



Ambition counts.  
The Linde Annual 2007

LeadIng.

  
THE LINDE GROUP

# Linde financial highlights

in € million	January to December 2007	2006	Change
<b>Share</b>			
Closing price	€ 90.45	78.26	15.6 %
Year high	€ 91.75	79.56	15.3 %
Year low	€ 75.26	56.32	33.6 %
Market capitalisation	15,046	12,579	19.6 %
<b>Earnings per share<sup>1</sup></b>			
Earnings per share	€ 5.02	4.66	7.7 %
Earnings per share	€ 5.87	13.30	-55.9 %
Number of shares outstanding (in 000s)	166,347	160,736	3.5 %
<b>Sales<sup>2</sup></b>			
Sales - comparable <sup>3</sup>	12,306	8,113	51.7 %
	12,306	10,803	13.9 %
<b>Operating profit<sup>2,4</sup></b>			
Operating profit - comparable <sup>3,4</sup>	2,424	1,586	52.8 %
	2,424	2,053	18.1 %
<b>EBIT before amortisation of fair value adjustments and non-recurring items</b>			
	1,591	989	60.9 %
<b>Earnings after taxes on income</b>			
	1,013	1,856	-45.4 %
<b>Number of employees<sup>2</sup></b>			
	50,485	51,038	-1.1 %
<b>Gases Division - comparable<sup>3</sup></b>			
Sales	9,209	8,421	9.4 %
Operating profit	2,314	2,035	13.7 %
<b>Engineering Division - comparable<sup>3</sup></b>			
Sales	2,750	1,958	40.4 %
Operating profit	240	172	39.5 %

<sup>1</sup> Adjusted for the effects of the purchase price allocation and non-recurring items.

<sup>2</sup> Continuing operations of The Linde Group: i.e. excluding KION and BOC Edwards Equipment.  
In 2006, other BOC companies included for four months from September 2006.

<sup>3</sup> Prior year figures including twelve months of BOC.

<sup>4</sup> EBITDA before non-recurring items including share of income from associates and joint ventures.

# Corporate profile



## The Linde Group

The Linde Group is a world-leading gases and engineering company which operates in around 100 countries and has more than 50,000 employees. It achieved sales in the 2007 financial year of EUR 12.306 bn. The strategy of The Linde Group is geared towards sustainable earnings-based growth and focuses on the expansion of its international business with forward-looking products and services.

## Organisation

The Group comprises three divisions: Gases and Engineering (the two core divisions) and Gist (logistics services, reported under "Other activities"). The largest division, Gases, has four operating segments, Western Europe, the Americas, Asia&Eastern Europe, and South Pacific & Africa, which are subdivided into nine Regional Business Units (RBUs). The Gases Division also includes the two Global Business Units (GBUs) – Healthcare (medical gases) and Tonnage (on-site) – and the two Business Areas (BAs) – Merchant & Packaged Gases (liquefied and cylinder gases) and Electronics (electronic gases).

## Gases Division

The Linde Group is a world leader in the international gases market. We offer a wide range of compressed and liquefied gases as well as chemicals and we are therefore an important and reliable partner for a huge variety of industries. Our gases are used, for example, in the energy sector, in steel production, chemical processing, environmental protection and welding, as well as in food processing, glass production and electronics. We are also investing in the expansion of our fast-growing Healthcare business, i.e. medical gases, and we are a leading global player in the development of environmentally friendly hydrogen technology.

## Engineering Division

Our Engineering Division is successful throughout the world, with its focus on promising market segments such as olefin plants, natural gas plants and air separation plants, as well as hydrogen and synthesis gas plants. In contrast to virtually all our competitors, we are able to call on our own extensive process engineering know-how in the planning, project development and construction of turnkey industrial plants. Linde plants are used in a wide variety of fields: in the petrochemical and chemical industries, in refineries and fertiliser plants, to recover air gases, to produce hydrogen and synthesis gases, to treat natural gas, and in the pharmaceutical industry.



# Ambition

# counts.

Fiscal 2007 was the first full year following acquisition of our British competitor, BOC – and The Linde Group has risen to the challenges this presented with great success. We were able to complete our extensive restructuring measures and meet all our financial goals, while simultaneously building a united, high-performance global organisation.

During this process, we placed particular value on developing and anchoring our new company philosophy, the Linde Spirit. This sets out our joint vision, values and principles. It acts as an overarching mission statement, fostering our desire to achieve and deliver, capacity to grow, drive to improve and passion to innovate. Ambition counts.

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A wide-angle photograph of a massive concrete dam. The dam's top is a curved walkway with a metal railing. A person in blue overalls and a white hard hat stands on the walkway, talking on a mobile phone. The dam is situated behind a large, calm reservoir. In the background, there are steep, green mountains with patches of snow and glaciers under a cloudy sky.

the spirit of  
leadership

# Foreword

*Dear Stakeholders,*

It gives me great pleasure to introduce the latest edition of the Linde Annual, which has now become an integral part of our Annual Report. This year, our title epitomises the Linde Group philosophy – “Ambition counts”. This sums up the key elements of our corporate culture, which we have systematically developed and anchored within the extended Linde organisation over the past year – the first one since the merger with BOC. It conveys our pursuit of excellence, our determination to deliver the best solution for each and every customer and our aim to foster a performance-driven mindset throughout the entire Group.

In defining the values that underpin our new corporate culture, we took care to distil the best of both Linde and BOC’s traditional strengths. And our success speaks for itself. The Linde Group’s projects, innovations and achievements over the last fiscal year provide clear confirmation that our employees are already living the new Linde Spirit.

In this Linde Annual, we present a cross-section of our wide-ranging activities across the globe in 2007. We feel these best capture our success, underscoring our leading role. On the one hand, these examples demonstrate the positive impact of tight collaboration between our global Gases and Engineering Divisions. And, on the other, they illustrate how we work closely with our customers to deliver targeted method and process improvements, increasing our competitive abilities in the long term.

This applies in particular to the complex engineering work involved in building plants to liquefy and distribute natural gas, for example, as well as to our major on-site gas supply projects and the eco-friendly hydrogen technologies we are pioneering with our partners in the automotive and petroleum industries.

As part of our focus on highly sustainable technologies to answer tomorrow’s energy challenges, we are also participating in trials to capture and securely store the greenhouse gas CO<sub>2</sub> in underground reservoirs. We are investigating this innovative technology within research projects such as CO<sub>2</sub>SINK and at the Schwarze Pumpe emission-free demonstration power plant in Germany.

Our innovative drive is also evident through our active involvement in projects to develop and expand renewable power sources such as solar energy. We work closely with our partners in the electronics industry, delivering electronic gases and highly sophisticated applications to accelerate the move towards eco-friendly production processes for the fast-growing semiconductor and solar-cell markets.

As the leading global supplier of the valuable noble gas helium, The Linde Group is also a strategic partner for numerous high-tech players – in fields ranging from healthcare and medical diagnostics through laser technology and fibre-optics to space and basic research.

This Annual allows you to discover our ambitious goals as we continue to give our very best – in the interests of both our customers and stakeholders. You will also find out how we are moving towards the new Linde Group's most important aim – becoming the number-one global gases and engineering company. A company that enjoys an outstanding reputation. And a company whose employees are always working on innovative solutions are helping to change the world.

A handwritten signature in black ink, appearing to read 'W. Reitzle', with a large, stylized flourish at the end.

Professor Dr Wolfgang Reitzle  
Chief Executive Officer of Linde AG

# Executive Board

## **Professor Dr Wolfgang Reitzle**

Born 1949

Doctorate in Engineering (Dr.-Ing.),  
Degree in Economics and Engineering  
Chief Executive Officer

Responsible for Gist and the following global and central functions:  
Communications & Investor Relations, Corporate Strategy, Group  
Human Resources, Group Information Services, Group Legal, Inno-  
vation Management, Internal Audit, SHEQ (Safety, Health, Environ-  
ment, Quality), Six Sigma

Member of the Executive Board since 2002

## **Dr Aldo Belloni**

Born 1950

Doctorate in Chemical Engineering (Dr.-Ing.)  
Responsible for the Engineering Division, the operating  
segments Western Europe and Asia & Eastern Europe,  
the Global Business Unit Tonnage (on-site) and the Business  
Area Electronics (electronic gases)

Member of the Executive Board since 2000

## **J. Kent Masters**

Born 1960

BS Chemical Engineering,  
MBA Finance

Responsible for the operating segments Americas and  
South Pacific & Africa, the Global Business Unit Healthcare  
and the Business Area Merchant & Packaged Gases (lique-  
fied and cylinder gases)

Member of the Executive Board since 2006

## **Georg Denoke**

Born 1965

Degree in Information Science,  
Degree in Business Administration (BA)

Responsible for the following global and central functions:  
Capital Expenditure, Financial Control, Group Accounting &  
Reporting, Group Treasury, Growth & Performance, Mergers &  
Acquisitions, Procurement, Risk Management, Tax  
Human Resources Director

Member of the Executive Board since 2006

The following member has retired from the Executive Board:

## **Trevor Burt**

Born 1958

Bachelor of Science (BS)

Responsible for the Regional Business Units of Greater China,  
South & East Asia, South Pacific, and the Business Areas  
Packaged Gases & Products (cylinder gases) and Electronics  
(electronic gases)

Member of the Executive Board since 2006

Retired on 31 December 2007



From left to right: Georg Denoke, Dr Aldo Belloni, Professor Dr Wolfgang Reitzle, J. Kent Masters.





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the spirit of  
performance

# Performance //

## Committed to the future.

The Linde Group is positioned as one of the world's leading suppliers of innovative process technologies and energy-efficient engineering solutions. Its competence extends from the liquefaction of natural gas and the supply of hydrogen to refineries that produce low-sulphur petrol and diesel through the separation of carbon dioxide (CO<sub>2</sub>) from the flue gases generated by coal-fired power plants to the safe underground storage of CO<sub>2</sub>. Inspired by its pioneering ideas and renowned for its professional project management, our Engineering Division makes a valuable contribution to safeguarding the environment, securing tomorrow's energy supplies and meeting today's industrial gas needs.

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### Putting our in-depth engineering competence to work for our climate and environment

Around the world, concerns surrounding climate change are rising. This calls for rapid, systematic action across all levels of politics, society and business. Attention is currently mainly focused on the reduction of energy consumption through more efficient use of fossil fuels, the minimisation of greenhouse emissions such as CO<sub>2</sub>, and the tapping of alternative sources of energy such as wind and solar power. The fact that our climate is undergoing change is undisputed. This was clearly evident in the Nobel Peace Prize-winning documentary by Al Gore, "An Inconvenient Truth", as well as at the Bali Climate Change Conference in December 2007.

Climate change is a highly complex, multi-faceted issue and cannot be resolved solely by appealing to people's consciences or through legislative measures or penalties. The challenge of reducing energy consumption and thus dramatically cutting greenhouse emissions without sacrificing quality of life and economic development can only be resolved in the long-term with the aid of modern and evolving technologies. This presents a massive playing field, one that benefits greatly from the many strengths of The Linde Group, extending from the production and supply of gases to the engineering of gas plants.

Synergising the core competencies of our Engineering and Gases Divisions, we develop and deliver economically viable technologies that secure energy supplies, reduce hazardous emissions from power plants, and help produce environmentally friendly fuels. We develop these solutions both directly for our customers and within the framework of pilot projects. Linde is a leading global technology player specialised in the engineering and construction of plants to liquefy natural gas, separate air and produce olefin, synthesis gases and hydrogen.

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### Liquefied natural gas booming

In the search for environmentally friendly fuels, hydrogen is already well established as a key enabler in the production of low-sulphur petrol. However, attention is also increasingly focusing on the conversion of natural gas into liquid, biodegradable and sulphur-free hydrocarbons such as diesel or kerosene. This process is referred to as GTL (gas to liquids). Equally interesting is the growing popularity of liquefied natural gas (LNG), which is increasingly being shipped around the globe by special tanker. These shipments are proving to be an extremely practical way of supplementing pipeline deliveries of natural gas. LNG is regarded as one of the more promising fuels of the future because of its high energy density, constant heat rating and high purity.

Demand for LNG is also being fuelled by increasingly strict legislation on emissions from cars and power plants and the high cost of crude oil. This, in turn, is driving demand for plants to produce LNG. Economically viable pipeline supply of natural gas is limited to distances of up to 3,000 kilometres. In addition, many gas fields are either too small or too isolated to warrant laying a pipeline. All of these factors combine to rapidly increase the importance of natural gas liquefaction and purification directly at the point of supply both on and offshore (see also p. 13). Liquefaction reduces the volume of natural gas to 1/600 of the original quantity, which means it can be cost-effectively shipped in tankers to even outlying markets. This opens up the entire world market for natural gas deliveries.

### LNG plant for Skangass

As a leading provider of natural gas liquefaction plants, we are ideally positioned to capitalise on this dynamic market in several ways. As an engineering company, we design and build natural gas plants. And as a gases company, we can sell the resulting product and – if so desired by the customer – also operate the plant.

One of our more recent large-scale wins in this area was a contract from the Norwegian company Skangass AS in July 2007 to build a natural gas liquefaction plant with an annual capacity of 300,000 tons of LNG. Linde Engineering will build the plant at Risavika near Stavanger in Norway. The contract is worth around EUR 100 m. Thanks to a highly energy-efficient liquefaction process developed specially by Linde, this new plant will cut emission levels significantly compared with similar plants of this scale.

Skangass is a joint venture between the energy company LYSE Gass AS and the financial investor Celsius Invest. Through its marketing company Nordic LNG AS, it will mainly target the Scandinavian and Baltic markets. Its customers will include the Linde subsidiary AGA Gas AB. Under the terms of the agreement between our Gases Division and Skangass, AGA will buy 50,000 tons of LNG from the new plant each year and market it itself. This arrangement also helps to ensure that the plant is producing to full capacity. Construction work is scheduled to commence on 1 September 2008 and the plant should become operational in autumn 2010.

### Europe's largest LNG plant brought on stream

Towards the end of September 2007, a mere two months after signing the contract for the plant at Stavanger, the Norwegian petroleum company Statoil ASA (now StatoilHydro), also operator of the Snøhvit gas field in the Barents Sea, opened Europe's largest LNG plant on Melkøya island off Hammerfest. Over the past five and a half years, the Linde Group was responsible for engineering, procurement and management/supervision of construction work for this extremely energy-efficient LNG plant. This sizeable deal was worth around EUR 900 m to Linde.

The gas is delivered to the plant through a 143 km sub-sea pipeline from production wells located on the seabed at a depth of 300 metres. CO<sub>2</sub>, water, condensate, glycol and mercury must be separated from the feed gas before it can be liquefied. The next step of the pioneering project involves compressing the CO<sub>2</sub> captured and piping it back into underground reservoirs to minimise CO<sub>2</sub>

emissions. The LNG is transferred to large interim storage tanks, from which it is transported by LNG tankers to customers in the US and Europe. On 20 October 2007, the first of these tankers, the Arctic Princess, set sail with 145,000 cubic metres of LNG on board.

Since the turn of the year, we have been working with Statoil to quickly and effectively resolve any outstanding technical teething issues. Once the Melkøya plant is working to full capacity, scheduled for mid-2009, a tanker will leave the port every five to six days to bring LNG to our customers around the globe.

### LNG plant in Piceance basin of Colorado

The liquefaction of natural gas is also gaining in importance in the US. Here again, this shift is working to the benefit of The Linde Group. Linde Process Plants (LPP), based in Tulsa, Oklahoma, was chosen by Williams Companies Inc. to build an LNG plant in the resource-rich Piceance basin located in north-western Colorado. The new plant will liquefy and purify natural gas at a maximum rate of 12.7 m standard cubic metres (scm) each day. The Piceance basin in Colorado is one of America's biggest reservoirs of natural gas.

### New playing field as LNG takes to the high seas

Linde and the Dutch company Single Buoy Mooring Inc. (SBM) have formed a global technology alliance for the development, construction and marketing of LNG floating production, storage and offloading (FPSO) facilities. These units enable even the remotest offshore fields with relatively low gas reserves to be developed cost-effectively. They do this by leveraging our proprietary liquefaction process technology. This alliance is a key stepping stone in our medium to long-term mission of becoming one of the leading players in the industrial and chemical offshore engineering market.

FPSO plants are designed to handle all types of conventional natural gas and have a capacity of around 2.5 m metric tons each year. This type of solution is therefore ideal for offshore gas fields with potential reserves of 1 bn cubic metres and upwards.

As part of this alliance, Linde provides the gas hardware for the FPSO units. This includes facilities for pretreatment, C3+ fractionation and liquefaction based on our proprietary Multi-Stage Mixed Refrigerant (LiMuM, see glossary) process. SBM, on the other hand, contributes the marine technology, including the hull and LNG storage tanks, plus power generation, mooring and loading systems.



Where pipeline deliveries of liquefied natural gas (LNG) are not cost-effective, tanker ships come into their own. The first gas tanker set sail from the Linde-engineered LNG plant on the Norwegian island of Melkøya, off Hammerfest, on 20 October 2007.

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*View of the control centre and storage tanks at the Hammerfest LNG plant – the largest of its kind in Europe. Since spring 2002, experts from Linde were responsible for engineering, procurement and overseeing construction. The plant then opened for operation in autumn 2007.*

Linde and SBM plan to both sell turnkey facilities and to offer their joint customers a leasing option. With this leasing model, we would build, own and operate the FPSO system, acting as joint investor with SBM. The first floating unit is expected to begin LNG production in 2012.

#### **On-board reliquefaction of LNG**

Once liquefied, the LNG is transported vast distances overseas at a storage temperature of  $-163$  degrees Celcius. Even at this cryogenic temperature, however, heat leakage into the storage containers causes a certain amount of LNG to evaporate or boil off during the trip. Particularly on extended trips, recapturing this boil-off gas can be financially lucrative. There are also environmental benefits to recapturing this gas. On ships with regular steam turbine engines, the boil-off is generally burnt in the boiler with crude oil. This releases  $\text{CO}_2$  into the atmosphere.

Although evaporation cannot be avoided, detrimental effects certainly can be avoided by reliquefying the boil-off gas on board. Reliquefaction on long-distance, slow-speed, larger tankers is not only financially attractive, but also a lot sounder from an environmental perspective.

Our French subsidiary Cryostar has developed a particularly energy-efficient reliquefaction process, which is being deployed by our partner Samsung Heavy Industries for a new generation of five LNG tankers. Cryostar delivers most of the cryogenic components as part of an agreement worth around EUR 50 m. These modern LNG membrane tankers can carry up to 265,000 cubic metres of LNG and are the largest of their kind. They are scheduled to start transporting LNG between Qatar and the US in 2008.

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### **Innovative technologies to reduce $\text{CO}_2$ emissions**

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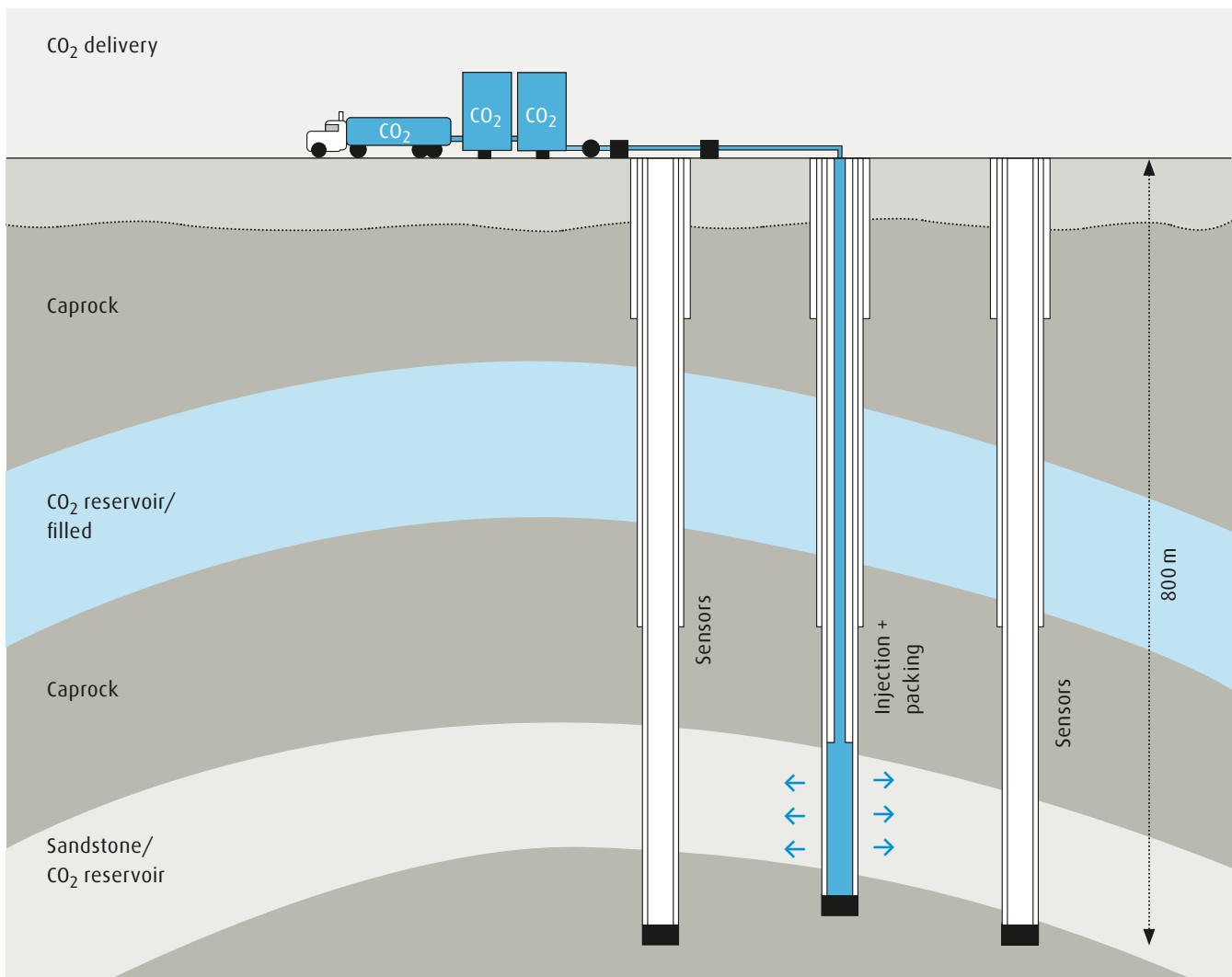
Every year, 3,000 gigatons of  $\text{CO}_2$  are released by natural processes into the atmosphere. Humans are responsible for an additional 25 gigatons. Although this seems comparatively low, it nonetheless puts the sensitive  $\text{CO}_2$  balance out of sync and it is precisely this balance that is so crucial for the earth's climate. Alternative sources of energy and energy efficiencies alone will not be sufficient to reduce our  $\text{CO}_2$  emissions by at least one third over the next two decades and keep global warming in check.

Given that crude oil, natural gas and, above all, coal will continue to be our main sources of energy for many decades to come, we need innovative technologies to minimise the  $\text{CO}_2$  emitted when these fossil fuels are burnt or to capture the  $\text{CO}_2$  and store it safely.

As a leading gases and engineering company, The Linde Group has already developed the process technologies required to separate and store  $\text{CO}_2$ . In addition, we are involved in a wide range of research and pilot projects in this area. Drawing on the insights and know-how we have gained thus far, we will be bringing new technologies to market in the near and medium term that are set to either dramatically reduce or eliminate  $\text{CO}_2$  emissions from power plants.

#### **New $\text{CO}_2$ separation processes**

Our Engineering Division is involved, for example, in the development and piloting of new processes to separate  $\text{CO}_2$  from the combustion flue gases generated by coal-fired power plants. In September 2007, plant operator RWE Power, the chemical company BASF and Linde reached an agreement to install a pilot facility for  $\text{CO}_2$  scrubbing at the lignite power plant located in Niederaußem, which is part of Bergheim in North Rhine-Westphalia, Germany. The plant, which will be constructed by Linde, will use new scrubbing solutions from BASF to effectively separate the  $\text{CO}_2$ . The objective of this long-term pilot is to make  $\text{CO}_2$  capture technology commercially available to Germany's key lignite plants by 2020. This scrubbing technology captures more than 90 percent of the  $\text{CO}_2$  contained in the combustion flue gases emitted by a power plant. The separated



**CO<sub>2</sub> sequestration** → This involves storing the CO<sub>2</sub> emitted by power plants, for example, when they burn fossil fuels. Sequestration is part of the carbon dioxide capture and storage (CCS) process. The CO<sub>2</sub> released when coal, oil and natural gas are burned is separated from the flue gases and then stored underground to prevent it escaping into the atmosphere. Storage of CO<sub>2</sub> makes an important contribution to combating climate change as it is one of the main gases responsible for the greenhouse effect. Strictly speaking, sequestration refers to the actual storage of CO<sub>2</sub>. The gas can be stored in underground reservoirs for crude oil or natural gas or in deep saline aquifers or exposed coal seams (geological sequestration). Research is also currently underway to investigate deep-sea storage.

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**Oxy-fuel process** → In the oxy-fuel process, carbon dioxide generated through lignite combustion is isolated and liquefied at the power plant instead of being released into the atmosphere. In this process, the lignite is combusted with pure oxygen rather than air. To cool the flames, the majority of the carbon dioxide released in combustion is mixed with this oxygen. Dust and sulphur is then removed from the flue gas, which is dehumidified in a condenser. The CO<sub>2</sub> can then be compressed, liquefied and transported to the sequestration site. All in all, an extremely environmentally friendly way of reducing CO<sub>2</sub> emissions.

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CO<sub>2</sub> can then be safely stored underground. One of the biggest advantages of this scrubbing process is that it can be used to refurbish existing lignite plants.

On successful completion of the pilot tests, the plan is to set up a demonstration plant in 2010 to establish the commercial viability of scrubbing.

#### **Moving towards zero-emission power plants**

Work on the pilot CO<sub>2</sub> sequestration facilities at the Schwarze Pumpe plant in Lausitz, Germany, run by the energy group Vattenfall, is close to completion. We delivered the cryogenic air separation (see glossary) and CO<sub>2</sub> recovery units for this emission-free lignite power plant based on oxy-fuel technology (see also blue breakout text above). This 30 megawatt power plant is scheduled to commence operations in 2008. Vattenfall also plans to construct a 250 to 600 megawatt oxy-fuel plant at the same location over the next decade. This second plant should advance CO<sub>2</sub> sequestration to industrial-scale maturity. This should be followed by a commercial plant with a typical rating of 1,000 megawatts by 2020.

The Linde Engineering Division will be involved in the planning and construction of another CO<sub>2</sub> sequestration and compression pilot project during the course of 2008. The project will be located at the Altmark gas field in the northern part of Saxony Anhalt in Germany. Erdgas Erdöl GmbH (EEG), Berlin, a subsidiary of Gaz de France, operates the natural gas field and has placed the order for the CO<sub>2</sub> plant.

The growing importance of CO<sub>2</sub> sequestration is also reflected in the contract placed by the Norwegian energy group StatoilHydro with our Engineering Division to investigate in detail ways of purifying, transporting and compressing CO<sub>2</sub> captured from power plant flue gases so that it can be injected into reservoirs in the North Sea. This project falls under the umbrella of an EU-sponsored initiative aimed at avoiding CO<sub>2</sub> emissions at the Norwegian industrial site of Mongstad.

#### **Former salt dome used to store CO<sub>2</sub>**

We are also involved in another pioneering research project focused on underground CO<sub>2</sub> storage. CO<sub>2</sub>SINK is sponsored by the EU and brings together 18 partners from nine countries across Europe to research and test ways of storing CO<sub>2</sub> underground in Ketzin in the German state of Brandenburg. CO<sub>2</sub> in cryogenic form from our Leuna refinery is injected into porous rock reservoirs filled with salt water

and located some 700 metres below the earth's surface. Led by the GeoForschungsZentrum research centre in Potsdam, the project investigates how the gas dissipates underground and, even more importantly, whether it remains in storage. Over the next two years, around 60,000 tons of pure CO<sub>2</sub> will be injected into a former salt dome as part of this research project.

Linde is responsible for all intermediate storage facilities and for conditioning the pressure, temperature and volume of the CO<sub>2</sub> to be stored. We also co-developed the technology for injecting the gas into the ground. This concept involves the controlled heating of 1.5 tons of liquid CO<sub>2</sub> per hour and injecting the CO<sub>2</sub> in gas form into the dome at a relatively high pressure (70 to 100 bar).

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#### **Hydrogen helps protect against climate change**

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Hydrogen (H<sub>2</sub>) is viewed as one of the most promising energy carriers of the future. Particularly when it comes to road transport, hydrogen is set to play an increasingly strategic role as we move forward (see also p. 42). Although hydrogen is currently mainly generated from fossil fuels, research and development work on green hydrogen is progressing rapidly. This involves generating hydrogen from different types of biomass and other regenerative sources. Our mission is to ensure a future stream of hydrogen that is as efficient and sustainable as possible.

Not only is hydrogen positioned as a highly promising alternative energy carrier, it is also widely used to purify and desulphurise crude oil. This application is growing in importance as government authorities tighten environmental regulations governing emissions. Refineries generally rely on on-site facilities to supply the hydrogen they need to desulphurise their petrol and diesel. Customers such as these benefit from the synergised, single-source offering of The Linde Group, spanning both engineering and operation of on-site plants.

Our Gases Division placed a key hydrogen contract with our US subsidiary Linde Process Plants (LPP) in fiscal 2007. We will build a second hydrogen plant at our Lemont site in Illinois. Linde Gas will use this plant to supply the neighbouring refinery run by CITGO Petroleum Corporation with around 1.3 m scm of hydrogen a day.

In September 2007, we opened Germany's second hydrogen liquefaction plant in Leuna. From Q1 2008, this plant will be supplying high-purity liquid hydrogen to the electronics industry in particular. Hydrogen is also used for purifying and desulphurising crude oil in refineries. At present, Linde is researching new methods of producing biohydrogen from renewable energy sources to facilitate the move towards sustainable mobility solutions.

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CITGO will use the hydrogen to treat high-sulphur (or sour) crude oil from Canadian oil sands.

We have also built hydrogen plants in Salt Lake City, Utah, and in Mobile, Alabama. Both of these went on stream in 2007. With a capacity of 700,000 scm a day, the steam methane reformer (SMR) in Salt Lake City will supply several refineries with pure hydrogen, including Chevron and Holly refineries. The Mobile plant has a capacity of around 300,000 scm a day and supplies hydrogen to the local Shell refinery.

Our Engineering Division won two additional contracts for hydrogen plants during the year under review. One was from Markwest Hydrogen Inc. in the US and the other was from our Taiwanese customer CPDC in Kaohsiung.

subsidiary Selas Fluid Process Corporation will design and build seven cracking furnaces.

The ethane plant is part of a petrochemical complex in Ruwais, which also produces polyethylene and polypropylene. A Linde cracker has been in use at this site since 2001, with an annual capacity of around 600,000 tons. Under the terms of the agreement, the project will run for 41 months till May 2010, at which point the plant will be handed over to the customer.

The close business relationship between Linde and ADNOC, the state-owned oil company of the United Arab Emirates, was further intensified in mid-December 2007 through a joint venture to secure the long-term supply of industrial gases to customers in Abu Dhabi (see also p. 23).

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## Other engineering highlights

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Looking beyond our strategic natural gas and hydrogen wins in fiscal 2007, our Engineering Division also provided proof of its competence and flexibility through a series of other projects. An engineering project in Asia and another one in Germany in particular are worthy of mention in this context.

### Big win from Abu Dhabi

Towards the end of 2006, our Engineering Division secured one of the biggest contracts of its history. Abu Dhabi Polymers Company Ltd. (Borouge), a joint venture between Abu Dhabi National Oil Company (ADNOC) and Borealis, contracted us to plan and construct the largest ethane cracking plant in the world. This turnkey project is worth USD 1.3bn to Linde. The plant will have a capacity of almost 1.5 m tons of ethylene a year and will be located in Ruwais, an industrial park around 250 kilometres to the west of Abu Dhabi in the United Arab Emirates. The cracking plant will be built under a consortium with Consolidated Contractors Company (CCC). As lead manager, Linde will be responsible for almost all engineering works, the supply of hardware and commissioning. CCC will look after plant assembly, largely under our direction.

Our plant in Schalchen, near Munich, will supply the aluminium plate-fin heat exchangers for the ethane cracker, whereas our US

### A technical and logistical tour de force

7 September 2007 marked another defining milestone for our Engineering Division. On that day, we replaced 17 cracking furnaces (see glossary) and two steam superheaters dating back to 1973 with five state-of-the-art and environmentally friendly industrial furnaces for the ethylene plant Olefin III run by BP in Gelsenkirchen-Scholven. The changeover was a technical and logistical tour de force. The powerful superheaters – each weighing 2,600 tons, measuring 46 metres in height and spanning a surface area between 20 and 30 metres – were assembled around 500 metres from the actual point of use, where they were prepared for commissioning. Once the old furnaces were disassembled and removed on self-propelled modular trailers (SPMTs), the new furnaces were transported to their point of use. Linde only had 35 days for disassembly, foundation work, transport, interconnection of the furnaces and connection of the furnaces to the ethylene plant. For financial reasons, the plant could not be taken offline for any longer than 35 days. In fact, Linde successfully completed the project in a mere 32 days – the fastest turnaround time for a project of its kind ever achieved worldwide.

The new cracking furnaces significantly reduce nitric oxide and dust emissions, improve general levels of reliability and expand capacity. Our Engineering Division and subsidiary Selas-Linde were responsible for planning, constructing and transporting the furnaces. All in all, the project is an impressive international reference for our ground-breaking environmental technologies and reliable project management skills.



A photograph of a forest of giant sequoia trees. The trees are tall and have thick, reddish-brown bark. The ground is covered in brown pine needles. A smaller, green evergreen tree is visible in the center of the frame. The text "the spirit of growth" is overlaid on the image in white, lowercase letters.

the spirit of  
growth







# Growth //

## Dovetailing to perfection.

In the reporting year, we were able to build on our business across the globe, consolidating our position as a world-leading industrial gases and engineering company. Not only were we successful in our established markets, we also significantly expanded operations in the burgeoning growth regions of Eastern Europe, across China and in South and East Asia in particular. And the multiple synergies between our Gases and Engineering Divisions are paying off to an ever greater extent here. On one hand, the Gases Division placed numerous on-site engineering orders with our Engineering Division and, on the other, our longstanding collaboration with engineering customers is increasingly generating new gas business for our company.

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### Major on-site projects in 2007

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In September 2007, we concluded a new supply agreement with the Austrian steel manufacturer voestalpine, a Linde customer for many years now. This supplements and extends our existing agreements to include the delivery of industrial gases to the Linz production site. Linde Gas Austria will be managing these deliveries. Our contract with this customer also covers construction of another on-site air separation plant, at an investment volume of EUR 62m. We will begin work on this in the second quarter of 2008, with operations due to commence in January 2010. The plant will use a pipeline to supply the steel works with up to 30,000 standard cubic metres each of (gaseous) oxygen and nitrogen per hour. It will also produce liquefied oxygen, nitrogen and argon and smaller amounts of krypton and xenon for general sale on the market.

In Hungary, the Engineering Division will construct a HyCO (hydrogen plus carbon monoxide, see glossary) plant to supply our customer BorsodChem in Kazincbarcika by mid-2009. Our Gases Division will then operate the plant, delivering carbon monoxide, hydrogen and high-pressure steam for the production of isocyanates (MDI and TDI), which is a polyurethane (see glossary) feedstock, and polyvinyl chloride (PVC, see glossary). The new plant will be the third of its kind in Kazincbarcika and will supply up to 12,000 scm/h carbon monoxide and 29,000 scm/h hydrogen from June 2009, as well as high-pressure steam for export.

The plant's cold box (see glossary) will be equipped with numerous innovations and technical extras, including

- Largest methane wash constructed by Linde to date
- Special wash column for separating nitrogen from carbon monoxide (CO)

- Liquid CO generation and storage facilities
- Additional liquid CO generator
- Storage for emergency supplies

The largest industrial gases company in the country, Linde Gas Hungary currently operates five production facilities nationwide.

The Linde Group will also be constructing a central air separation plant in the special economic zone near Wroclaw (Breslau), Poland. This will supply not only the Polish market, but also bordering regions in eastern Germany and the Czech Republic.

Our air-separation business is booming in Russia and the former Soviet Union, too, with several orders coming in over the last fiscal year. These include an air separator to supply gaseous oxygen (capacity: 9,000 scm/h) to the fertiliser manufacturer JSC ACRON in Nowgorod and a plant with 3,000 scm/h production capacity for Linde Gas Russia in Berezovsky. The Karabaschmed company in the Russian Karabash region (western Siberia) placed an order for the delivery of a major turnkey air separation plant with 30,000 scm/h capacity. This will supply industrial gases for the company's copper mill and electrode production.

### Air separation plants for East Asia

The Linde Group has also made major headway in penetrating markets both in the South Pacific and in the Far East, notably China and South and East Asia.

In China, The Linde Group concluded a long-term supply contract with the polyurethane manufacturer Ningbo Wanhua Polyurethane in December 2007. This will involve our Gases Division delivering oxygen and nitrogen to Wanhua's major plants in Ningbo, on the coast of southern China, from 2010.

For this purpose, our Engineering Division will construct two air separation plants of 38,000 scm/h capacity each and a new 30 kilometre pipeline on behalf of Linde Gas Ningbo. In addition to Wanhua, the plant will supply gases to Ningbo Steel and produce 800 tons per day (tpd) liquid nitrogen and oxygen plus noble gases krypton and xenon for the open market. This is Linde's largest single investment in China to date, valued at USD 125 m.

Once the new plant is operational, Linde Gas Ningbo will probably be China's largest cluster. By 2012, our production capacity will enable us to supply further on-site customers in the region.

#### **New method for direct coal liquefaction**

Our Chinese Engineering subsidiaries in Hangzhou und Dalian mainly focus on the sale of air separation plants and coiled heat exchangers. Their activities in the reporting period included delivery of two air separators to the Shenhua coal company in Inner Mongolia, with operations commencing gradually since the end of 2007. The facilities each have a capacity of 50,000 scm/h and will be used for direct coal liquefaction. This is the first project of its kind worldwide and is arousing a high degree of political interest in China, since it helps diminish the country's reliance on oil imports by exploiting its own major coal reserves.

We have also constructed a number of air separation plants in South and East Asia over the last year, some of which are already operational. In Bhiwadi, in the north-east Indian state of Rajasthan, a new air separator has been supplying medical and industrial oxygen as well as nitrogen and gas mixtures since June 2007. And in Bellary, in the southern Indian state of Karnataka, we are now delivering industrial gases to India's second-largest steel manufacturer, JSW Steel Ltd., from a plant commissioned in 2007.

We also received an order from the Steel Authority of India Ltd. (SAIL) last year to construct two air separation plants for its steel works at the Rourkela (Rourkela Steel Plant) and Burnpur (ISP Steel) locations. The combined order value is in excess of EUR 100 m.

In Vietnam, we constructed an air separation plant near Ho Chi Minh City in the reporting period, with operations commencing at the end of 2007. The plant boasts a production capacity of 300 tpd, of which oxygen accounts for 110 tpd. This makes it the largest facility of its kind in Vietnam. It delivers oxygen to the steel company Thep Viet Co. Ltd. via pipeline and also produces liquid oxygen for the open market.

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**Strategic joint venture in Abu Dhabi** → In November 2007, The Linde Group established a joint venture with The Abu Dhabi National Oil Corporation (ADNOC), United Arab Emirates, for the long-term supply of industrial gases to customers in Abu Dhabi. The new organisation, ADNOC Linde Industrial Gases Company Ltd., will operate under the name "Elixir".

This joint venture represents the logical expansion of the previous collaboration between our Engineering Division and ADNOC in the petrochemical industry. Since ADNOC has access to around 90 percent of Abu Dhabi's oil and gas reserves, which are considered to be the fourth largest in the world, it is also of major strategic importance to us.

In the first phase of the joint venture, Elixir will construct a USD 65 m air separation plant in the industrial park of Ruwais,

Abu Dhabi. From the end of 2009, this new plant will supply nitrogen to industrial customers in Ruwais and will also produce liquefied nitrogen and oxygen.

ADNOC is also the majority shareholder in the joint-venture company Borouge, which produces polyethylene in Ruwais. In November 2006, when Borouge was seeking to expand its production facilities, Linde was awarded a major contract to build one of the largest ethane crackers in the world, with a production capacity of ca 1,500,000 tons of ethylene per annum. The first cracker at the Ruwais site, with an annual capacity of 600,000 tons, was also constructed by Linde and successfully opened for operations in 2001 (also see p. 19).

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Demand for on-site plants that generate industrial gases next to our customers' production facilities is growing worldwide. Our Engineering Division delivers air separation units for the production of nitrogen, oxygen, argon and other air gases to customers across the globe – from Western and Central Europe through Russia and China to South-East Asia and America. We are currently constructing a HyCO plant for the Hungarian chemicals company BorsodChem in Kazincbarcika. We already operate three other plants for this customer (see image) and will be supplying carbon monoxide and hydrogen from the new facility as of June 2009.







*Linde's plant engineering expertise is in demand worldwide. During the reporting year, we expanded our market position in Eastern Europe in particular thanks to significant on-site projects and targeted acquisitions.*

The Linde Group also constructed an air separation plant in the Map Ta Phut industrial estate in Thailand, supplying industrial gases to several national chemical companies.

#### **New plants for North America**

The Linde Group commissioned four air separation plants in North America in fiscal 2007:

- Cartersville, Georgia – air separator with 800 tpd capacity to supply customers in the food, metal, chemical and healthcare industries across the South-East US
- Columbus, Mississippi – new plant with 550 tpd capacity to deliver oxygen and nitrogen to the SeverCorr steel works and supply argon for the local market
- Bethlehem, Pennsylvania – expansion plant (joint venture with Air Products) to produce 575 tpd liquid nitrogen for customers in the food, metal, chemical and healthcare industries in the North-East US and on the Atlantic coast
- Cantarell, Mexico – fifth module of nitrogen plant for the Mexican oil company Pemex to meet oil production demands in the Gulf of Mexico

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#### **Acquisitions for a firmer foothold**

Over the last fiscal year, we have continued to build on targeted regional activities and strengthen our market position with a number of smaller acquisitions. These included the takeover and integration of our former competitor, Messer, in Finland. Having purchased Messer's gas operations – launched a good decade before – in November 2006, the Linde subsidiary AGA Gas AB then integrated the organisation in our Gases Division during the reporting period. As part of this process, we consolidated Messer's former gas cylinder filling station in Tuusula at our AGA site in Riihimäki, while continuing to operate the Messer air separation plants in Tuusula and Imatra as before.

In Turkey, Linde concluded the purchase of the Turkish industrial gases company Birlesik Oksijen Sanayi A. S. (BOS), part of the Koc Group, with an equity value of approximately EUR 92 m. BOS is active in the industrial and specialty gases sector and achieved a good EUR 19 m in revenue during fiscal 2007, with a staff of around 190. This is our second acquisition in Turkey, following Karbogaz A. S. in 2006, and rounds out our product portfolio in this key strategic market with its booming steel industry. At the same time, it also allows us to strengthen our foothold as a supplier to neighbouring markets in the Middle East.

#### **Expansion in Eastern Europe**

In Russia, The Linde Group acquired the SaKiZ company (ZAO Samarsky Oxygen Plant), a regional industrial gases provider based in Samara, in the south. With over 200 employees, SaKiZ produces and distributes air gases (nitrogen, oxygen, carbon dioxide, helium and argon) in both liquefied and gaseous form. This acquisition forms an important pillar of our growth strategy in the emerging markets of Eastern Europe.

In May 2007, Linde signed a contract with URALTECHGAS (UTG) of Ekaterinburg, the leading gases company in Russia's central Ural region, agreeing the gradual acquisition of a majority shareholding in URALTECHGAS. The joint venture will supply customers with liquid gas products sourced from the neighbouring Berezhovsky region, where Linde is currently constructing an air separation plant for on-site provision of the Maksi Group steel works located there. This means we are now ideally placed to strengthen our foothold as a gases supplier in this industrial region.

We have also consolidated our position in Romania, acquiring the remaining shares held by our partner Petrom – a joint venture between the Austrian mineral oil group OMV and the Romanian State – in two other joint venture companies. Thus we acquired a 49 percent stake in Linde Gaz Brazi Srl, which operates an air separation plant for the Petrobrazi refinery, and a 22 percent stake in the former Acetilena Brazi Srl, which runs an acetylene facility on the refinery site.

Linde has been the sole proprietor of both of these companies since August 2007. We will be integrating them in our regional subsidiary in Romania, Linde Gaz Romania Srl, during the current fiscal year.

In the course of our full acquisition of Linde Gaz Brazi Srl, we also signed a 15-year supply contract with Petrom, which includes construction of an air separator. This on-site facility will replace the existing one built in 1974 and proceed to supply gases to the refinery. It will go on stream in September 2008.

#### **Stronger presence in Africa**

In mid-2007, The Linde Group acquired the majority stake in the Algerian national industrial and medical gases company ENGI (Enterprise

Nationale de Gaz Industriels). With ten production locations, ENGI is Algeria's leading gases company. It employed a staff of around 700 and generated revenue of approximately EUR 32m in fiscal 2006.

This transaction means Linde is now able to position itself as the leading full-line supplier of industrial and medical gases on Algeria's rapidly growing market.

After Egypt, Algeria is the second-largest industrial gases market in North Africa. The market volume for the entire region currently amounts to EUR 200m and experts put annual growth at around 15 percent.

Alongside our ongoing activities south of the Sahara, this acquisition will help cement our position on the African continent.

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**Innovative engineering technology for renewable energy** → Our acquisition of Swiss plant engineering and construction company Bertrams Heatec AG represents another promising extension to our portfolio. Bertrams is a leading specialist in the construction of systems for the safe transfer of process heat, primarily for the chemical and petrochemical industries. These systems are used in manufacturing artificial fibres, synthetic resins (melamine), aluminium oxide and dyestuffs for applications in the textile and food industries and in solar power plants. Headquartered in Pratteln (near Basel), the company employs a staff of 35 and generated sales of approximately EUR 15m in 2006. Linde will continue to operate Bertrams Heatec as an independent subsidiary. This acquisition will enable us to open up new business opportunities in the heat transfer system segment, with solar power plants offering particularly high growth potential.

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Linde has established itself as a key gases and engineering partner for the most varied industries in North Africa and on the Arabian Peninsula – regions with huge natural gas reserves. In the United Arab Emirates, we are working with our joint-venture partner ADNOC to construct on-site facilities for the long-term supply of industrial gases to customers in Abu Dhabi. And in Africa, we acquired a majority stake in the industrial and medical gases company ENGI, thus further strengthening our footing on this continent.

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A large, modern auditorium with a curved wooden ceiling and yellow seats. The text "the spirit of improvement" is overlaid on the image.

the spirit of  
improvement





# Improvement //

## Innovation knows no boundaries

Industrial and medical gases, coupled with professional, efficient application equipment, have the power to improve processes, replace hazardous substances and help people. This holds true across a broad spectrum of industries, from food to metal processing and from chemical to pharmaceutical/medical. At The Linde Group, we bundle our application know-how and work closely with our customers to keep unlocking new and cost-effective fields of application for the widest range of gases. And once again, our efforts in this area paid dividends over the past fiscal year.

To drive sustainable growth in our business with industrial and medical gases, we are constantly investigating new fields of application. At the same time, our experts also collaborate closely with our customers to systematically optimise proven gas applications and process technologies. Our mission is to make existing customer processes even more efficient, safe, environmentally friendly and economically viable, at the same time paving the way for totally new solutions.

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### Gases in medicine and pharmaceuticals

At The Linde Group, medical gas operations and supporting services are bundled in the Healthcare Global Business Unit (GBU). This is subdivided into Hospital Care, covering hospitals and doctors' surgeries, and Homecare, for chronically ill patients. Under the umbrella of the Healthcare GBU, dedicated global teams collaborate closely with our Innovation & Development unit and the individual national organisations. This ensures we are in a position to implement new products, applications and services in healthcare rapidly and successfully across the regional markets.

The acquisition of BOC has positioned The Linde Group as the global market leader for medical gases and associated hospital therapies. We supply healthcare institutions with medical gases for applications ranging from anaesthetics to surgery and from intensive care to pain relief.

Through our Homecare business, we now deliver medical gases, equipment and services to around 150,000 patients in more than

40 countries, primarily to treat respiratory diseases such as COPD (chronic obstructive pulmonary disease, see glossary). Since 2004, we have also been operating special treatment centres, in which specialised therapists deliver high-tech care to ventilated patients over extended periods.

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### Promoting science and research

The therapeutic potential of medical gases is nowhere near exhausted. For over 15 years now, Linde has been working intensively with research institutes, hospitals and individual scientists to conduct scientific and clinical research into new gas applications. We support and promote these efforts with research funds and grants.

#### GEMI Fund

In October 2007, our Linde Gas Therapeutics business unit, in conjunction with the Karolinska Institute (Stockholm, Sweden) and Harvard Medical International (Boston, US), awarded a total of USD 1 m to eight scientists under the umbrella of our Gas Enabled Medical Innovations (GEMI) Fund. Together with these partners, Linde has been supporting leading scientists and medics since 2003, allocating the GEMI Fund every two years to enable intensive research into medical gases. This also allows us to develop new diagnostic and therapeutic solutions based on the results, helping patients across the globe.





Left: Rapid assistance in accidents and acute illness – the LifeLine resuscitation kit combines oxygen supply with an automated external defibrillator (AED) and oxygen suction apparatus for effective first aid in emergencies. Right: Central gas supply station at the Jena-Lobeda university hospital, Germany.

### Inspire Award

Established in 2005 by BOC Medical, the Inspire Award has been continued by Linde Gas Therapeutics since 2006. Its aim is to promote empirical research into clinical applications of gases.

Last year, we used the Inspire Award to support a remarkable project – Caudwell Xtreme Everest. This entailed a team of doctors climbing Mount Everest, the highest mountain in the world. Led by the doctor and mountaineer Mike Grocott from the Centre for Aviation, Space and Extreme Environment Medicine (CASE) at University College London (UCL), 23 scientists and 200 volunteer test subjects climbed to the base camp at 5,300 metres to research the impact of lack of oxygen on the heart, cognitive abilities and the muscular system.

Thanks to numerous tests and blood samples taken at extreme altitude and low oxygen levels, the project provided new insights into the optimum treatment of patients suffering severe oxygen deficiency or chronic respiratory diseases. This has enabled development of new treatment methods and ventilation equipment. On 23/24 May 2007, a team of five doctors even scaled the summit of Mount Everest to perform further tests and take blood samples there. The 8,848 metre climb was also intended to increase medical understanding of how the human body adapts to low oxygen supplies and why people react differently to oxygen deficiency.

These findings and resulting improvements to treatment methods will ultimately be of particular benefit to patients suffering

acute respiratory distress syndrome (ARDS) – progressive lung failure – and cystic fibrosis, as well as “blue babies”, who suffer from oxygen deprivation at birth.

To attain important basic data, 40 Linde Group employees at our Guildford location in Surrey, South England, volunteered to participate in several cardiovascular and blood tests prior to the expedition.

Linde Gas Therapeutics supported Caudwell Xtreme Everest with financial aid totalling GBP 300,000, as well as providing calibration gases and medical oxygen for the project.

### Clinical trial to treat bronchiolitis with heliox

The Linde Group is collaborating with a medical team at the prestigious Imperial College, London, on a three-year clinical trial to investigate heliox – a mixture of helium and oxygen gas – as a treatment for the viral lung disease bronchiolitis. This illness affects the bronchioles (smaller airways branching off the bronchial tubes) and is particularly painful for babies, even proving fatal in isolated cases. Heliox is already used successfully in adults and older children, but there had not previously been any research into its suitability for infants under two years. The current trials started in three London hospitals and were then continued in Australia over the last year. A BOC team spent five months treating affected babies in a hospital in Adelaide.

Many doctors are convinced that heliox ventilation could benefit thousands of babies, as it alleviates coughing and breathing

**Lifeline service on path to success** → Our LifeLine resuscitation kit portfolio for first aid in emergencies is meeting with growing interest on the market. We have expanded our selection of oxygen therapy equipment to include an automated external defibrillator (AED) and oxygen suction apparatus, dramatically widening our target market. Whereas prospects in the past were limited to hospitals, emergency medical services and doctors' and dentists' practices, our new innovations have expanded our potential market to include all heavily frequented institutions and public places such as office and factory buildings, stations, airports, sport and leisure centres, bars and nightclubs.

A key factor behind the lively interest in this equipment is its simple operation, with spoken instructions facilitating usage by the general public. We are also seeing growing awareness of the importance of rapid assistance for heart-attack victims. Survival chances following a heart attack drop 10 percent with every minute that passes without treatment.

We launched our LifeLine service in Europe and the US during the last fiscal year and will be rolling it out to additional markets in the near future.

A team of scientists set out to conquer Everest with material and financial support from Linde Gas Therapeutics, performing extensive tests to research the effects of oxygen deprivation on humans. The objective of the expedition was to gain valuable insights into the optimum treatment of patients suffering severe oxygen deficiency or chronic respiratory diseases. The Caudwell Xtreme Everest project took 23 scientists and 200 voluntary test subjects up the highest mountain in the world.

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*In medicine, gases are used not only to ventilate patients with respiratory diseases, but also in laser eye surgery and for sterilising medical equipment.*

difficulties associated with bronchiolitis and significantly reduces the duration of the illness. To provide scientific support for these assumptions, BOC contributed GBP 2m as well as providing the gases for the clinical tests.

#### Paediatric pain relief

LIVOPAN™, another gas from our therapeutics portfolio, has already proven its worth in the treatment of children. This analgesic is widely used for both outpatient and inpatient care. This gas mixture consists of nitrous oxide or laughing gas (N<sub>2</sub>O) and oxygen (O<sub>2</sub>) in equal parts. Its analgesic and sedative qualities make it ideal for use in infant medicine, for instance for injections or lumbar punctures, outpatient surgery or suturing wounds. Information collected from children, parents and medical staff confirms the positive impact of LIVOPAN™. In one study, 90 percent of parents and nurses surveyed reported positive effects from treatment with nitrous oxide and oxygen. Other analyses showed that 95 percent of children did not notice receiving an injection after treatment with LIVOPAN™ and that its analgesic effect leads to improved acceptance of subsequent treatment stages.

In view of these findings and the proven success of this product in Europe, we also launched LIVOPAN™ in Brazil last year. We anticipate rising sales potential here, particularly since the government is strongly supporting the development of pain-relief strategies in paediatric care.

#### Curing cluster headaches

At the International Headache Congress in Stockholm last summer, the results of a study by Prof. Peter J. Goadsby, a leading headache expert at the Institute of Neurology in London, were presented. This study looked at the use of oxygen in treating cluster headaches. On inhaling oxygen following sudden onset of an attack, 80 percent of participating patients experienced significant pain relief within 15 minutes. These findings therefore provide additional evidence for the high success rate of oxygen therapy and should serve to promote it further.

Cluster headaches can be extremely intense and present as repeated attacks lasting 15 to 180 minutes if untreated. Men between 20 and 50 years of age are particularly susceptible. Launched last year, our cluster headache programme aims to significantly increase the number of patients receiving oxygen therapy. We therefore kicked off campaigns in several countries during the reporting year to raise awareness of this illness among neurologists and promote the positive effects of oxygen.

**Sterilising medical equipment** → The many applications of ethylene oxide (EO), a colourless gas with a sweet smell, include its use as a sterilising agent. In addition to the treatment of organic insulating materials such as wool or vegetable fibres, it is used in particular to sterilise medical equipment. Alongside syringes, surgical instruments, catheters and blood bags, this also includes supplies such as bandages and sutures.

Following the acquisition of BOC, The Linde Group has gained a strong foothold in the booming medical sterilisation market

with EO. Through our Belgian affiliate Chemogas, we are one of the world's leading suppliers of EO and specialty gas mixtures in this field. We currently supply customers in around 40 countries from our filling and mixing facilities in Belgium, Great Britain, Turkey, Malaysia, Thailand, Indonesia and Australia and plan to expand this business area further worldwide, particularly in the emerging Asian markets.

### Professional treatment in care centres

An area of growing importance for our Homecare segment is the challenge of bridging the gap between hospital and home treatment for chronically ill patients. That is why Linde is systematically expanding its care centre concept. Once patients have been diagnosed, trained staff in these hospital-based facilities assist them in learning how to use the medical equipment they will need for subsequent treatment and therapy at home.

We also continued to build on our REMEO® supply concept for patients in need of long-term ventilation. During the year under review, we opened other centres for mechanically ventilated patients in a Berlin clinic and in Colombia. We are also experiencing strong interest in the REMEO® concept in Italy and various South American countries. These centres allow individual treatment of long-term ventilated patients, offering a far higher quality of life than is feasible during protracted hospital stays – and at much lower costs. The cost factor resonates in particular among health insurance companies. Depending on the patient's condition and the family support network, Linde Homecare also offers a home transfer service. The patient continues to receive care from our qualified professionals in the home. Altogether, we see strong growth potential for both REMEO® and our new care centres over the coming years.

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### Gases for environmental protection and safety

There is practically no limit to the potential applications and diversity of industrial gases. An atmospheric gas mixture enables low-impact pool cleaning, for instance, while carbon dioxide provides a safe, eco-friendly way to control fires in waste bunkers. And our special VAPORMATE™ product has proven its value as a pesticide.

#### POOLGON for healthy swimming

In an ideal world, the water in your swimming pool would stay clean without chlorine-based chemical treatments, would not irri-

tate the skin or eyes, and would be refreshing and free of strong odours. And that is exactly the thinking behind the new water purification system from our Swiss affiliate PanGas, harnessing the naturally occurring gases carbon dioxide and oxygen. The POOLGON mixture maintains the pH value of the water at an optimum level thanks to carbonic acid, while also raising the ratio of pure oxygen in the pool.

To ensure lasting protection throughout the entire swimming pool, a small amount of water is constantly extracted downstream of the circulation system filter. This is channelled through a plate capacitor, creating an electric field, which then disinfects the water. This process kills bacteria and germs throughout the pool. The environmentally friendly system can be installed in any swimming pool without major outlay – opening up a promising market for our cylinder gases business.

#### Controlling fires in waste bunkers

Environmental protection and safety inspired our innovative solution for combating fires in waste bunkers at incineration plants. Smouldering fires frequently break out in the stored waste, often releasing highly toxic fumes deep down in the deposits. While fires on the surface of the waste can easily be removed by grabbers and transferred to the incinerator, fires deeper down cannot even be extinguished with water or foam, since these agents are not able to reach the source of the fire.

Our recently developed process solves this problem by using special nozzles to pipe carbon dioxide directly to the source, where it quenches the fire, preventing further release of toxic and pollutant fumes. An additional benefit is that using carbon dioxide keeps the waste dry and easier to incinerate than it would be following the use of liquid fire-fighting agents.

We have applied for a patent on this innovative extinguishing system and a major European energy supplier has already installed it in ten German waste incineration plants as a new safety standard. The solution offers promising growth prospects for The Linde Group.

#### Innovative pest control

Another valuable contribution to health and environmental protection comes from VAPORMATE®, Linde's new pest control solution. After



*The many and varied applications of industrial gases include carbonating drinks and protecting bananas and pineapples against pests.*

initial success in Australia and the Philippines, we anticipate that this technology will also take hold in North and South America, Africa and South-East Asia – in other words, in regions with significant crops of tropical fruits.

We are seeing particular interest in VAPORMATE® from food manufacturers, as its application can be tailored to meet the differing requirements of the individual products to be treated. In October 2007, our subsidiary Southern Industrial Gases (SIG) agreed a supply contract with Dole Asia Ltd, a subsidiary of Dole Food Company. This covers VAPORMATE® supplies as well as logistical and technical support for Dole Stanfilco's banana plantations in the Philippines. VAPORMATE® has a substantially lower impact on the environment than the methyl bromide previously in general usage, for example. This toxic gas has been identified as damaging to the stratospheric ozone layer. Most countries have therefore banned its use under the Montreal Protocol, signed by around 160 nations.

Extensive tests performed in collaboration with Dole have shown that VAPORMATE® also yields excellent results when applied to pineapples.

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## Innovations for the food industry

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Consumers and authorities are placing increasingly high requirements on the quality and shelf-life of foods and drinks, stimulating demand for both gaseous and liquefied gases. Food-grade gases are used, for example, to chill and freeze foodstuffs, protect against germs, maintain freshness in packaged goods and carbonise drinks.

### Low-impact freezing with CRYOLINE® MT

Since the launch of our CRYOLINE® MT tunnel freezer in 2005, its efficiency and reliability has benefited 40 food-industry customers worldwide. Building on this success, we rolled out our system for fast and gentle freezing in the US in October 2007. CRYOLINE® MT is the first cryogenic freezer that complies with the extensive health regulations from the US Department of Agriculture and the American Meat Institute. It represents an important contribution by Linde to hygienic, high-quality preservation of fresh foodstuffs such as fish, meat, fruit and vegetables. CRYOLINE® MT uses the low temperature of liquid nitrogen ( $-196^{\circ}\text{C}$ ) or carbon dioxide ( $-78^{\circ}\text{C}$ ) to freeze products rapidly and with low impact. In comparison with other freezer systems, CRYOLINE® MT is more powerful, uses less coolant and retains more of the product's natural liquid content, which, in turn, preserves flavour and appearance.

### Serving 40,000 drinks in 15 minutes

Dispensing fresh, cool drinks on a large scale in a major football stadium is certainly a mammoth task – and not only for those at the taps. The gas supplier also has to rise to a complex technical and logistical challenge, especially when the mission is to pour 40,000 drinks in 15 minutes while keeping gas cylinders out of the gangways. That was the order from FC Arsenal, London, and our Gases Division delivered the solution – a system comprising eight large containers for liquid  $\text{CO}_2$  and several large gas-mixture cylinders to supply the many dispensing points on different levels of the stadium.

We also received a major order from Coca-Cola in 2007 to provide  $\text{CO}_2$  for the company's filling plant in Cork, Ireland.

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**Sureserve Safe Cellar Award** → In October 2007, our British subsidiary BOC Sureserve presented its first gas management award for the safest and best-maintained pub cellar. This inaugural prize went to the licensees of the Ship Inn in Winchester, whose cellar impressed with its gas cylinder storage and safeguards, easy access and effective lighting. BOC Sureserve supplies more than 53,000 British pubs, restaurants and bars with dispense gases and associated installations and safety systems.

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**Cooling down in the kitchen** → Linde has developed a cryogenic flour cooling and conveying process for wholesale bakeries that keeps flour and other ingredients at an optimum temperature at all times. This helps improve the quality of baked goods, while reducing the reject rate by over 50 percent. We unveiled this new technology to great acclaim at the International Baking Industry Exposition in Orlando, Florida, in October 2007. Our cooling system maintains flour, sugar, sourdough and other ingredients at the desired processing temperature even when ambient temperatures exceed 30 degrees Celsius.

#### Sparkling water from the tap

Linde is currently experiencing great success in Sweden with a new water carbonator. This can be connected directly to domestic water systems, supplying soda from the tap on demand. Our Swedish subsidiary AGA launched this product last June in the midst of debates about the environmental and economic impact of buying bottled water when high-quality drinking water is already available in every household. We are also planning to offer this carbonator throughout Scandinavia and Finland in the future.

#### Partner for production processes

Industrial gases, application technologies and user-friendly gas-supply systems are used in almost all industries to ensure high-quality, safe, efficient and cost-effective production processes. Examples from the metal processing and plastics industries illustrate this to good effect.

#### Global success with LASERLINE®

Laser treatment is gaining importance in the metal processing industry. Under our LASERLINE® products and services brand, we provide our customers worldwide with comprehensive solutions for laser beam treatment, in particular laser-cutting and laser-welding. Our offering here includes process gases and gas mixtures for laser-cutting and laser-welding metals (see glossary). The composition of these gases takes account of the material's metallurgical properties and they can be tailored to specific types of alloy and particular tasks. Linde is a leading supplier in this field and cooperates closely with manufacturers of lasers and laser systems as well as with users across the automotive, space, electronics and consumer goods industries, for instance. Our LASERLINE® programme has become a byword for best-in-class performance and quality standards plus reliable service across the globe.

This strong reputation also played its part in securing a long-term cooperation agreement with Bystronic Laser AG, a Swiss manufacturer of laser-cutting systems with operations worldwide. Under this agreement, Bystronic Laser is relying on Linde for the predictable, global supply of high-quality gases for its new ByVention lasers.

#### Eco-friendly use of separating agents with CO<sub>2</sub>

In the plastics processing industry, moulds for manufacturing plastic parts from polyurethane (PUR) foam are coated with wax, which acts as a separating agent. Previously, applying the wax to the surface of the mould involved dissolving it in organic solvents or VOCs (volatile organic compounds, see glossary) and spraying it into the mould using compressed air. The VOCs then evaporated from the hot mould into the surrounding atmosphere – with damaging effects for employees and the environment. The European Union has therefore imposed stringent restrictions on the use of VOCs.

Linde has now developed a far more eco-friendly alternative to this process. Our solution uses compressed liquid carbon dioxide as the solvent and carrying agent for the concentrated wax. This enables a significant reduction in the use of VOCs without necessitating any large technical investments. This substantially reduces the impact on the environment. In addition, this process allows manufacturers to comply with strict environmental regulations. For this application, the development engineers in our Gases Division are working in close collaboration with Chemtrend, a leading producer of separating agents and another innovative customer in this field.





Linde has developed a special process for wholesale bakeries that keeps flour and other ingredients at an optimum processing temperature at all times, even in warm surroundings. This improves the quality of the goods and reduces the reject rate by over 50 percent.



Linde is continuing the international roll-out of its eco-friendly recycled-CO<sub>2</sub> textile cleaning method under the FRED BUTLER® brand. Our plan is to establish a strong foothold for FRED BUTLER® on the European market by 2011. Following successful trials, we opened 16 service shops and textile cleaning stations and three major plants in Germany by the end of 2007.

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## Success through service

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Comprehensive service offerings are a key success factor in the gases business. One example of this at Linde is our user-friendly cylinder gas handling solution – VIVANTOS™.

### Convenient cylinder system

Linde's VIVANTOS™ cylinder system is a family of cylinder valves with integrated pressure regulators, available to various different specifications. Safety, speed and convenience are the trademarks of this product line. These valves are protected against external impact with a robust aluminium cap. The valve is accurately set to the customer's specific pressure rating and automatically blocked when the cylinder is not in use. Thanks to the quick-fit design, these valves ensure that gas is always on tap, eliminating the hassle involved in changing pressure regulators.

The high pressure of up to 300 bar combines with a lower geometric volume to significantly reduce the weight of these cylinders and shift the centre of gravity downwards. This makes them easier to handle, although they still have the same capacity as the traditional 50 litre cylinders at 200 bar filling pressure.

We developed this system over the previous year in collaboration with BOC and started by rolling it out in Great Britain and the Benelux countries. Western Europe, Canada and Australia are set to follow during the current fiscal year. Our intention is to expand the VIVANTOS™ range in the future, offering a product tailored to the needs of each Regional Business Unit.

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## Textile cleaning with CO<sub>2</sub>

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Service is also central to our latest venture – eco-friendly textile cleaning with recycled CO<sub>2</sub>. This service is provided by our Cleaning Enterprises GmbH subsidiary under the FRED BUTLER® brand. Alongside the innovative cleaning process itself, FRED BUTLER® also offers a novel service – drop-off points within companies. So the employees of banks, insurance providers or publishing houses,

say, can bring clothes to the workplace and get them back 48 hours later, clean and ready to go.

Having successfully completed the test phase of the FRED BUTLER® concept in Frankfurt, we took the next step last year, opening five shops, a central cleaning plant and several drop-off points in Munich. In November, we continued with a cleaning plant and three shops in Nuremberg. And in September, a shop opened in Erlangen. This brought the total in Germany to 16 FRED BUTLER® service shops and textile cleaning stations and three plants by the end of 2007. We plan to step up our activities in the B2B space, cooperating for example with large hotels and textile leasing companies.

October 2007 saw the first franchise shop and first office service depot in the Düsseldorf region. This franchise holder plans to operate its own cleaning plant in Düsseldorf as of May 2008.

FRED BUTLER® is planning to expand further in 2008, breaking into densely populated areas with ten franchise and four company areas across Europe. In the following years, from 2009 to 2011, we will continue to drive this new line of business.

FRED BUTLER® only uses liquid CO<sub>2</sub>, biodegradable washing agents and water. Low temperatures and a gentle spin action protect the clothing and enhance wearability. CO<sub>2</sub> cleaning thus prolongs the life of clothes by 30 to 40 percent. Thanks to the method's eco-friendly ratings, FRED BUTLER® is currently the only dry-cleaning company to have gained Blue Angel environmental certification and the Scandinavian Nordic Swan Award, both of which we received last year.

All in all, FRED BUTLER® is an excellent example of how industrial gases can be innovatively applied in conjunction with a successful service concept.





the spirit of  
pioneering







# Pioneering //

## Forging new paths

As a leading technology player, our mission is to find ways of using industrial gases to develop pioneering, environmentally friendly and cost-effective solutions. We complement our efforts in this area through close collaboration with partners in science, research and industry. This allows us to play an instrumental role in the move to establish hydrogen as an everyday energy carrier for stationary and mobile applications, for instance. We are also helping to optimise solar cells as a promising source of energy for the future. And we ensure a steady supply of the noble gas helium in the purities and volumes required for the most varied high-tech applications.

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### On the road to a hydrogen-based society

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Once again, we have undertaken numerous activities in the reporting year to continue developing hydrogen (H<sub>2</sub>) technology, harness its environmental benefits, and increase its acceptance by both the general public and political decision-makers. A key focus here was sustainable hydrogen-based mobility. For years now, Linde has been among the trailblazers in developing this eco-friendly technology and covers the entire hydrogen value chain, from production to vehicle fuelling. Over the last year, we have participated in a range of demonstration projects with vehicle manufacturers across the globe, established additional H<sub>2</sub> filling stations and made further progress in gradually setting up an H<sub>2</sub> infrastructure.

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### H<sub>2</sub> partner for the automotive industry

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During 2007, Linde collaborated with almost every major vehicle manufacturer at various events all over the world, successfully demonstrating the capabilities of mobile H<sub>2</sub> technology and the suitability of hydrogen as an everyday fuel.

### Around the world with hydrogen

Linde is BMW's exclusive hydrogen partner for the second CleanEnergy world tour, presenting the limited-series "BMW Hydrogen 7" vehicle across the globe. In addition to European demonstrations in Great Britain, France, the Netherlands and Switzerland, the tour also took us to the US and China last year, with over 60 events altogether.

Linde was on hand at four Chinese locations between April and October last year – Shanghai, Beijing, Guangzhou and Hong Kong – to supply the BMW Hydrogen 7 with hydrogen from a mobile filling station.

As in Shanghai and Beijing, the partners also used a CleanEnergy forum to showcase the possibilities of hydrogen technology in Hong Kong. This was held jointly with the University of Hong Kong and various government agencies. Here we offered participants – including customers, politicians and scientists – the opportunity to test-drive an H<sub>2</sub> vehicle and observe the fuelling process.

In March 2007, we participated in the National Hydrogen Association (NHA) conference in San Antonio (US). Alongside liquid hydrogen for the BMW saloons, we also supplied gaseous hydrogen for vehicles from Mercedes Benz, Honda, Toyota, General Motors and Volkswagen.

### Unveiling the LIFECar

The LIFECar is a new sports car developed by the British manufacturer Morgan in partnership with the universities of Cranfield and Oxford and the British Department for Business, Enterprise and Regulation (DBER), with support from BOC. The car is powered by four electric motors (one at each wheel), which draw their energy from an ultra-small and light fuel cell (see glossary). This converts hydrogen supplied by BOC and oxygen from the air into electrical energy.



The braking and surplus energy in turn charges a double-layer capacitor, which releases its power during acceleration.

Visitors were able to gain a first impression of the new model at the Grove Fuel Cell Symposium in September 2007 in London.

The LIFECar will officially be unveiled at the Geneva Motor Show in March 2008.

#### **Putting fuel cells to the test**

The latest version of the Honda FCX fuel cell concept vehicle also met with great interest at its launch in June 2007 on the Swedish island of Gotland. Linde ensured that the demonstration and initial test drives ran smoothly with a mobile hydrogen filling station.

The vehicle is powered by three electric motors with a total output of 129 hp. To generate electricity from hydrogen and oxygen, the fuel cell requires around 30 litres of hydrogen per 100 kilometres. The FCX vehicle has a range of 570 kilometres and therefore provides a good example of the suitability of this green technology for general usage.

Marketing of the Honda FCX is to begin in 2008 to test the car in everyday use. A limited series of 100 vehicles will be available in Japan and the US under a leasing model.

#### **Hydrogen stacks up against the elements**

We also worked with Toyota in the reporting year, using a mobile hydrogen filling station to supply the new fuel cell hybrid vehicle (FCHV) on tour. It took the fuel-cell-powered vehicle seven days to travel the 3,700 kilometres from Fairbanks in Alaska (US) to Vancouver (Canada). The FCHV drove the first 505 kilometre leg without a fuel stop and subsequent analysis showed that it could have covered more than 100 km further. Even in extremely cold weather conditions, the vehicle and fuelling system both proved highly reliable.

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## **Establishing the H<sub>2</sub> infrastructure**

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The widespread use and acceptance of hydrogen for regular road traffic hinges not only on the delivery of enabling everyday technologies at competitive costs, but also on the establishment of a suitable infrastructure. A sufficiently dense network of H<sub>2</sub> filling stations is essential to ensure the long-term breakthrough of hydrogen-powered transport. And that is why Linde is committed to installing fuelling systems in all relevant markets, collaborating on pilot projects for stationary filling facilities in densely populated areas and providing mobile refuelling units for the numerous demonstrations of vehicles powered by fuel cells or liquid hydrogen combustion engines.

#### **Filling station at Hamburg airport**

Airports make particularly good candidates for pilot projects dedicated to the development of local hydrogen infrastructures. So it made sense for Linde to develop and construct the most modern H<sub>2</sub> filling station to date for Hamburg airport. Since May 2007, the transportable refuelling unit has been supplying a people carrier and two fuel-cell-powered tow trucks from STILL. Since the tow trucks have an operating pressure of 350 bar and the pick-up 200 bar, we installed two separate pump systems. In each case, fuelling takes seven minutes at most.

The acquisition of CO<sub>2</sub> certificates ensures that the hydrogen used at Hamburg airport is climate-neutral. The compensation of emissions through certificates from a climate protection project has been inspected and awarded a seal of approval by the TÜV SÜD technical service group. Our goal is to meet the hydrogen requirements of the test fleets using sustainable production methods within the foreseeable future. The project is planned to run for two years as a collaboration between The Linde Group, Hamburg Airport and local hydrogen initiatives.

#### **First H<sub>2</sub> filling station for Shanghai**

In China, Linde was heavily involved in the planning and construction of the first hydrogen filling station in Shanghai, opened in November

The new hydrogen liquefaction plant in Leuna, our largest gas production site in Germany, has a capacity of around 33,000 litres liquid hydrogen (LH<sub>2</sub>) per hour. Once it comes on stream, scheduled for Q1 2008, it will be supplied with gaseous raw hydrogen via pipeline from the adjacent hydrogen production facilities. Thanks to its higher storage density, cryogenic LH<sub>2</sub> offers clear benefits over gaseous hydrogen, including more efficient transport.





*Linde covers the entire hydrogen value chain – from production through liquefaction and storage to fuelling systems and filling stations. We work closely with partners in the automotive and petroleum industries to take hydrogen technology forwards.*

2007. This represents an important milestone on the way to establishing a hydrogen infrastructure in China. Designed to supply fuel-cell vehicles, the high-pressure hydrogen refuelling station was realised under the patronage of China's elite Tongji University, in collaboration with Linde and Shell Hydrogen. Linde not only delivers the facility with compressed gaseous hydrogen (CGH<sub>2</sub>), but also co-developed the technology for storing and dispensing the gas.

The refuelling station is located in Anting New Town, near Shanghai International Auto City. It will supply three fuel-cell buses with 45 kg of hydrogen each and 20 fuel-cell cars with up to three kg of hydrogen each.

With this project, Linde is pleased to support China in its first step towards realising its ambitious plans to commercialise fuel-cell vehicles.

#### **Bringing hydrogen to the Czech Republic**

We are also enthusiastic about the order we have received from the Czech Nuclear Research Institute to construct and supply the country's first hydrogen filling station near Prague. This facility is scheduled to open in November 2008 and will provide H<sub>2</sub> for fuel-cell buses. There are also plans for fuelling systems to refuel other hydrogen vehicles.

**Germany's second H<sub>2</sub> liquefaction plant** → To meet the rising demand for liquid hydrogen (LH<sub>2</sub>) – particularly from the electronics industry – we officially opened a second hydrogen liquefaction plant in September 2007 in Leuna, our largest gas production site in Germany. Linde also operates Germany's first plant of this kind, located in Ingolstadt. In view of the increasing use of hydrogen as a vehicle fuel, we see this second liquefier as a sound investment in the future.

The new liquefier in Leuna has a capacity of around 33,000 litres LH<sub>2</sub> per hour (approximately five tons per day). Once it comes on

#### **Innovative gas applications for the photovoltaic industry**

Demand for electronic gases in the semiconductor and solar cell industries continues to outpace global GDP growth by more than two times. In traditional semiconductor segments such as microchips and flat panel displays, market researchers expect sales growth of around 8 percent per year between now and 2010 – and for the solar segment, the annual forecast lies at around 30 percent. Experts anticipate that from 2012, photovoltaic producers will spend more on gases than flat-screen manufacturers, and from 2017 they are even set to overtake the chip sector. Although only a handful of different gases are used in solar-cell manufacturing – in comparison with more than 20 for semiconductors – the volumes required are significantly greater. As a leading partner for the electronics industry, Linde provides electronic gases for eight of the top ten semiconductor manufacturers worldwide and is now gaining an increasingly strong foothold as a supplier to the photovoltaic industry.

Gases play a versatile role in a wide range of process steps in manufacturing semiconductors and solar cells. Electronic gases are used for etching, doping, layer removal and cleaning process chambers, for instance. Gases such as nitrogen, argon, helium, hydrogen, ammonia, silane, sulphur hexafluoride (SF<sub>6</sub>) and nitrogen

stream, scheduled for Q1 2008, it will be supplied with gaseous raw hydrogen via pipeline from the adjacent hydrogen production facilities. This is then liquefied at a temperature of -253 degrees Celsius and pumped into LH<sub>2</sub> tankers at special filling stations for transport to the customer.

Thanks to a storage density significantly higher than that of gaseous hydrogen, cryogenic LH<sub>2</sub> offers clear efficiency gains in transport and logistics. The very high purity of LH<sub>2</sub> also makes it the ideal fit for the exacting requirements of the electronics and solar cell industries.



trifluoride (NF<sub>3</sub>) are used in large volumes, while Fluorine (F<sub>2</sub>) of the highest purity is also becoming increasingly vital to production.

Linde has responded to this booming demand by establishing a global network of state-of-the-art production facilities, spanning Europe, the US and Asia, including China and Taiwan.

#### **Major new orders from the solar industry**

In Europe, the Linde Nippon Sanso Group – a joint venture between Linde and the Taiyo Nippon Sanso Corporation (TNSC) – supplies customers in the semiconductor and solar cell industries primarily from our electronic gases facility in Unterschleißheim, near Munich, which opened in 2006.

Since the middle of last year, these customers include Conergy, with its new production plant in Frankfurt (Oder), Germany. Based in Hamburg, Conergy AG is Europe's leading solar energy corporation and has placed a contract with us for our total gas and chemical management service. This involves providing all liquid and specialty gases for the new location, constructing and operating an on-site nitrogen production facility and developing and running a gas supply system. In addition to nitrogen, the long-term supply agreement also covers argon, helium, hydrogen, ammonia and silane.

#### **Partner for tandem layer technology**

Berlin is increasingly becoming a hub for the photovoltaic industry. As such, it is the location of choice for start-up company Inventux Technologies AG's production plant for thin-film solar modules, currently under construction. The plant will have an initial production capacity of 33 megawatt (MWp). This corresponds to 275,000 modules with a total area of 7,500 m<sup>2</sup> or around 60 football fields.

At the end of last year, Linde Nippon Sanso (LNS) received a long-term contract from Inventux to deliver all the necessary gases for the new solar cell plant, including an on-site facility for nitrogen production and supply. LNS will also be offering a total gas and chemical management service for the plant.

The Inventux plant will use the tandem layer process to produce the solar modules, rated by experts as one of the most promising thin-film technologies. The term "tandem layer" refers to two different semiconductor materials stacked in one cell – microcrystalline and amorphous silicon. This combination increases efficiency by around 50 percent in comparison with purely amorphous cells. The production process is also significantly more cost-effective and energy-efficient than that involved in conventional crystalline cells. Whereas the energy delivered by thin-film cells matches the energy required to manufacture them after two to three years, monocrystalline cells have double the pay-back period. Another major benefit

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**Thin-film solar cell technology – the hottest new trend** → Similar to microchip production, the construction of traditional crystalline solar cells is based on silicon wafers and therefore consumes large amounts of silicon. The new generation of thin-film solar cells, on the other hand, is no longer wafer-based (wafer, see glossary). Instead, the silicon is deposited in several thin layers onto other substrate materials such as glass, foil or ceramic.

The key benefit of thin-film cells is that they can be manufactured in much larger sizes and can therefore also be used as electricity-generating panels on the exterior of buildings, for example.

Linde supports the development of these new technologies both by ensuring a reliable flow of gas from our global production centres and distribution hubs and by leveraging our extensive know-how to enable intelligent gas applications, low environmental impact and optimum cost efficiency. We work in close cooperation with the organisations developing and producing these technologies, securing our pioneering position in this seminal market. Linde has been rewarded for its expertise and emerging market sector preparation and has captured more than 65 percent of the rapidly expanding thin-film solar market in 2007.

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The solar cell industry is currently experiencing a major growth spurt, with new production facilities springing up across the globe – and particularly in Europe and East Asia. Electronic gases play a key role in photovoltaic cell manufacturing. The image shows the solar panelling system on the roof of the Jakob-Kaiser building in Berlin, with the Reichstag dome in the background.

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Gases are indispensable for semiconductor manufacturing, as in chip production at the Infineon fab in Dresden, Germany, shown here. Electronic gases are used for etching, doping, layer removal and cleaning process chambers. Nitrogen, argon, helium, hydrogen, ammonia, silane, sulphur hexafluoride and nitrogen trifluoride play a particularly important role.





**Nanotechnology partner** → The proven partnership between Linde's Gases Division and the College of Nanoscale Science and Engineering at the University at Albany, State University of New York is confirmation that our products are equal to even the toughest demands. This leading global research and teaching institute for nanotechnology (see glossary) has renewed its supply contract with Linde for nitrogen, hydrogen, oxygen, helium and argon and also requested an on-site nitrogen generator with a capacity of 1,500 m<sup>3</sup>/h. We will be delivering the required hydrogen and oxygen from our production facilities in Quebec, Canada, and Vermont (New England), US, at a purity level that even exceeds stringent ultra-large-scale integration (ULSI) standards. Linde also offers additional purification and control units for nano manufacturing.

is that thin-form cells are deposited on ordinary glass versus the much more expensive and supply-constrained semiconductor-grade silicon wafers used for crystalline cells.

#### Thin-form solar cells for Spain

Solar energy is also experiencing an upturn in Spain, driven partly by the local climate. In line with this trend, T-Solar S. A. in Galicia is constructing the country's first production facility for thin-film solar cells. The Linde Group is a key partner in this project and will be supplying a wide range of high-purity gases for the production process. The plant will open for operation in mid-2008 and manufacture solar modules five times larger than the current standard. This will involve using the gases and supply units delivered by Linde to coat large glass plates with a thin silicon film. This process is intended to bring the price of electricity from photovoltaic facilities closer to grid parity (see glossary).

#### First photovoltaic cell plant for Austria

In Austria, Blue Chip Energy GmbH has launched a EUR 50 m project to build the nation's first photovoltaic cell plant. This will start producing highly efficient silicon-based solar cells from May 2008. Linde Nippon Sanso is providing all gases and supply equipment and will be delivering a total gas management service. At full capacity, the plant will be equipped to deliver 800,000 m<sup>2</sup> of solar cells annually – enough to provide power to 16,000 households.

#### Supplying electronic gases to the Far East

As in Europe, new production plants for silicon-based thin-film solar cells are also springing up in India and East Asia. There are plans to construct up to three solar cell facilities in Taiwan alone during 2008 and 2009 – fuelling rising demand for electronic gases.

Linde has already secured its first supply contract for argon, hydrogen, silane and nitrogen trifluoride (NF<sub>3</sub>) from NexPower, a subsidiary of the UMC Group. NexPower has selected Linde to be its gases partner for the thin-film solar cell facility it is building in Taichung, Taiwan. Gas deliveries will commence in the second quarter of 2008 and the plant will become fully operational during the following year. Breaking into this future-orientated market puts us in a strong position to win future orders of this kind in Asia.

### New technologies for zero emissions

The increasing use of electronic gases in semiconductor and solar-cell manufacturing also increases Linde's need for industry-leading stewardship to provide sustainable solutions. In particular, the deposition chambers, where the most important process steps take place, have extremely high cleaning requirements. The conventional cleaning gases sulphur hexafluoride (SF<sub>6</sub>) and nitrogen trifluoride (NF<sub>3</sub>) are harmful to the climate: an NF<sub>3</sub> molecule has a global warming potential around 11,000 times greater than that of a carbon dioxide molecule and an SF<sub>6</sub> molecule 22,000 times greater. Linde is rising to this challenge by developing technologies to prevent these gases being released into the atmosphere – either through recycling or through alternative applications using less harmful gases.

While SF<sub>6</sub> provides a reliable and cost-efficient means of cleaning deposition chambers, the gas must not be allowed to escape into the environment due to its harmful effects. Linde has developed a process for capturing the 50 percent unused SF<sub>6</sub> from the deposition chamber and recycling it back into the production process after purification. This closed-loop technology recaptures 100 percent of the residual gas for cost-effective reuse. Two of these SF<sub>6</sub> recycling systems are already in operation in German solar cell plants.

#### Eco-friendly alternative: new on-site fluorine generator

The other option is to eliminate the use of greenhouse gases in cleaning entirely, instead generating fluorine – the active cleaning agent – directly where it is required. Linde has developed a fluorine (F<sub>2</sub>) generator for the on-site supply of pure fluorine gas and mixtures with nitrogen or argon for semiconductor, LCD and solar-cell production. Fluorine is climate-neutral and the new process also speeds up cleaning, increasing plant productivity. In addition, switching from NF<sub>3</sub> to the fluorine generator does not require major modifications to existing distribution systems.

This innovative solution is already a proven success. We have installed 24 F<sub>2</sub> generators for customers now – twelve in manufacturing plants for 300 mm wafers and the other twelve in Korean and Japanese production facilities for LCD displays.

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**Eco-Snow for nanotechnology** → Environmental sustainability and cost-efficiency also take centre stage in a research project conducted by our subsidiary Eco-Snow Systems in collaboration with the Belgian research centre IMEC. Its purpose is to assess the effectiveness of cleaning electronic components with carbon dioxide “snow” in conjunction with solvent-based, non-oxidising chemicals. The aim is to establish a reliable and cost-effective method of removing photoresist after it has been implanted with high doses of ions, while not damaging exposed, nano scale semiconductor structures on the wafers. This is therefore a key technology with the power to enhance the manufacture of silicon-based electronic components.

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In summer 2007, the trade journal EUROAsia Semiconductor recognised Linde’s on-site F2 generator with its Materials Improvement Award 2007.

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## Helium – noble gas for high-tech applications

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The acquisition of BOC has also established The Linde Group as a leading supplier of helium (He) and related services. Demand for this noble gas is growing substantially worldwide, particularly in research and for industrial, electronic and medical purposes. Whether as a cooling agent for super-conductive magnets in magnetic resonance imaging (MRI, see glossary) and accelerator technology or as a lifting agent for airships and balloons – the unique properties of helium make it indispensable in a number of fields. Other applications of this versatile gas include manufacturing fibre-optic cables and semiconductors, producing laser technology and space systems, welding and cutting, and being the key element in breathing mixes used in deep sea diving. Helium is the least reactive of all gases and boasts a very low boiling point (–269 degrees Celsius), good thermal conductivity and high diffusibility.

In view of a brisk demand coupled with scarce resources, Linde has further expanded its production capacities and developed intelligent recycling technologies to keep this valuable element circulating in a closed loop for as long as possible.

### Australia’s first helium plant

In 2007, we continued preparations for the construction of a helium production and liquefaction plant in Darwin, Australia. Linde has signed a long-term agreement with the consortium Darwin LNG Pty. Ltd. covering the extraction of helium from the Darwin company’s liquefied natural gas (LNG) plant. Our Swiss subsidiary Linde Kryotechnik AG, a global leader in the design and manufacture of helium purification and liquefaction facilities, is responsible for construction.

The first of its kind in the southern hemisphere, the plant will boast an annual production capacity of around 750 tons or approximately six million litres of high-purity liquid helium. This will not only meet Australia’s entire helium demand, but also allow us to export two thirds of the output, primarily to customers in the Asia-Pacific region.

### 100th helium container from Helison Production

Helison Production Spa, a joint venture between Linde and the Algerian gas and oil company Sonatrach, recently celebrated a landmark anniversary – its helium production plant in Skikda, Algeria, delivered its hundredth container of helium on 12 September 2007. The plant has been operational since last April, supplying the European market with high-purity helium in liquid form.

The raw gas feedstock, a mixture of helium, nitrogen and methane, is drawn from three Sonatrach LNG plants. In helium production, the nitrogen is separated, liquefied and delivered back to Sonatrach to be used in the petrochemical industry. The methane is also returned to heat the boilers in the LNG plants.



*Our helium extraction plant in Skikda, Algeria (left) dispatched its hundredth container of helium in September 2007. Global demand for this noble gas continues to grow, with increased consumption for research purposes and in industrial, electronic and medical applications.*

The Skikda plant fills four to six containers of liquid helium per week, equivalent to eight million cubic metres per year. When a new LNG plant opens for operation in 2011, weekly production will increase to up to 13 containers, or an annual output of 16 million cubic metres.

#### Expanding our helium infrastructure

To ensure an optimum flow of helium for our customers in Great Britain, including Siemens Magnet Technology (SMT), Magnex Scientific and British Nuclear Fuels, Linde has constructed a new helium filling plant in Thame, east of Oxford. This commenced operations in mid-2007, replacing the former plant in Leeds. The new facility delivers both gaseous helium in compressed gas cylinders and liquid helium in special low-temperature containers. It is the largest plant of its kind in Great Britain and one of the largest in Europe, employing a staff of around 30 in double-shift operations to ensure a reliable supply for our customers. We were able to draw on our experience with the former plant in Leeds and similar facilities in the US to design a maximum degree of safety and efficiency in our new plant in Thame.

In 2007, we also expanded our helium infrastructure in the US by building two new, state-of-the-art helium filling plants in Houston, Texas and Orlando, Florida.

#### Safer driving with helium

A key factor behind the growing demand for helium is the emergence of new fields of application which are driven by its unique properties. The gas is increasingly being used to inflate side airbags in cars. Air cushions in the steering wheel and dashboard are only required to protect a car's occupants from injuries for few seconds during a frontal collision, so their heated gases can rapidly cool and dissipate. Side airbags however, must remain inflated for significantly longer times. This is essential to protect the head in a rollover scenario, which usually lasts much longer than a collision. And this is where the benefits of helium come into play – a cold-gas generator inflates the airbag with compressed helium or helium mixtures on impact and maintains a constant pressure for several seconds to protect the car occupants.

As a provider of helium for this application, Linde has signed a long-term agreement with iSi Automotive, an Austrian manufacturer of helium-argon cartridges. We have developed a system to ensure safe and reliable helium supply, comprising a station capable of docking large liquid helium containers, the necessary vaporiser, a compressor, a containerised control and data-transfer unit and four high pressure storage tanks to supply a steady flow of compressed helium. The entire system can be monitored and operated remotely.

**Helium recycling** → In order to use this scarce and valuable noble gas as economically as possible, helium is increasingly being captured, purified and returned to the customer process to be reused. Linde has developed a new, cost-efficient technology specially for helium recovery and recycling in fibre-optics production.

This solution involves collecting the He off-gas from the preliminary and final stages of fibre-optics manufacturing and removing the hydrogen chloride (HCl). The helium and the unreacted

chlorine are then separated, purified, treated and returned to the fibre optics furnace. Since the pre-stage of fibre-optics production uses most of the helium required in the manufacturing process, our innovative technology cuts overall helium consumption by around 70 percent. This results in significant cost savings for our customers. Linde developed this new solution in the Gases Division research and development laboratory in Murray Hill, US, and it has now been patented.



# Review of the year

## January

The Linde Group acquires the Russian company SaKiZ (ZAO Samarsky Oxygen Plant), a regional supplier of industrial gases located in Samara in southern Russia. The company, which has more than 200 employees, produces and distributes air gases (nitrogen, oxygen, carbon dioxide, helium and argon), in both liquefied and gaseous states. SaKiZ is the market leader in the fast-growing economy of the Volga region. With this acquisition, Linde strengthens its leading position in Eastern Europe.

## February

Linde receives an award for its innovative Hydrogen Centre in Lohhof near Munich from the federal initiative "Germany – Land of Ideas". On 21 February 2007, the Linde Hydrogen Centre, which combines the functions of a hydrogen filling station with those of a technology test centre, a training centre and a presentation platform, is officially designated one of the "365 Landmarks in the Land of Ideas". "This award is an incentive for us to continue working hard on sustainable mobility based on hydrogen," says Professor Dr Wolfgang Reitzle, CEO of Linde AG.

## March

The Linde Group sells the components business of its subsidiary BOC Edwards at a price of around EUR 685 m (GBP 460 m) to the international private equity company CCMP Capital. After its acquisition of The BOC Group plc and subsequent focus on the international industrial gases and plant construction business, Linde offers the BOC Edwards components business (vacuum pumps and components for the semiconductor industry) for sale. However, Linde retains the liquefied gases and electronic gases business.

## April

Linde acquires the Turkish industrial gases company Birlesik Oksijen Sanayi A.S. (BOS), a company in the Koc Group, at an enterprise value of around EUR 92 m. BOS is in the industrial gases and specialty gases business and in the 2007 financial year achieved sales of some EUR 19 m with around 190 employees. The acquisition of BOS is the second-largest transaction ever effected by Linde in Turkey, second only to the acquisition of Karbogaz A.S. in July 2006.

## May

The Linde Group intensifies its cooperation with the leading Hungarian chemical company BorsodChem Zrt. to supply industrial gases to BorsodChem's principal site in Kazincbarcika, Hungary. "With new investment of around EUR 100 m, we will add to the three existing plants in Kazincbarcika," says Dr Aldo Belloni, a member of the Executive Board of Linde AG. "As a result, this site will become one of the five most important Linde production sites for hydrogen and carbon monoxide worldwide."

## June

The Linde Group acquires a majority of the shares in the state-owned Algerian industrial and medical gases company ENGI (Entreprise Nationale de Gaz Industriels). ENGI, which has 10 production sites, is the leading gases company in Algeria and achieved sales in the 2006 financial year of some EUR 32 m with around 700 employees. After Egypt, Algeria is the second-largest market for industrial gases in North Africa. The current market volume in the whole region is EUR 200 m. The annual growth rate in the market is estimated to be 15 percent.

## July

Linde is awarded a contract for the turnkey construction of a natural gas liquefaction plant in Risavika near Stavanger in Norway by Skangass AS, a joint venture between the utility company Lyse Gass and the financial investor Celsius Invest. The contract value is around EUR 100 m. The natural gas liquefaction plant has a capacity of 300,000 tons per year and will supply liquefied natural gas (LNG) to customers in Scandinavia and in the Baltic region from 2010. The Linde subsidiary AGA Gas AB, the market leader for industrial gases in Sweden, will take delivery of one-sixth of the total production and distribute it itself.

## August

Linde embarks on a research project which will take several years, in collaboration with the University of Glasgow, Scotland, and the Gesellschaft für Unternehmensgeschichte, Frankfurt (GUG, a company for the promotion of research in business history), on the economic and technological significance of the international industrial gases sector. A team of scientists led by the American corporate historian, Ray Stokes, will examine sources and material worldwide and consult major companies in the industry sector. To support the project, Linde is also funding a doctoral scholarship at the University of Glasgow.

### September

Linde inaugurates a new air separation plant and Germany's second hydrogen liquefaction plant officially at its Leuna site. The additional investment at Linde's largest gases production site in Germany is around EUR 52 m.

Linde receives the 2007 Image Award. The prize, which is awarded jointly by the market research institute PRIME research international, the FAZ Institute (a subsidiary of Frankfurter Allgemeine Zeitung) and Deutsche Public Relations Gesellschaft, is for the best corporate media image in international opinion leader media in the previous twelve months. The jury justifies its choice on the basis of the successful restructuring and positioning of The Linde Group as a world-leading gases and engineering company, the sustained professionalism of its communications and the credible and comprehensive dialogue it has established with the public.

Europe's largest natural gas liquefaction plant on the Norwegian island of Melkøya near Hammerfest commences production. Over the last five and a half years or so, the Linde Group has been responsible for engineering, procurement and supervision of the assembly of the plant. The total value of the contract to Linde is some EUR 900 m.

The Linde Group enters into an agreement with RWE Power and BASF AG to develop new processes for the separation of CO<sub>2</sub> from combustion gases from coal-fired power stations. The collaboration will involve the construction and operation of a pilot plant at RWE Power AG's lignite-fired power station in Niederaußem, Germany, in which BASF's newly developed technologies and solvents for CO<sub>2</sub> separation, or CO<sub>2</sub> wash, will be tested. Linde is responsible for the engineering and construction of the pilot plant.

### October

The Linde Group achieves double-digit growth in sales and operating profit for the nine months to 30 September 2007, continuing its positive performance from the first six months of the year. "More than a year after our acquisition of BOC, I am pleased to say we are robustly placed and prepared for all eventualities," says Professor Dr Wolfgang Reitzle, CEO of Linde AG, at the presentation of the nine-month figures. "The Group reorganisation has been successful and we are much stronger now as we approach the tasks ahead." Linde gives a more precise forecast for the whole year 2007: "At a Group

level, we are expecting to achieve sales of around EUR 12 bn and operating profit of EUR 2.3 to 2.4 bn," explains CEO Reitzle. These figures represent a double-digit growth rate. Linde's medium-term objective remains the achievement of operating earnings of over EUR 3 bn in the 2010 financial year.

### November

The Chinese government opens the first hydrogen filling station in Shanghai. The Shanghai Anting Hydrogen Filling Station was designed and built through a collaboration between Tongji, the Chinese elite university, Linde and Shell Hydrogen. The filling station is part of the National 863 programme. This initiative, set up by the Chinese Ministry of Science and Technology, is driving forward the commercialisation of fuel cell vehicles.

### December

The Linde Group sets up a joint venture with The Abu Dhabi National Oil Corporation (ADNOC), United Arab Emirates, for the production and long-term supply of industrial gases to customers in Abu Dhabi. ADNOC Linde Industrial Gases Company Ltd is established under the name Elixir and will have ADNOC (51 percent of the shares) and Linde (49 percent of the shares) as shareholders. This joint venture is of major strategic importance to Linde, as ADNOC has access to around 90 percent of Abu Dhabi's oil and gas reserves, which are considered to be the fourth-largest oil and gas reserves in the world. The first phase of the new Elixir joint venture will be the construction of a USD 65 m air separation plant in the Industrial Zone of Ruwais, Abu Dhabi. The new air separation plant will supply nitrogen from the end of 2009 to industrial customers in Ruwais and will also produce liquefied nitrogen and oxygen.

# Supervisory Board

## Members of the Supervisory Board

**Dr Manfred Schneider**

Chairman  
Chairman of the Supervisory Board  
of Bayer AG

**Hans-Dieter Katte<sup>1</sup>**

Deputy Chairman  
Chairman of the Pullach Works Council,  
Engineering Division, Linde AG

**Michael Diekmann**

Second Deputy Chairman  
Chairman of the Board of Management  
of Allianz SE

**Dr Karl-Hermann Baumann**

Former Chairman of the  
Supervisory Board of Siemens AG

**Dr Gerhard Beiten**

Lawyer

**Dr Clemens Börsig**

Chairman of the Supervisory Board  
of Deutsche Bank AG

**Siegried Friebe<sup>1</sup>**

Chairwoman of the Works Council  
of Linde-KCA-Dresden GmbH

**Gerhard Full**

Former Chairman of the Executive Board  
of Linde AG

**Gernot Hahl<sup>1</sup>**

Chairman of the Worms Works Council,  
Gases Division, Linde AG

**Thilo Kämmerer<sup>1</sup>**

Trade Union Secretary on the Executive  
Board of IG Metall Frankfurt

**Klaus Peter Müller**

Chairman of the Board of Managing  
Directors of Commerzbank AG

**Jens Riedel<sup>1</sup>**

(appointed on 22 January 2007)  
Chairman of the Leuna Works Council,  
Gases Division, Linde AG

**Josef Schregle<sup>1</sup>**

(appointed on 22 January 2007)  
Manager responsible for finance and  
financial control, Engineering Division,  
Linde AG

**Josef Schuhbeck<sup>1</sup>**

(appointed on 22 January 2007)  
Chairman of the Schalchen Works Council,  
Engineering Division, Linde AG

**Professor Dr Jürgen Strube**

Chairman of the Supervisory Board of BASF SE

**Wilfried Woller<sup>1</sup>**

Member of the Managerial Board respon-  
sible for management sector 5, IG Bergbau,  
Chemie, Energie

<sup>1</sup> Employee representative.



## Supervisory Board committees

### Mediation Committee in accordance with § 27 (3) of the German Codetermination Law (MitbestG):

Dr Manfred Schneider  
(Chairman)

Hans-Dieter Katte<sup>1</sup>  
Michael Diekmann  
Gernot Hahl<sup>1</sup>

### Standing Committee:

Dr Manfred Schneider  
(Chairman)

Hans-Dieter Katte<sup>1</sup>  
Michael Diekmann  
Gerhard Full  
Gernot Hahl<sup>1</sup>

### Audit Committee:

Dr Karl-Hermann Baumann  
(Chairman)

Gerhard Full  
Hans-Dieter Katte<sup>1</sup>  
Dr Manfred Schneider  
Wilfried Woller<sup>1</sup>

### Nomination Committee:

(set up on 11 September 2007)

Dr Manfred Schneider  
(Chairman)

Michael Diekmann  
Klaus-Peter Müller

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## Imprint

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Our Annual Report, which includes the Linde Annual and the Financial Report of the Linde Group, is available in English and German. You can download either version from our website at [www.linde.com](http://www.linde.com). You will also find an interactive version of the Annual Report online.

If you require any additional information about the Linde Group, please contact our Investor Relations department. Our staff would be delighted to send you anything you need free of charge.

# Glossary

## **Cold box**

Completely encased and fully equipped, ready-to-use unit comprising heat exchangers to separate gases at low temperatures.

## **COPD**

Abbreviation for chronic obstructive pulmonary disease, a condition affecting the lungs.

## **Cracking furnace**

The most important component of a steam reformer, in which steam and heat are used to crack liquid or gaseous hydrocarbons into olefins such as ethylene and propylene.

## **Cryogenic air separator**

Plant that separates gas mixtures by applying extremely low temperatures. For instance, air is separated into oxygen, nitrogen and noble gases.

## **Fuel cell**

A system in which hydrogen and oxygen react to form water without combustion (cold burning), generating a significant amount of electrical energy. In this way, fuel cells transform chemical energy into electrical power.

## **Grid parity**

This term from the energy industry refers to a situation whereby solar electricity reaches parity with grid electricity prices (generated at a coal-fired power plant, for example). Certain sunny regions of the earth have already achieved grid parity. Interest in photovoltaic systems is highest on islands such as Hawaii that otherwise use diesel fuel to produce electricity. Once crude oil prices climb above the USD 70/barrel mark, grid parity becomes a reality.

## **HyCO plant**

Collective term for plants producing hydrogen, carbon monoxide and synthesis gas. These HyCO plants primarily comprise steam reformers, partial oxidation plants and methanol crackers.

## **Laser welding**

A procedure in which the energy required for soldering is obtained from a laser beam. The high intensity of the beam generates a vapour capillary at the welding point, enabling high-speed welding, deep penetration and minimal distortion.

## **Linde Multi-Stage Mixed-Refrigerant Process**

The LiMuM process is used for liquefaction of natural gas in small to medium-sized plants (<3 million tons LNG per annum). The cooling down and liquefaction of the natural gas takes place in spiral wound heat exchangers by using a mixed refrigerant (typically nitrogen, methane, ethane and butane). The refrigerant is compressed to different pressure levels, partially condensed and divided into separate streams to provide refrigeration power at different temperature levels in the spiral wound heat exchanger which allows for an energy-efficient liquefaction process.

## **Magnetic resonance imaging (MRI)**

An imaging procedure that allows examination of structures inside the human body. MRI generates cross-sectional images of the body using magnetic fields rather than X-rays.

## **Nanotechnology**

Collective term for a wide range of technologies dedicated to the research, development and production of objects and structures smaller than 100 nanometres (one nanometre is one billionth of a metre,  $10^{-9}$  m).

## **Polyurethane**

An extremely versatile plastic which is used in the most diverse areas, e. g. as foam for upholstered furniture, mattresses and sponges or for coating carpets, insulating foam in buildings and as varnishes and adhesives etc.

## **Polyvinyl chloride (PVC)**

A hard white plastic made more flexible by the addition of softeners and stabilisers so that it can be used for technical applications.

## **Rectisol® plant**

The Linde Rectisol® process is being used more and more often in the production of synthesis gases by partial oxidation/gasification of heavy oil and coal. This process is a physical acid gas wash, which uses an organic solvent (typically methanol) at low temperatures. In this way, most hydrogen sulphide and carbon dioxide is removed from the synthesis gas.

## **VOC (Volatile Organic Compounds)**

Refers to a variety of organic compounds, many of which are used as solvents or thinners in paints and varnishes. They act as precursors of ground level ozone, also known as "summer smog".

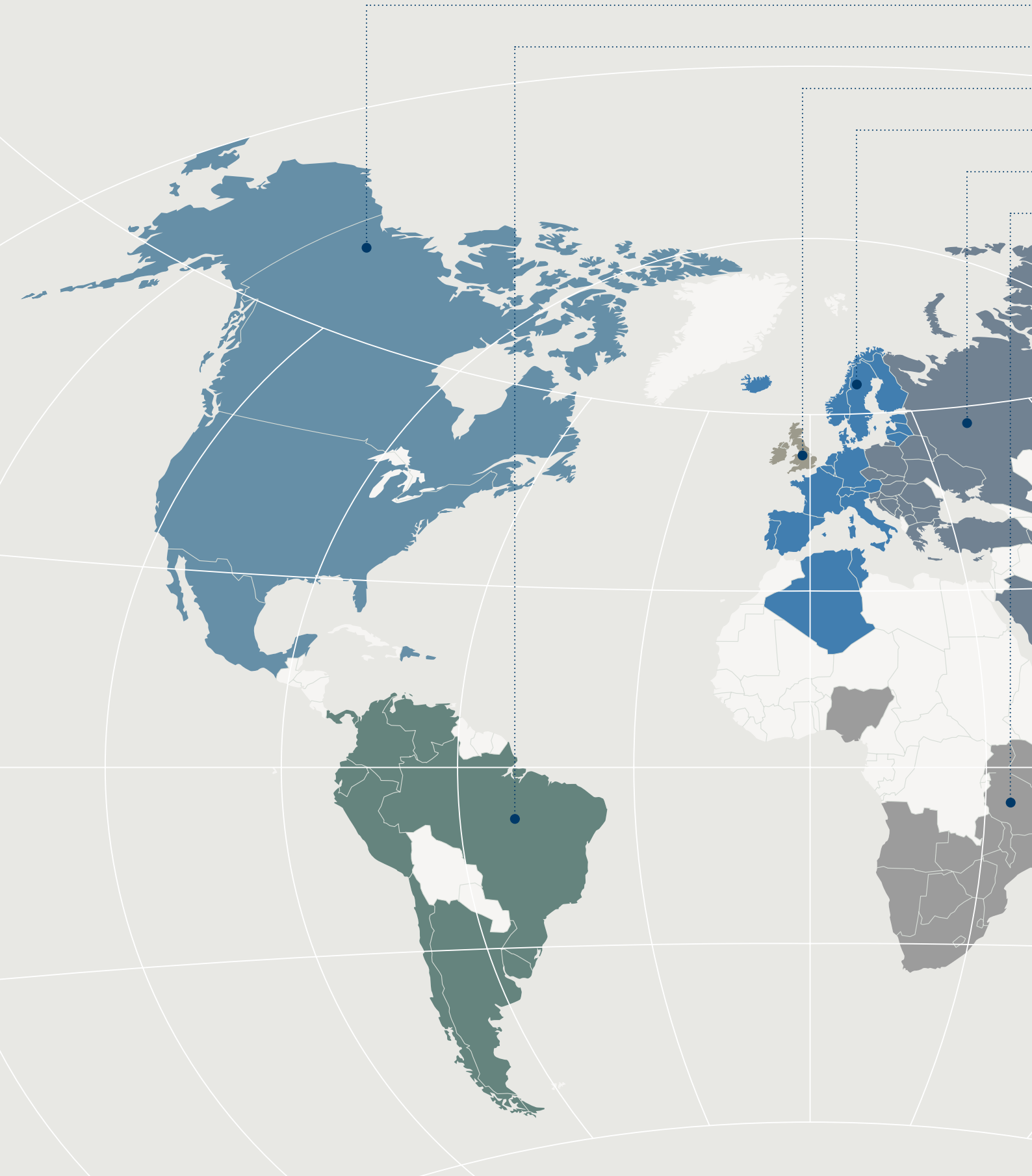
## **Wafer**

In the semiconductor, photovoltaic and micromechanics industries, a wafer is a circular or square slice, around one millimetre thick, on which electronic and micromechanical components or photoelectric layers are constructed. These slices are usually made of monocrystalline silicon with diameters of between 150 and 300 mm, although 450 mm is under discussion. The larger the wafer, the more integrated circuits (chips) it can hold, so the cheaper the production.



# The Linde world

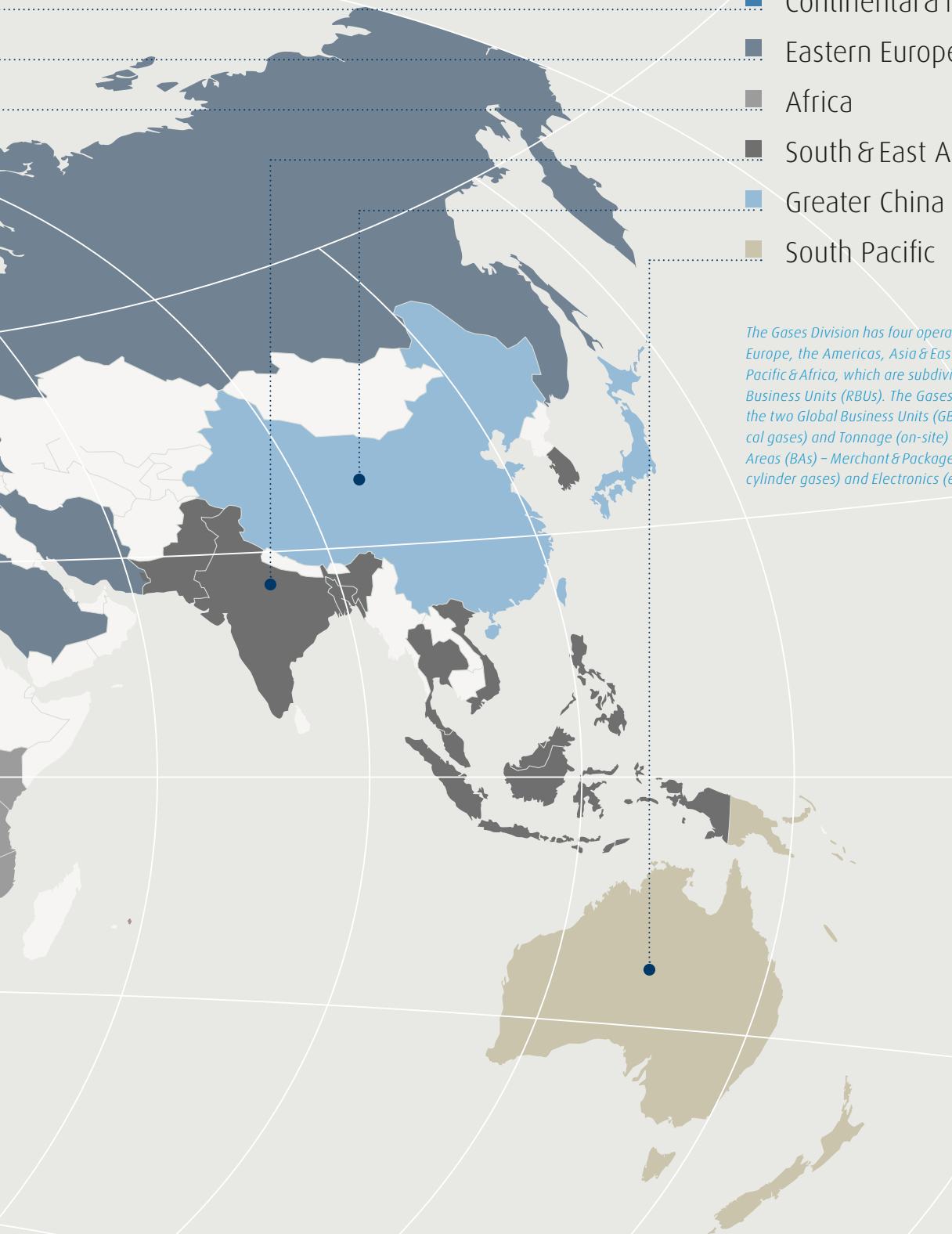
The company is divided into three divisions:  
Gases and Engineering (the two core divisions) as well as Gist (logistics).



## The Regional Business Units of the Gases Division

- North America
- South America
- UK & Ireland
- Continental & Northern Europe
- Eastern Europe & Middle East
- Africa
- South & East Asia
- Greater China
- South Pacific

*The Gases Division has four operating segments, Western Europe, the Americas, Asia & Eastern Europe, and South Pacific & Africa, which are subdivided into nine Regional Business Units (RBUs). The Gases Division also includes the two Global Business Units (GBUs) – Healthcare (medical gases) and Tonnage (on-site) – and the two Business Areas (BAs) – Merchant & Packaged Gases (liquefied and cylinder gases) and Electronics (electronic gases).*





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