THE LINDE GROUP

Raising the sustainability stakes:

Hydrogen balances personal mobility with climate protection

As an energy carrier, hydrogen (H_2) has the potential to fundamentally change the way we source energy for a whole range of stationary, mobile and transportation applications. It is also set to play a key role in securing future energy supplies as it can be used to directly store energy captured from fluctuating regenerative sources. This energy can then be efficiently converted back to electricity, for example, via fuel cells. Furthermore, hydrogen does not generate harmful emissions when used to power vehicles. The closed 'hydrogen-water-hydrogen' cycle is paving the way for a sustainable energy economy. Hydrogen technology also has the capacity to significantly reduce dependency on single energy sources and imports. The Linde Group is a pioneer in the development of forward-looking hydrogen technologies. The company's expertise covers the entire value chain, from generation and liquefaction through transportation solutions to fuelling of hydrogen-powered vehicles.

Crude oil's reign as the dominant source of energy for road transport is slowly coming to an end. Today's global, mobile society is facing major challenges in light of rising energy consumption, dwindling resources and increasing levels of harmful emissions. In order to meet the 80-percent CO_2 reduction target set by the G8 in September 2009, emissions from the transport sector alone must fall 95 percent by 2050. This cannot be done with conventional methods and technologies. And so the focus must shift to new, zero-carbon energy sources and CO_2-friendly mobility. Renewable energies are readily available, but not always at the right time or place. Hydrogen is an energy carrier that can be used to store regenerative energy efficiently. Effective energy converters such as fuel cells can then be used to release the stored energy whenever it is needed, thus balancing out peaks and troughs in supply and demand. Water vapour is the only emission produced by hydrogen-powered cars – just one of the numerous features that makes hydrogen the most environmentally sound fuel to date.

Hydrogen has been deployed as an industrial gas for over one hundred years and large volumes are used across the widest range of applications every day. Hydrogen is also set to play a defining role in the much-publicised third, 'green' industrial revolution. It is the most commonly occurring element in nature and – unlike fossil fuels such as crude oil or natural gas – it will never run out. Like electricity, hydrogen is an energy carrier – not a source of energy. It therefore has to be produced. Yet hydrogen offers several key benefits that raise its potential to replace fossil fuels, particularly in the transportation sector. Stored hydrogen, for example, can be used directly as a fuel or to generate electricity. Hydrogen is the only alternative fuel that promises regenerative, sustainable everyday mobility choices, sufficient vehicle range and fast fuelling windows. The Linde Group is a pioneer in the development of forward-looking hydrogen technologies. The company's expertise covers the entire value chain, from generation and liquefaction through transportation to fuelling of hydrogen powered vehicles. Decades of research, development and testing have shown that hydrogen technology is a workable, economically viable alternative suited to mass deployment. There is still a long way to go before broadscale commercialisation. Nevertheless, today's conventional method of using steam reforming to generate hydrogen from natural gas already reduces carbon dioxide emissions along the entire value chain, from well to wheel. Hydrogen-powered vehicles emit up to thirty percent less CO_2 than modern diesel cars.

In terms of environmental and climate protection, hydrogen-powered transportation makes most sense when hydrogen is produced using regenerative energy sources. Linde has therefore set itself the long-term goal of producing green hydrogen from regenerative energy sources such as the sun and wind as well as from renewable raw materials and biological waste. The list of possible production chains is long and includes, for example, sourcing hydrogen from glycerine, a by-product of biodiesel production.

One of the key steps in building a viable hydrogen infrastructure entails equipping public transport fleets and local vehicle pools with hydrogen drivetrains. Central hydrogen clusters could accelerate commercialisation and quickly bring down the cost of zero-emission mobility in urban areas. Key market players have already come together to advance the market breakthrough of hydrogen and fuel-cell technologies. The automobile industry, for example, has pledged that the first series-produced fuel-cell cars will be on German roads by 2015. And drivers of these vehicles will be able to refuel at an established network of hydrogen fuelling stations. More and more stations will be added to the network as the number of hydrogen-powered cars increases. There are currently around 200 hydrogen fuelling stations across the globe. Germany alone already has almost thirty stations, some of which are open to the public, making Germany the hydrogen pioneer in Europe. In September 2009, Linde joined forces with Daimler, EnBW, OMV, Shell, Total, Vattenfall and the National Organisation for Hydrogen and Fuel Cell Technology (NOW) to found 'H_2 Mobility'. In a move to accelerate expansion of the existing infrastructure, Linde and Daimler agreed in June 2011 to construct twenty additional hydrogen fuelling stations over the next three years. These initiatives and the commitments from car manufacturers are significant breakthroughs. Public hydrogen fuelling stations can only be economically viable if there is a sufficient number of hydrogen-powered cars to use them. By aligning series production of fuel-cell vehicles with the gradual expansion of the enabling hydrogen infrastructure, industry can finally resolve the 'chicken or egg' dilemma that currently dogs the advancement of hydrogen-powered mobility. Hydrogen cars from Mercedes Benz have already proven the robust technical maturity of fuel-cell powered electric cars during a unique endurance tour known as the F-Cell World Drive. Throughout the tour, Linde was the exclusive supply partner for H_2.

Hydrogen's value as an eco-friendly energy carrier extends far beyond public and private transportation. It can also reduce the carbon footprint of in-house logistics processes for large industrial enterprises. In the US, for example, The Linde Group equipped the forklift fleet at BMW's Spartanburg plant in South Carolina with hydrogen drivetrain technology. This part of BMW's internal logistics operations now runs on zero emissions.

Many industry players – and not just Linde – are challenged to systematically lower investment and deployment costs along the entire value chain of hydrogen fuel. The Group is stepping up to the plate with its extensive know-how in the field of hydrogen generation and distribution as well as its innovative fuelling technologies such as high-pressure cryogenic pumps and ionic compressors. These new products and processes enable vehicles to be refuelled very quickly. They also make fuelling stations easier to maintain and help further reduce the cost of building and running stations.