technologies help to improve the generating efficiency or reduction in greenhouse gas emissions of existing power generation equipment. Important technologies in these technologies include breakthroughs in motor or generator design, as well as software, sensor and control technologies, which result in step-change improvement.

The term **Passive house** (or ***Passivhaus*** in German) refers to the rigorous, voluntary, *Passivhaus* standard for energy use in buildings. It results in ultra-low energy buildings that require little energy for space heating.

Power efficiency and demand reduction approaches may not strictly be part of the renewable energy and energy technology industry. This sector covers a range of technologies that reduce the use of energy in retail and commercial buildings, including advanced insulation, building components and intelligent systems for managing power consumption. It also includes technologies focused on reducing the use of energy in a wide variety of industrial processes.

Power storage. Many renewable energy and emerging energy technologies are either intermittent, or have response curves that are unable to follow the dynamic demands that will be put on them when deployed. Batteries and other energy storage technologies such as mechanical technologies like flywheels (that are straight potential replacements for batteries) therefore become key enablers for any shift to these technologies.

Smart energy distribution includes a number of technologies that target improvements from the forecasting of renewable resource availability, through innovative IT solutions and software to balance supply and demand or find grid faults, to technology that allows peak shifting or intelligent meter reading.

Super insulation is an approach to building design, construction, and retrofitting. A super insulated house is intended to be heated predominantly by intrinsic heat sources (waste heat generated by appliances and the body heat of the occupants), without passive solar or large amounts of thermal mass, and with very small amounts of backup heat. This has been demonstrated to work in very cold climates but requires close attention to construction details in addition to the insulation.

Hydrogen technologies

Bio-hydrogen production is done via biological processes or by using biomass. It can also involve an element of anaerobic digestion, where the methane from biogas is converted through steam reforming into hydrogen.

Fuel cells are electrochemical energy conversion devices. A fuel cell produces electricity from external supplies of fuel (on the anode side) and oxidant (on the cathode side). These react in the presence of an electrolyte. Generally, the reactants flow in and reaction products flow out while the electrolyte remains in the cell. Fuel cells can operate virtually continuously as long as the necessary flows are maintained. Fuel cells have the potential to replace the internal combustion engine in vehicles and provide power in stationary and portable power applications because they are energy-efficient, clean, and fuel-flexible. Hydrogen or any hydrogen-rich fuel can be used by this emerging technology.

Hydrogen delivery is important for a hydrogen economy, which requires an infrastructure to deliver hydrogen from where it is produced to the point of end-use, such as a dispenser at a refueling station or stationary power site. Infrastructure includes the pipelines, trucks, storage facilities, compressors, and dispensers involved in the process of delivering fuel.

Hydrogen production is commonly produced from hydrocarbon fossil fuels via a chemical path. Unfortunately such methods emit carbon dioxide. Hydrogen may also be extracted from water via biological production in an algae bioreactor, or using huge amounts of electricity (by electrolysis) or heat (by thermolysis).

Hydrogen storage is the main technological problem of a viable hydrogen economy. Some attention has been given to the role of hydrogen to provide grid energy storage for unpredictable energy sources, like wind power, but most research into hydrogen storage is focused on storing hydrogen in a lightweight, compact manner for mobile applications.

Hydrogen vehicles. See also: *Electric vehicles*.

Liquid hydrogen is hydrogen in the liquid state and is typically used as a practical form of storing hydrogen. As in any gas, storing it as liquid takes less space than storing it as a gas at normal temperature and pressure. Once liquefied it can be maintained as a liquid in pressurized and thermally insulated containers. Liquefied hydrogen can be used as a fuel in an internal combustion engine. Various concept hydrogen vehicles have been built using this form of hydrogen.

Renewable energy sources

Renewable energy (or *non-conventional energy*) is defined as energy derived from resources that are regenerative or for all practical purposes cannot be depleted.

- Atmospheric Cold Megawatts
- Biomass and biofuels (see also: *Renewable fuels*)
- Blue energy
- Fuel cells (see also: *Hydrogen technologies*)
- Geothermal energy
- Hydro energy
    - Hydroelectric power
    - Mini-hydroelectric power
    - Ocean thermal energy conversion (OTEC)
    - Tidal power/Marine current power
    - Wave power
- Solar energy
    - High efficiency solar cells
    - Photovoltaic panels production
    - Solar chemicals
    - Solar electric power
    - Solar furnace production
    - Solar heating
    - Solar power towers
- Waste-to-energy conversion (see also: *Water management*)
    - Agricultural waste
    - Anaerobic digestion (see also: *Agribusiness*)
    - Industrial solid waste
    - Landfill gas
    - Municipal solid waste
    - Wood/Wood waste
- Wind energy
- Thermal electric power

For more detailed information on electricity generation, you may consult the research report published in January 2007 by Mora Associates Ltd. "Overview of main electricity generation techniques".

Renewable fuels

Biodiesel refers to a diesel-equivalent, processed fuel derived from biological sources, which can be used in unmodified diesel-engined vehicles. See also: *Vegetable oil*.

Biodiesel production from algae has emerged as one of the most promising sources for biodiesel for two main reasons. The yields of oil from algae are orders of magnitude higher than those for traditional oilseeds, and algae can grow in places away from the farmlands and forests, thus minimizing the damages caused to the eco- and food chain systems.

Bioethanol (or *ethanol fuel*) is an alternative to gasoline. It can be combined with gasoline in any concentration up to pure ethanol (sometimes referred to as *E100*). Anhydrous ethanol, that is, ethanol with at most 1% water, can be blended with gasoline in varying quantities to reduce consumption of petroleum fuels, as well as to reduce air pollution. In the United States, ethanol capabilities vary widely and most spark-ignited gasoline style engines will operate well with mixtures of 10% ethanol (sometimes referred to as *E10*).

Biofuel is any fuel that is derived from biomass – recently living organisms or their metabolic byproducts, such as manure from cows. It is a renewable energy source, unlike other natural resources such as petroleum, coal, and nuclear fuels.

Biogas typically refers to a biofuel gas produced by the anaerobic digestion or fermentation of organic matter including manure, sewage sludge, municipal solid waste, biodegradable waste or any other biodegradable feedstock, under anaerobic conditions. Biogas is comprised primarily of methane and carbon dioxide.

Biomass refers to living and recently living biological material, which can be used as fuel or for industrial production. Most commonly biomass refers to plant matter grown for use as biofuel, but also includes plant or animal matter used for production of fibers, chemicals or heat. Biomass may also include biodegradable wastes that can be burnt as fuel. It excludes organic material, which has been transformed by geological processes into substances such as coal or petroleum.

Biomass-to-Liquid (BtL) **conversion** is a multi-step process to produce liquid fuels out of biomass. According to a study released by the German Energy Agency (Deutsche Energie-Agentur GmbH) in December 2006 biomass-to-liquids are technically feasible and one of the most promising options for future fuels.

Butanol may be used as a fuel in an internal combustion engine. It is in several ways more similar to gasoline than ethanol is. Butanol has been demonstrated to work in some vehicles designed for use with gasoline without any modification. It can be produced from biomass as well as fossil fuels. Some call this biofuel *biobutanol* to reflect its origin, although it has the same chemical properties as butanol produced from petroleum.

The **Emissions-to-Biofuels™** process harnesses photosynthesis to grow algae, capture CO_2 and produce high-energy biomass. The process serves as a flexible platform for retrofitting fossil-fired power plants and other anthropogenic sources of carbon dioxide. Using commercially available technology, the algae can be economically converted to solid fuel, methane, or liquid transportation fuels such as biodiesel and ethanol.
Emissions-to-Biofuels is a registered trademark of GreenFuel Technologies Corporation.

Vegetable oil (also called *Waste Vegetable Oil*) has similar fuel properties to diesel fuel, except for higher viscosity and lower oxidative stability. If these differences can be overcome, vegetable oil may substitute for diesel fuel, most significantly as engine fuel or home heating oil.

Wood fuel can be used to generate electric power and useful thermal output. Wood for use as fuel comes from a wide variety of sources: private land clearing, silviculture, urban tree and landscape residues. A major wood resource is waste wood, which includes manufacturing and wood processing wastes, as well as construction and demolition debris.

Waste management

Automotive recycling is an industry dedicated to the efficient removal and reuse of automotive parts, and the safe disposal of inoperable motor vehicles.

Chemical packing is the proper handling, packaging, transportation and disposal of hazardous chemicals.

Municipal solid waste is a waste type that includes predominantly household waste (domestic waste) with sometimes the addition of commercial wastes collected by a municipality within a given area. They are in either solid or semisolid form and generally exclude industrial hazardous wastes.

Recycling is the reprocessing of materials into new products. Recycling prevents useful material resources being wasted, reduces the consumption of raw materials and reduces energy usage, and hence greenhouse gas emissions, compared to virgin production.

Waste management is the collection, transport, processing (waste treatment), recycling or disposal of waste materials, usually ones produced by human activity, in an effort to reduce their effect on human health or local aesthetics or amenity. A sub-focus in recent decades has been to reduce waste materials' effect on the natural world and the environment and to recover resources from them.

Water management

Reclaimed water is wastewater (sewage) that has been treated and purified for reuse, rather than discharged into a body of water. It is frequently used to irrigate golf courses and parks, fill decorative fountains, and fight fires. It can also be used to irrigate crops, as long as they will be peeled or boiled before human consumption.

Sewage treatment, or domestic wastewater treatment, is the process of removing contaminants from sewage. It includes physical, chemical and biological processes to remove physical, chemical and biological contaminants. Its objective is to produce a waste-stream (or treated effluent) and a solid waste or sludge also suitable for discharge or reuse back into the environment. This material is often inadvertently contaminated with toxic organic and inorganic compounds.

Water conservation (or *water-saving technology*) refers to reducing use of fresh water, through technological or social methods. The goals of water conservation efforts include: sustainability (to ensure availability for future generations, the withdrawal of fresh water from an ecosystem should not exceed its natural replacement rate), energy conservation (water pumping, delivery and wastewater treatment facilities consume a significant amount of energy) and habitat conservation (minimizing human water use helps to preserve fresh water habitats for local wildlife and migrating waterfowl, as well as reducing the need to build new dams and other water diversion infrastructure).

Water purification (or *water recovery*) is the removal of contaminants from raw water to produce drinking water that is pure enough for human consumption or for industrial use. Substances that are removed during the process include parasites, bacteria, algae, viruses, fungi, minerals (including toxic metals such as lead, copper, etc.), and man-made chemical pollutants. Many contaminants can be dangerous – but depending on the quality standards, others are removed to improve the water's smell, taste, and appearance. A small amount of disinfectant is usually intentionally left in the water at the end of the treatment process to reduce the risk of re-contamination in the distribution system.

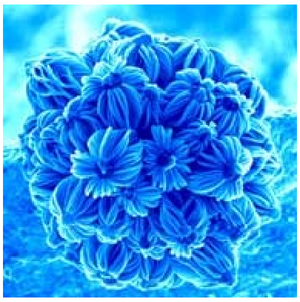
Nanotechnology applications

Although nanotechnology is not strictly part of the cleantech industry, we are going to analyze this field of applied science, since materials sciences have the potential for significant breakthroughs in a number of clean technology areas.

Introduction

Nanotechnology (commonly referred to as "nanotech") **is a field of applied science and technology** covering a broad range of topics. **The main unifying theme is the control of matter on a scale smaller than one micrometer** (nanoscale)**, as well as the fabrication of devices on this same length scale**.

Despite the apparent simplicity of this definition, nanotechnology actually encompasses diverse lines of inquiry. It cuts across many disciplines, including colloidal science, chemistry, applied physics and biology. In fact, nanotechnology could variously be seen as an extension of existing sciences into the nanoscale.



A 3-D nanomaterial grown from tiny droplets of a liquid metal on a silicon surface. CGhim Wei Ho/Mark Welland, Nanostructure Center, University of Cambridge

Environmental issues

Regulatory bodies such as the Environmental Protection Agency and the Food and Drug Administration in the United States or the Health & Consumer Protection Directorate of the European Commission **have started dealing with the potential risks posed by nanoparticles**. So far, neither engineered nanoparticles nor the products and materials that contain them are subject to any special regulation regarding production, handling or labeling.

Not enough data exists to know for sure if nanoparticles could have undesirable effects on the environment. Two areas are relevant here:

- In free form nanoparticles can be released in the air or water during production or as waste byproduct of production, and ultimately accumulate in the soil, water or plant life.
- In fixed form, where they are part of a manufactured substance or product, they will ultimately have to be recycled or disposed of as waste. It is not known yet whether certain nanoparticles will constitute a completely new class of non-biodegradable pollutant. In case they do, it is not known how such pollutants could be removed from air or water because most traditional filters are not suitable for such tasks.

To properly assess the health hazards of engineered nanoparticles the whole life cycle of these particles needs to be evaluated, including their fabrication, storage and distribution, application and potential abuse, and disposal. The impact on humans or the environment may vary at different stages of the life cycle.

Regulatory bodies in the United States as well as in the EU have concluded that nanoparticles form the potential for an entirely new risk and that it is necessary to carry out an extensive analysis of the risk. The challenge for regulators is whether a matrix can be developed which would identify nanoparticles and more complex nanoformulations which are likely to have special toxicological properties or whether it is more reasonable for each particle or formulation to be tested separately.

Application: Advanced materials

Nanomaterials

Nanomaterials are interesting because they can often have very different chemical and biological properties than their normal-sized counterparts. Currently some companies are developing antimicrobial coatings, pollution absorption methods, and other potentially clean technologies using nanoscale materials.

Advanced solid-state lighting

Solid-state lighting holds promise for dramatic energy savings and has been described by the United States Department of Energy as a pivotal emerging technology that promises to alter lighting in the future. It is the first new lighting technology to emerge in over 40 years and, with its energy efficiencies and cost savings, has the potential to be a very disruptive technology in the marketplace as well.

Sensor technology

Another potential application is sensitive-sensor technology, which involves the use of carbon nanotubes, nanowires, and micro- and nanoscale cantilevers to detect contaminants. These sensors could effectively and affordably protect against contamination of water supplies.

Application: Photovoltaic panels

Nanostructured solar cells

Silicon-based solar cells is at the heart of the industry's current rapid growth, but nanotech-based “thin-film” photovoltaics promise to deliver higher efficiencies than silicon wafer-based solar cells at much lower cost.

For example, GreatCell of Switzerland, a spin-off from the Ecole Polytechnique Fédérale de Lausanne, now offers small-scale production of dye-sensitized solar cells (DSCs) in collaboration with STI of Australia. The active components in these cells are nanoparticles of titanium oxide – a semiconductor with a large bandgap of 3-3.2 eV – formed into a thin layer on a glass substrate. Incident light excites organic dye molecules absorbed onto the titanium sites in the nanoporous film. This causes electrons to be released into the semiconductor layer to generate an electrical current.

According to a new report, *Nanomaterials for Next-Generation Energy Sources*, these DSC modules convert about 7% of the incident solar energy into electricity. That compares with up to 18% for conventional solar panels based on costly monocrystalline silicon. However, the DSC modules are able to absorb sunlight over a wide range of angles, which means that a module installed on a building facade can generate as much energy as a silicon version that is 12% efficient.

Application: Water management

Water decontamination

Nanotech can also help tackle decontamination of groundwater from industrial and natural sources. Semi-permeable membranes can act as a molecular sieve, allowing water to pass through while rejecting impurities such as viruses, spores, bacteria, heavy metals, and other health threats. Nanoscale filters will be able to actively screen out items matching certain criteria.

Water desalination

Desalination is an area, where nanotechnology could cut costs, save energy, and improve the lifetime and efficiency of membranes. Today, seawater is most often turned into drinking water through a 40-year-old process called reverse osmosis, which is slow, expensive, and energy intensive. If nanotechnology can make the process cheaper and more efficient, it could have a large impact.

Water purification

Then there are nanofibers, which are already used in many industrial applications. NASA is evaluating ceramic nanofibers for water purification in space because of their ability to increase throughput and reduce clogging compared to traditional filtration methods.

Derivative technologies

Carbon markets

The ratification of the Kyoto Protocol gave a boost to the *European Emissions Trading Scheme* (abbreviated EU-ETS). Elsewhere in the world other carbon markets are emerging, whether as a result of regulation or for voluntary trading. The carbon market is not part of the clean energy industry, but will significantly influence its development.

Services & Support

The rapid growth of the cleantech industry will require the development of a complete sector of service companies dedicated to serving the needs of technology and equipment suppliers, owners of renewable energy and biofuels assets, etc. These companies include providers of information and research, specialized clean tech financial services companies, consultants and the like.

References

- Bioconversion of biomass to mixed alcohol fuels - Wikipedia, the free encyclopedia. Retrieved on January 27th, 2007 from http://en.wikipedia.org/wiki/Bioconversion_of_biomass_to_mixed_alcohol_fuels

- Biological hydrogen production (Algae) - Wikipedia, the free encyclopedia. Retrieved on January 27th, 2007 from http://en.wikipedia.org/wiki/Biological_hydrogen_production

- Biomass to liquid - Wikipedia, the free encyclopedia. Retrieved on January 27th, 2007 from http://en.wikipedia.org/wiki/Biomass_to_liquid

- Category: Sustainable technologies - Wikipedia, the free encyclopedia. Retrieved on January 27th, 2007 from http://en.wikipedia.org/wiki/Category:Sustainable_technologies

- Clean technology - Wikipedia, the free encyclopedia. Retrieved on January 27th, 2007 from http://en.wikipedia.org/wiki/Clean_technology

- Cleantech Investing – A news and commentary blog for those interested in venture capital in clean technologies. Retrieved on January 28th, 2007 from http://cleantechvc.blogspot.com

- Deutsche Energie-Agentur GmbH (dena): BtL-Realisierungsstudie (13.12.2006). Retrieved on January 27th, 2007 from http://www.dena.de/de/themen/thema-mobil/pressemitteilungen/pressemeldung/btl-realisierungsstudie/

- Directory: Biodiesel from Algae Oil – PESWiki. Retrieved on January 27th, 2007 from http://peswiki.com/index.php/Directory:Biodiesel_from_Algae_Oil

- Energy Information Administration: Wood/Wood Waste. Retrieved on January 27th, 2007 from http://www.eia.doe.gov/cneaf/solar.renewables/page/wood/wood.html

- Energy start-ups bank on nanotechnology (May 2005) - News - nanotechweb.org. Retrieved on January 27th, 2007 from http://nanotechweb.org/articles/news/4/5/2/1

- Government of Japan – Ministry of the Environment: Air Pollution Control Technology Manual (page 145). Retrieved on January 27th, 2007 from http://www.env.go.jp/earth/coop/coop/materials/01-apctme/contents.html

- GreenFuel Technologies Corporation: Emissions to Biofuels™ Technology. Retrieved on January 27th, 2007 from http://www.greenfuelonline.com/technology.htm

- Guide to Discovery: Hydrogen Storage. Retrieved on January 27th, 2007 from http://www.csa.com/discoveryguides/hydrogen/overview.php

- Institute of Advanced Energy: Advanced Energy Materials Research Section. Retrieved on January 27th, 2007 from http://www.iae.kyoto-u.ac.jp/gaiyou/AEM.html

- New Energy Finance: Renewable Energy & Bioenergy Sectors. Retrieved on January 27th, 2007 from http://www.newenergyfinance.com/NEF/HTML/Sectors.html

- RED HERRING | Water - The New Oil: Nanotech (August 15, 2005). Retrieved on January 27th, 2007 from http://www.redherring.com/article.aspx?a=13220

- Renewable energy - Wikipedia, the free encyclopedia. Retrieved on January 27th, 2007 from http://en.wikipedia.org/wiki/Renewable_energy

- Solid-state lighting – Wikipedia, the free encyclopedia. Retrieved on January 28th, 2007, from http://en.wikipedia.org/w/index.php?title=Solid-state_lighting&oldid=92063883

- U.S. Department of Energy: Alternative Fuels Data Center: P-Series. Retrieved on January 27th, 2007 from http://www.eere.energy.gov/afdc/altfuel/p-series.html

- U.S. Department of Energy: Hydrogen, Fuel Cells and Infrastructure Technologies Program: Hydrogen Delivery. Retrieved on January 28th, 2007 from http://www1.eere.energy.gov/hydrogenandfuelcells/delivery/

- Vegetable oil used as fuel - Wikipedia, the free encyclopedia. Retrieved on January 27th, 2007 from http://en.wikipedia.org/wiki/Straight_vegetable_oil

- Water conservation - Wikipedia, the free encyclopedia. Retrieved on January 27th, 2007 from http://en.wikipedia.org/wiki/Water_conservation

