# Innovative process technologies for environmental and climate protection

**Increasingly strategic lines of business for our Engineering Division include the latest process technologies to efficiently produce biofuels from biomass and hydrogen from regenerative energy sources.**

## Biofuels

Bioethanol is created by breaking down or fermenting biomass substances such as wheat and maize straw, grasses and wood. The drive to refine biotechnologies that turn renewable raw materials into ethanol is inspired by the prospect of a sustainable, CO -neutral liquid fuel. Dwindling crude oil resources and rising oil prices provide added momentum. As a matter of priority, Linde is determined to push bioethanol production technologies that avoid any conflict with food production, especially in emerging economies. In contrast to 1G biofuels, 2G biofuels safeguard food supplies by exclusively using plant waste from food production. At the end of 2007, we entered into an exclusive cooperation agreement with Süd-Chemie AG, a world-leading manufacturer of catalyst and adsorbent materials, to develop and market plants for the production of 2G biofuels.
Industrial-scale gasification of biomass is also suited to a wide variety of regenerative raw materials including straw, organic waste and wood by-products. Our Engineering Division is a trusted partner for many companies involved in this process chain.

See Corporate Responsibility at www.linde.com for more information.

## Biogas

From a chemical perspective, biogas is a by-product of fermentation. Its most valuable energy-rich component is methane. Methane is twenty-five times more damaging to the earth's atmosphere than carbon dioxide, making landfill sites the world's largest man-made sources of methane if the gas is not captured before escaping into the atmosphere.
The Linde Group has partnered with US company Waste Management Inc. to build the world's largest facility for converting landfill gas into environmentally sound biogas in Livermore, California. The liquefied biogas is set to fuel 300 of Waste Management Inc.'s refuse collection trucks in California. Under the joint venture, Linde is responsible for engineering and building the plant, as well as for purifying and subsequently liquefying the landfill gas.
But biofuels alone are not enough. It must be possible to refuel vehicles with compressed biogas and natural gas efficiently and cost-effectively. To achieve this, Linde developed the iKompressor™ system. Instead of solid, metal pistons, this refuelling innovation uses ionic liquids to compress gases at an almost constant (isothermal) temperature.
iKompressor™ refuelling systems cut energy costs and maintenance effort without compromising on reliability. This means that operators of compressed natural gas and biogas refuelling stations will be able to offer their customers with particularly cost-effective fuel in future.

## Hydrogen from regenerative sources of energy

Hydrogen is widely regarded as the energy carrier of the future. And once a way can be found to produce "green" hydrogen from regenerative energy sources on a commercial scale, this energy carrier will be in a league of its own.
The largest hydrogen plant engineer in the world and Europe's leading gases company, Linde has been supplying hydrogen for the most varied of applications in the chemical, petrochemical and food industry, for example, since 1910.

Now, thanks to a range of hydrogen breakthroughs, including innovative refuelling and supply systems, Linde is also positioned as a defining player in the move to establish hydrogen as one of tomorrow's strategic energy carriers.
Hydrogen can be generated from both fossil fuels and renewable energy sources. Primary renewable sources include the sun, water and wind. Hydrogen can, however, also be made directly by microorganisms such as microalgae.
The biomass process chain involves first turning the raw material into a hydrogenous gas which can then be used to generate hydrogen. Linde continues to research ways of producing hydrogen from biogenic raw materials that are readily available, do not compromise food supplies and are already sophisticated enough to generate commercially viable hydrogen. Following extensive studies to explore suitable raw materials and in-depth laboratory tests, work is now underway on a landmark demo plant at our Leuna site. This facility will pyroreform glycerol to create a hydrogen-rich synthesis gas.