

Lurgi

– your clean conversion partner



Lurgi is a leading company operating worldwide in the fields of process engineering and plant execution and design. Around the globe, Lurgi engineers, supplies and builds turnkey plants for application in the fields of gas technology, refining, in the petrochemical and polymer industries as well as for the renewable markets.

### Your Partner for Clean Conversion

Based on selected leading-edge technologies, we develop optimal solutions for our customers. With the highest emphasis on safety and the environment, we build world-class facilities with a focus on syngas, hydrogen production and clean conversion technologies for fuels or chemicals.

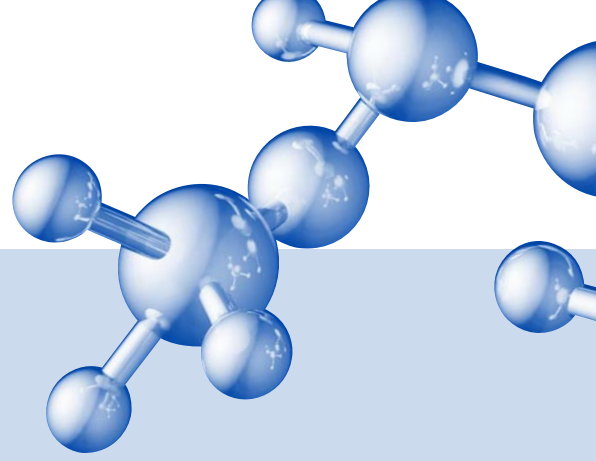
Lurgi maintains a highly competitive edge by using proprietary technologies deployed for making products that are in worldwide demand including fuels and plastics. Interdisciplinary, cross-border communications through 'simultaneous engineering' allow the coordination of decisions and work flows at an early stage, thus warranting a reliable project execution process – on time and within budget. With good reason Lurgi is synonymous with tradition and continuous innovation.

### Strong Global Network

For a couple of years already Lurgi has been part of the worldwide Air Liquide Engineering & Construction network. With a working relationship that stretches back to 1970 and covers several completed projects, Lurgi and Air Liquide have an excellent knowledge of their respective fields of expertise. One of the key strengths is that the technologies owned and mastered by both companies are complementary. The combination results in an enlarged capacity to meet customers' needs especially in high-potential markets linked to energy and environmental applications.

All this is fundamental. We are experienced, flexible, future oriented and have the global resources and technology to make things happen.

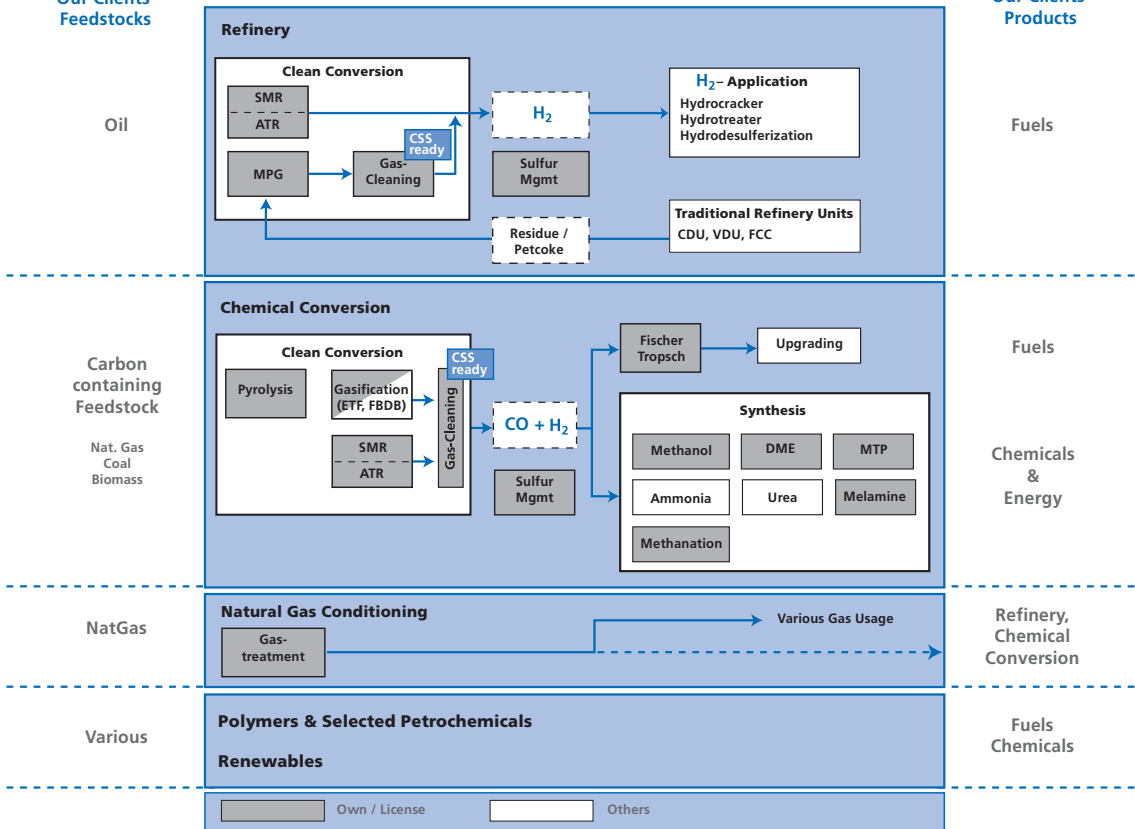
Energy efficient and environmentally friendly.  
That is our mission.



## Lurgi's Market and Technologies

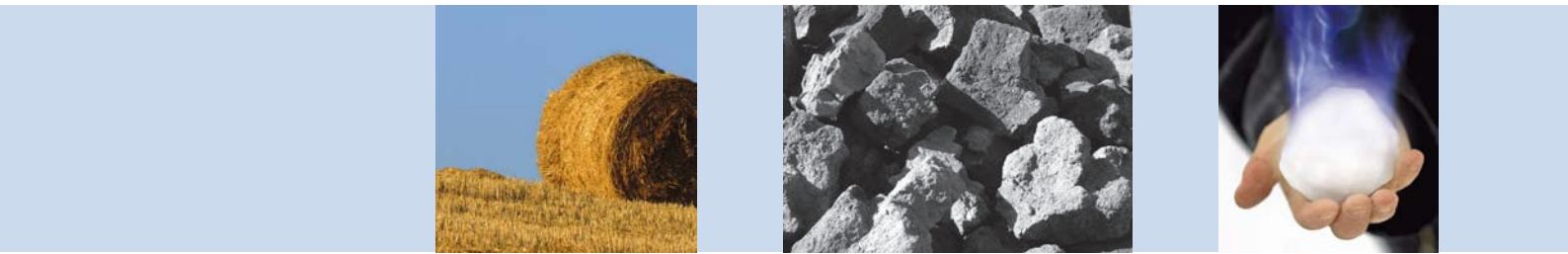
Our Clients' Feedstocks

Our Clients' Products





What can you count on in the future?  
On global integrated solutions.



## The Future is Universal.

Today, at the beginning of the 21<sup>st</sup> century, flexibility knows no more bounds. Conventional raw materials such as oil, gas and coal, as well as renewable resources like biomass, can be used anywhere and at any time to arrive at end products such as fuel, petrochemical plastics and fertilizers. The choice as to which product is to be made from which base material is simply a matter of taste.

Our times are characterized by the harmonious coexistence of various energy sources. Such variety is the result of unrestricted technological possibilities. In the efficient high-capacity plants built by Lurgi, more than just premium quality materials are obtained from the universal fuel syngas – thereby creating necessary independence for a secure future.

**2050**

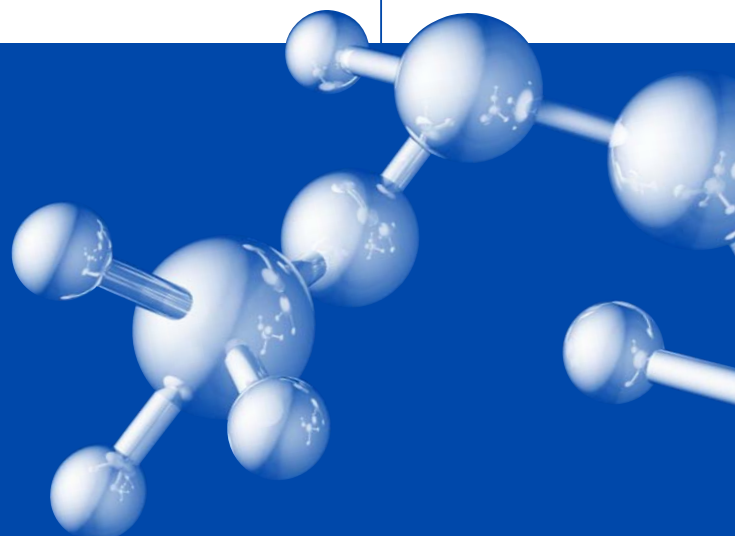
The population requiring energy has grown from 6.7 to 9 bn.

**2030**

Mineral oil loses its position as the leading raw material used in the production of fuels and chemicals.

**2010**

In Europe, the blending of biodiesel and bioethanol reaches 5.75 % and beyond.





Advanced technologies must address  
a very special challenge:  
Daily life.



## Alternative Fuels Conquer the Market.

Today, mobility and productivity are continually on the rise. With the development of new technologies for the production of diverse synthetic fuels, the quality and environmental compatibility of such fuels also improves. In just a few years, synfuels will prevail worldwide and broadly replace conventional fuels.

Technological innovations in the manufacture of these fuels address a multitude of demands. In the highly complex Lurgi plants, the feedstock derives from natural gas, coal and all other kinds of hydrocarbon feedstock. They allow high-grade and low-emission fuels to be produced worldwide, in each case exploiting the most efficient local conditions.

**2008**

Oil prices reach an all-time high at almost 150 US dollars.

**2007**

Lurgi builds the first BtL plant at Forschungszentrum Karlsruhe.

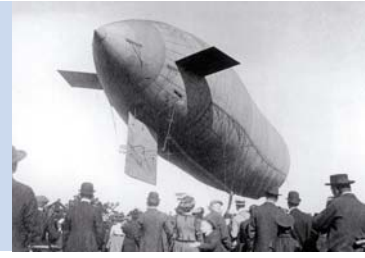
**2003**

The EU directive on biofuels comes into force.





One of our concerns has  
always had a long tradition:  
The future.



## Tradition and Innovation.

1897: Long live mobility! In line with the invention of the automobile and of the combustion engine, it became necessary to meet the growing demand for fuel. As early as in the 1920s, German scientists developed efficient processes for the production of suitable fuels. In 1925, the Fischer-Tropsch synthesis technology allowed the conversion of coal to liquid hydrocarbons and thus paved the way for the commercial production of gasoline and oil.

Highly qualified Lurgi employees were decisively involved in this development and established the basis for hydrocarbon and petrochemical technologies.

From 1953, Lurgi focused its technological business specifically on these sectors and quickly succeeded in becoming the leading player in this industry.

### Entrepreneurial Spirit at the Customer's Service

The competitiveness of a company is directly related to the qualification of its employees. High professional competence at all levels is a basic prerequisite for achieving this objective. At Lurgi, all employees consider themselves entrepreneurs in their own right, setting high standards for themselves and providing their services to 'their' customer.

**1953**

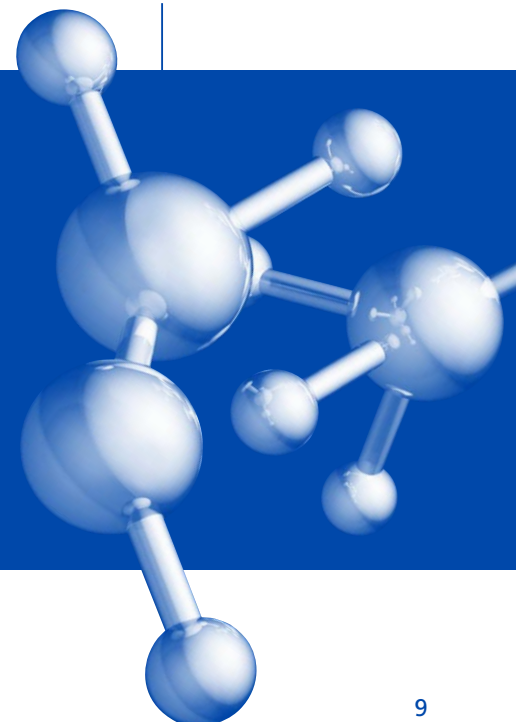
Lurgi enters the field of mineral oil refining.

**1925**

Lurgi becomes materially involved in the development of the Fischer-Tropsch synthesis.

**1897**

Establishment of Metallurgische Gesellschaft AG.





## With Reliable Concepts to the Top

The core activities of Lurgi, headquartered in Frankfurt am Main, mainly focus on its proprietary technologies in the areas of refining, gas technology, petrochemicals, polymers and renewable resources. In these sectors, Lurgi develops, in its own worldwide engineering centers, customized solutions for strongly growing markets.

From project development through to LSTK (lump sum turnkey) execution, plant complexes are globally engineered, built and commissioned by Lurgi under single-source responsibility.

Our plants benefit from the latest technologies and offer both, a high degree of reliability as well as energy efficiency. Therefore, we are working to continuously improve our processes to enhance their efficiency, meet the customers' demands and live up to our responsibility for protecting the environment.

### Lurgi – Your Clean Conversion Partner

Energy demand is increasing dramatically. Even if the per capita consumption remained unchanged, this would imply a dramatic rise in the overall energy consumption and hence a quick depletion of our natural resources, combined with a multiplication of today's emissions. Another fact is the declining quality of raw materials; heavy crude oils in particular feature ever higher sulfur contents.

This calls for new and intelligent solution concepts. Lurgi has taken up this ambitious challenge. Our innovative technologies can contribute to meeting these requirements. To this effect, we will focus on the processing and upgrading of natural gas and oil as well as on our clean conversion technologies for fuels and chemicals.

With Lurgi's processes, natural gas and associated gases from oilfields, as well as from coal, refinery residues and biomass, can be economically and

# Lurgi – your clean conversion partner.

efficiently converted into petrochemical products and synthetic fuels which are needed worldwide. For this purpose, Lurgi integrates its sustainable processes into complete, environmentally friendly technology chains.

## Refining Market

Over the next decade, refineries in many parts of the world will have to face the challenge of converting heavier and lower-grade crudes to clean transportation fuels. This will require continued investment into conversion technologies for refineries. The considerable price difference between light and heavy products will make such investments economically attractive. Heavier crudes and the shrinking fuel oil market will favor retrofitting refineries with residue conversion units. Against the backdrop of high crude oil prices, gasification of crude residues and the production of hydrogen

and methanol from the resulting synthesis gas represent a viable option.

Lurgi can contribute refinery concepts to this effect by designing and building state-of-the-art plants based on its proprietary processes, e.g. residue gasification with the Multi-Purpose-Gasification (MPG) process, or licensed units of third parties.

Lurgi also provides various own technologies for the refineries' hydrogen consumers via steamreforming or gasification. As an option, Lurgi's parent company Air Liquide can satisfy those needs over-the-fence (OTF) to the refineries.

Lurgi's Gas-to-Liquids processes based on the Fischer-Tropsch (FT) or synfuels technologies and on new technologies which are in the pipeline for the gasification of biomass (2<sup>nd</sup> generation biofuels) include conversion and hydrotreating technologies for the production of ultra-clean transportation fuels.





## Chemical Conversion Market

### Tailored Synthesis Gas Solutions

Syngas is a gaseous mix containing mainly H<sub>2</sub> and CO and its major role is that of a key intermediate in the modern synthesis of a range of petrochemicals and fuels.

Therefore, Lurgi offers a variety of processes for the generation of synthesis gas from several types of feedstock. Lurgi has developed the key to ultra-large capacities for methanol, Fischer-Tropsch and other synthesis plants.

Lurgi and Air Liquide joined forces in a strong cooperation to develop and maintain the leading technologies for all applications in the field of hydrogen and syngas.

### Coal – Old Feedstock with a New Perspective

Regional diversity in natural resources and differences in production costs are changing the market situation. Dwindling resources of oil and natural gas combined with new technologies have led to a renaissance of coal. Petrochemical products and

syngas can be produced at appreciably lower costs. Our modern technologies comply with the newest environmental standards.

### Lurgi MegaMethanol®: Basis for more valuable Products

Lurgi's MegaMethanol® process, the 'chemical' liquefaction of natural gas, represents a proven technology for converting syngas to methanol at low cost and in large quantities. It permits the construction of highly efficient single-train plants. The facility using this technology in operation today produces more than 5,000 tons per day. This is more than twice the output of conventional plants and results in a significant reduction of capital and operating costs.

Lurgi technology contributes to saving resources and decisively reduces the dependence on scarce crude oil reserves. The hitherto flared-off crude-oil associated gases can be utilized economically and ecologically. Thus, a multitude of new products can be developed to increase the quality of life.

Monetize gas differently ...  
... with clean conversion.



In this respect, the Lurgi MegaMethanol® process is a technology that pays for itself. With good reason, Lurgi has been able to gain market leadership, with around 50 % of all methanol produced worldwide originating from Lurgi plants.

#### SynGas to Fuels

The generation of synthetic fuels from natural gas, coal and biomass using cutting-edge and efficient Fischer-Tropsch routes is gaining momentum. The improved combustion of these fuels in engines and the fact that they are free from sulfur and aromatics, make cars more environment-friendly and more efficient. Not surprisingly, the automotive industry is interested in adding such fuels to conventional petroleum-based fuels. Substitution of 20–30 % of conventional fuel with synthetic fuels reduces emissions by up to 80 %.

Fuel production represents one of the largest markets in the world. For Europe, it is estimated that the share

of petroleum-based fuels will drop from currently over 90 % to below 40 % in about 30 years' time, while the share of synthetic fuels made from natural gas is expected to rise by an almost similar percentage.

#### SynGas to Petrochemicals

Demand for methanol is substantial and the utilization of methanol generated from natural gas and coal is set to rise appreciably over the next few years. Methanol is one of the main feedstocks for syntheses in the petrochemical industry. The percentage of plastics produced from natural gas is predicted to increase fivefold over the next 20 years.

Lurgi recognized the global market trends early on and developed the Methanol to Propylene (MTP®) process as a competitive alternative to the production of propylene. It constitutes a simple, cost-effective and highly selective technology, yielding an excellent value-added product for the utilization of syngas via MegaMethanol®.





## Natural Gas Conditioning

Due to its favorable carbon foot-print, natural gas is increasingly used for residential heating, cooking and as feedstock for petrochemicals. Hence, the natural gas consumption is predicted to grow by more than 30 % within the next twenty years.

On the way from gaseous, liquid or solid feedstocks to petrol, heating oil or petrochemical and other valuable products, the feedstocks need to be purified to meet the environmental and final product specifications.

Natural gas is found all over the world with varying quality. To meet the specifications imposed by countries and customers Lurgi has an array of technologies that can be packaged fit for purpose known as OmniSulf®.

## Polymers and selected Petrochemicals

### Polymers

The discovery of polymers was indispensable for the rapid development of synthetic fibers. Lurgi offers the Zimmer® processes for the polymers polyester and polyamide.

The availability of polyesters and polyamides has led to the development of new areas of application and usage alternatives, such as packing materials.

The core element of Zimmer® polymer technology is the consistent further development of reactors and processes for meeting the demands of our customers. Lurgi offers customized solutions in the form of continuous and discontinuous processes for a wide range of polymers.

Our plants have not one advantage.  
They have innumerable.

### Polyester

PET (polyethylene terephthalate) is the dominant polyester for textile applications and for packaging, in particular for bottle production. It is a commodity that is subject to constant further developments and characterized by strong growth.

The continuous process for PET production can be designed in different ways according to the desired end products. Continuous processes with capacities of up to 1,500 tons of polymer per day in a single line are currently viable.

### Polyamide

For the polyamide PA 6 (perlon), Zimmer® continuous and discontinuous process with corresponding recycling concept is available.

### Petrochemicals

Within its petrochemical portfolio, Lurgi offers versatile and innovative proprietary technologies and maintains exclusive arrangements with several licensing partners.

Lurgi possesses outstanding know how and core competencies in technologies for oxidation, hydrogenation and extraction of different aromatics and/or olefins, which are used worldwide for the production of oxygenates and petrochemical intermediates, i.e. Propylene, Butadiene, Butanediol, Phthalic Anhydride, Acrylic Acid, Terephthalic Acid and Benzene.

Lurgi has distinctly expanded its competence in the field of polymers by integrating Zimmer's technologies and by extending its Alliance with Eastman to include their IntegRex™ technology. Furthermore, Lurgi features specific expertise in the synthesis of Melamine.





## Renewable Market

### Biofuels: Natural Resources as Fuel Suppliers

The demand for biofuels is continuously increasing throughout the world. There is a growing awareness of global warming due to excessive CO<sub>2</sub> emissions and the resulting adverse effects on our ecology and, ultimately, on our economy. The provisions of the Kyoto Protocol have addressed this issue and the ratifying countries have committed themselves to its key objectives.

In view of the long and consistent history of environmental awareness, responsibility and having developed the know-how to generate innovative technological solutions in chemical engineering, Lurgi is one of the forerunners and promoters of biofuels. Lurgi builds 2<sup>nd</sup> generation biofuels plants. These plants do not need to enter the food chain to produce fuels. The raw materials will be wood, straw and agricultural residues.

### Oleochemicals

For many decades Lurgi has been the world leader

for processing technologies of oils and fats to value-added products. Lurgi provides complete technology chains and innovative concepts to process oils to high-grade intermediate oleochemicals such as fatty acids, fatty alcohols, methyl esters and pharma-grade glycerin. Such products derived from Lurgi plants are acknowledged as the benchmark quality by the consumer markets.

Why do we restrict ourselves?  
Because we value unrestricted variety.

## Research & Development.

R&D is a cornerstone of our future. It decides on tomorrow's world. So it is a crucial asset for Lurgi's R&D now to be part of the Air Liquide R&D network. Air Liquide backs R&D with an annual budget of € 200 million. Small wonder therefore that every day a new patent is applied for.

### A Culture of Innovation and Performance

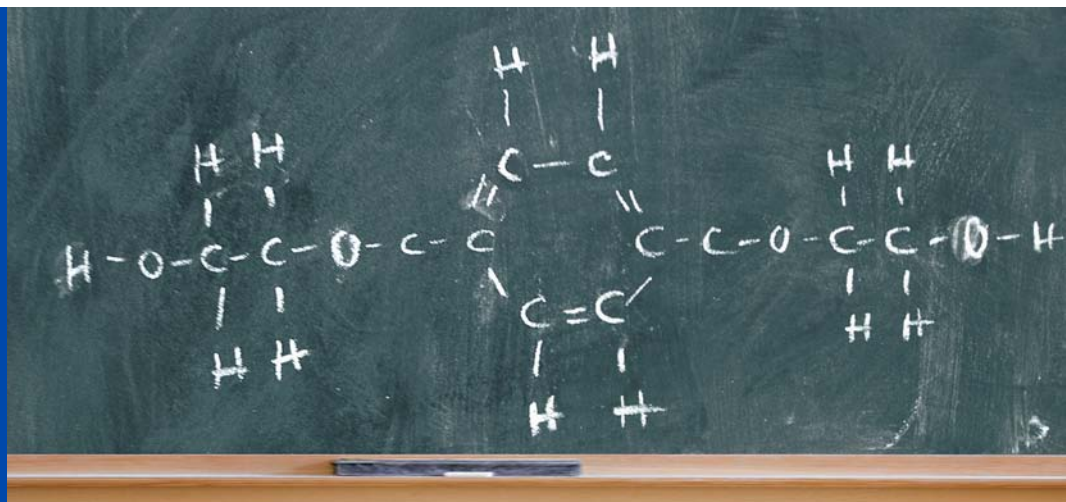
At Air Liquide, R&D is carried out at 8 research centers – in France, Germany, United States and Japan – and by "satellite teams" working directly at our customers' sites. This offers a true pool of talents for the Group: over 920 researchers of 25 different nationalities.

Research and development at the Air Liquide R&D network do not only take place in-house. Collaboration in development partnerships with customers and cooperation with more than 120 universities and research institutes are also highly valued.

Joint research brings many synergies that contribute to the more efficient, and consequently more rapid, development of significant new processes. Exemplary is a 'gas-to-petrochemicals' research project together with the Chemical Engineering Faculty of the Technical University of Freiberg, Germany. The objective of this project is to explore ways in which to increase the capacity and reduce the capital and operating costs of existing Lurgi processes for the gasification/reforming of fossil and renewable feedstocks to synthesis gas.

Sustainable development aims at "giving values to progress" by combining long-term wealth creation, consideration for individuals, and preservation of the environment.

## Proactive and credible – Drivers for innovation





## All Services Reliably from One Single Source.

Focused on its customers' business success, Lurgi offers services from project development to the turnkey construction of plants, Lurgi globally designs, builds and starts up plants from a single source and on its sole responsibility.

Working for our clients means that the latest technologies and the vast experience across all engineering disciplines within Lurgi are made available to ensure continuing competitiveness and maximum financial return.



- Studies
- Consulting
- LP-Modelling
- Technology Studies
- R&D Work

### Customized Solutions

Adding value to customers' businesses is the primary motivation for Lurgi and all its employees. To meet the varying demands of its customers Lurgi offers a complete portfolio of consultancy services intended to encompass the entire lifecycle of a process plant. In this way Lurgi is able to offer solutions to its customers' problems tailored in such a way as to maintain or improve the competitiveness of the process, thereby yielding additional economic benefit.

We accept only one criterion:  
Your success.



**Financial Engineering**

**Licensing**

**Project Execution**

**Technical Service**

**Licenses Service**

- PMC
- Contracting
- Project Management
- Authority Engineering
- Basic Engineering
- Detail Engineering
- Global Sourcing
- Erection Supervision
- Operator Training
- Maintenance/Repair
- Revamping/Retrofitting
- Spare Part Supply
- Licensees Conferences
- Technology Symposia



## International Network of Subsidiaries and local Partners.

Lurgi executes around three quarters of its business outside Germany. Subsidiaries and representative offices – together with the associated subgroups – in 33 countries afford proximity to our customers and a thorough knowledge of the market in all important regions worldwide.

There is hardly a country in the world in which Lurgi is not represented with its own company, or a cooperation agreement, or where it has not already executed a project.

Lurgi is a member of the Air Liquide Group.

### **Lurgi GmbH**

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