THE LINDE GROUP

Linde

Committed to efficient and reliable plant operation.

LINDE PLANTSERV™.

Process excellence. Proven time and time again by Linde Engineering.

Process plants are among the largest and most complicated constructions. Only a few companies worldwide are able to master their design and realisation. In this area, Linde Engineering has proven its unique expertise many times over – for example by building air separation plants, hydrogen and syngas plants, olefin plants as well as plants for natural gas treatment.

With more than 1,000 process patents and 4,000 completed plants, Linde Engineering is one of the international technology leaders in plant engineering and can therefore rely on its own, extensive process know-how for the design, planning and construction of process plants as well as for modification of existing plants.

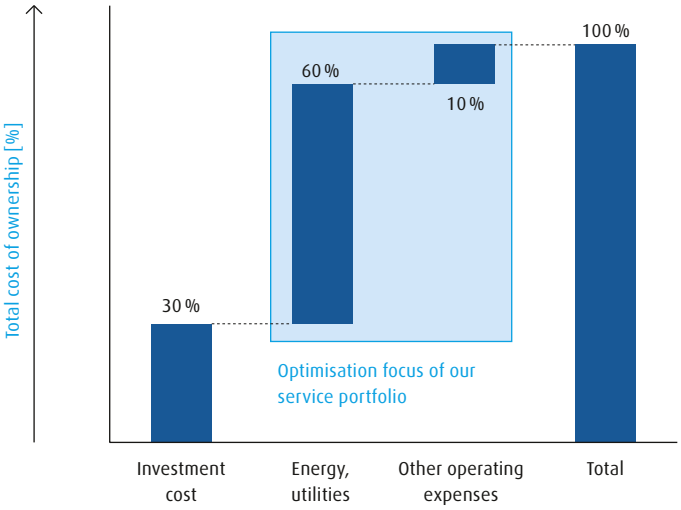
This is why, for the construction of their plants, customers around the world rely on the extensive experience of Linde Engineering, profiting from our well-proven reliability, cost economy and adherence to delivery dates.

A strong partner in a strong group

Linde Engineering is part of The Linde Group, a world-leading gases and engineering company, which is active in over 100 countries and serves customers from virtually all industries with around 65,000 employees.

The focus is on the targeted expansion of international business with future-oriented solutions and services. The Linde Group develops technologies and products that combine customer benefits with a contribution to sustainable development.

Typical cost of ownership for an air separation plant



Committed to optimal plant operation. LINDE PLANTSERV™.

With a broad range of services, Linde Engineering supports you in the best possible way by minimising the total cost of ownership of your plant. This starts with reduced investment cost through the application of suitable technology, through modularisation of important components and by consolidating our strengths in a global network.

The bulk of the total cost of ownership, however, arises during the operating phase – typically about 70 % in the case of air separation plants and even more than 80 % for hydrogen plants. These are predominantly energy costs, but significant costs are also generated by downtimes, maintenance work, repairs and spare part management. Along with an optimal plant operation, adjusting the plant specifically to your requirements can in some cases considerably reduce these costs.

Based on our well-proven plant engineering know-how, our service portfolio addresses all main drivers for cost reduction after commissioning. If you are looking to maximise your competitive advantage, you will certainly profit from our experts' experience.

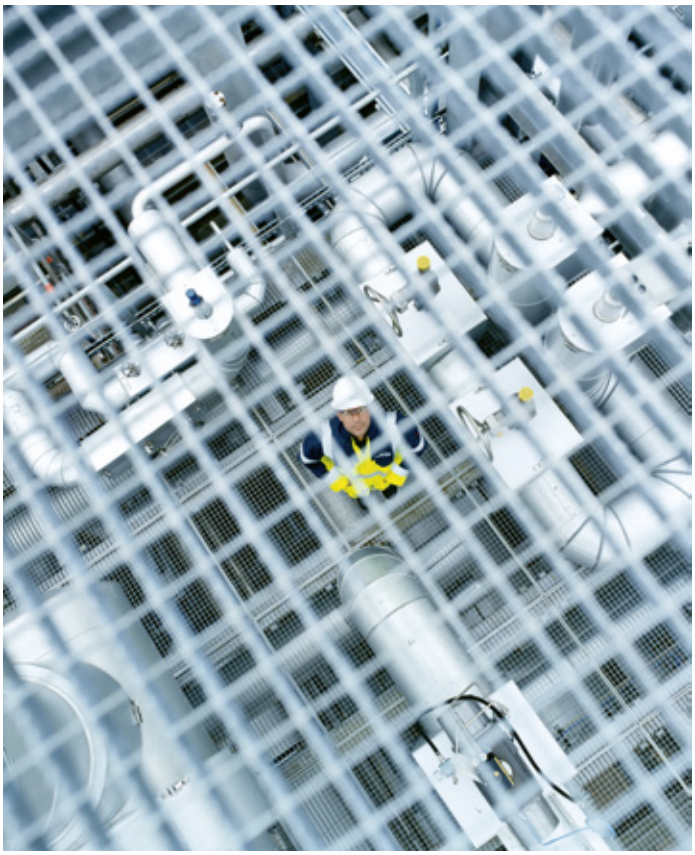
LINDE PLANTSERV™ is available to you all over the world.
Please find our service locations and contact data on page 16 ff.

With us, your plant will always run smoothly. LINDE PLANTSERV™ supports you in the operation of your plant.

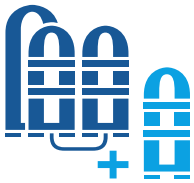
As its engineers, we know your plant right from the start. Our in-depth technological expertise, along with our long experience, makes LINDE PLANTSERV™ the ideal partner for a smooth and efficient operation of your plant.

Our strengths – your benefits

- More than 40 years of proven expertise in customer services for plant engineering
- Well-founded know-how based on the experience of building over 4,000 Linde plants around the globe
- Full access to the entire plant engineering expertise of Linde Engineering, ranging from technology development and in-house manufacturing up to global procurement and construction
- Linde service network with highly qualified and experienced employees, exclusively committed to the servicing of Linde plants
- Access to an extensive international network of partners
- Organisation combining the advantages of local proximity and global consolidation of strengths
- Ownership of all necessary certificates and authorisations



A comprehensive, one-stop shop for services.
Our portfolio.

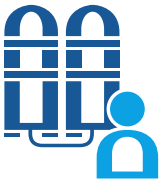


Plant modification and revamp

Spare part management

Maintenance and repair

Training



Operational support

Our portfolio comprises all elements that are necessary for cost-efficient and safe plant operation. Our engineers take on the task of handling the modification and revamp of your facilities, including all technical and organisational issues. We support you in procuring suitable spare parts for your plant and specify viable alternatives, if needed. Emergency repair work is carried out by highly qualified employees, who are available for assignment around the globe. Our training offer ensures that your employees are always up to date in terms of technology, safety and plant operation. And last but not least, thanks to our technological expertise and long experience, we can also offer you direct support for the operation of your plant.

We offer our service on demand or as part of a modular service package. Within the five modules you benefit from a set of different services like engineering services, fixed-price audits, spare part management, training and Linde Information Services, tailored to your requirements.

Our portfolio at a glance

Plant modification and revamp
- Feasibility studies
- Plant modification and revamp
- Plant relocation

Spare part management
- Spare parts and components for all plants delivered by us
- Optimisation of warehouse stock

Maintenance and repair
- Remote support with LindeGO augmented reality glasses
- Emergency repairs and troubleshooting
- Consumables
- Inspection and diagnosis

Training
- Operator Training Simulator (OTS) – classroom-based and using digital simulators
- Trainee programme

Operational support
- Remote operating monitoring
- Modular service package
- Plant assessments

Plant modification and revamp.
Individual and reliable optimisation.

If a modification or a revamp of a plant becomes necessary – whether due to technological, economical or operational reasons – LINDE PLANTSERV™ has the required know-how. Our experts take care of all necessary measures, including the realisation of very complex plant modifications. You benefit not only from the necessary technological know-how and reliable execution, but you always get the appropriate solution for your individual requirements as well.

Your benefits

- Safe and reliable execution by an experienced technology and execution partner
- An optimal solution that meets your requirements thanks to the comprehensive technological expertise of Linde Engineering – from small to very large modifications

Our service offer

Feasibility studies
- Preparation of studies for the modification and revamp of existing plants
- Operational improvements

Plant modification and revamp
All work relevant for modifications of existing plants, e.g.:
- Modernisation of the process control system
- Retrofitting of plant components
- Capacity increase/de-bottlenecking
- Optimisation of energy consumption
- Optimisation of availability
- Adjustment to legal requirements
- Lifetime extension
- Changes in feedstock and products of the plant (e.g. feed change from light to heavy naphtha, installation of an additional argon column)

Plant relocation
- Concept
- Dismantling
- Transport
- Re-assembly
- Commissioning

Case study: Plant modification.
Hydrogen plant.

Starting point

After several years of operation, one of our customers wanted to improve the performance of his hydrogen plant (steam reformer) and simultaneously convert the feedstock from naphtha to natural gas.

Our solution

As a first step, bottlenecks in the existing plant were identified by high-performance test runs and detailed process simulations. Moreover, the plant's hydraulic limits were determined by the use of pressure profiles. Based on these analyses, specific suggestions for improvement were made and carried out, including the replacement of the existing safety valves and the installation of an additional low-temperature shift reactor and a pre-reformer.

Result

All work was carried out on schedule. During the test run, a capacity increase of 15 % and a successful operation with natural gas were confirmed. Since then, the plant has been running safely, reliably and with the desired higher capacity.

Spare part management. Quickly at hand.

Our experienced engineers support you in procuring suitable spare parts. Having access to original documents enables them to quickly and clearly identify the required parts. Should certain spare parts not be available any more or if, due to technical changes, they may not be used any more, we can specify a suitable alternative for you. Moreover, due to our market positioning, we can provide spare parts in the best possible quality and at a reasonable price, and have them quickly delivered to you.

Your benefits

- Clear identification of the suitable spare part thanks to access to original documents
- Specification of suitable alternatives, if required
- Optimal value for money and quick delivery

Our service offer

Spare parts and components

- Compliance with oxygen safety requirements: identification, special inspection and cleaning of oxygen relevant parts including packing, labeling and certificates
- Identification of suitable spare parts
- Specification of applicable alternatives if original spare parts are no longer available
- Procurement and delivery
- Organisation of global express delivery for urgently needed parts

Optimisation of warehouse stock

- Analysis of the warehouse stock
- Suggestions for optimisation in terms of availability and costs of capital

Case study: Spare part management.
Process plant.

Starting point

A customer operates a Linde process plant which has already been running successfully for 10 years. For a planned shutdown, wear parts on several valves are due for replacement. The manufacturer of these valves, however, has ceased production and is no longer on the market.

Our solution

All relevant technical equipment documents concerning the process plant delivered by Linde Engineering are on file. With the help of these documents, LINDE PLANTSERV™ is able to identify all parts and components of the plant. If needed, each individual part can be newly specified and produced by alternative manufacturers.

Result

By letting Linde Engineering handle the spare part specification and procurement, our customer saves a lot of time and effort in terms of the necessary specification, engineering, organisation and logistics. Due to our market positioning and experience, we can provide the right parts at reasonable prices and have them quickly delivered.

Maintenance and repair. Best conditions for safe and reliable operation.

Frequent inspections as well as the diagnosis of essential plant components are suitable methods of preventing unplanned plant downtimes. Based on our technical expertise and special diagnosis tools, we can provide support and advice in this area. Should a malfunction of your plant occur all the same, we can help you with the repair of essential components. For this, we have an emergency team within our manufacturing unit that has the right qualifications, experience, certificates and tools to quickly help you with the required repair work. Moreover, we organise technology-based maintenance work for you, particularly the replacement of essential consumables such as molecular sieves, adsorbent materials and catalysts.

Your benefits

- Qualified analysis and consulting based on our technical expertise
- Optimal execution of repairs by qualified manufacturing experts
- Optimal value for money and quick delivery of essential consumables
- Full aluminium welding expertise with all relevant certificates

Our service offer

Remote support with LindeGO

- Operational support via remote link to your plant
- Real-time site support for operational issues with live video stream

Repairs and troubleshooting

- Emergency repairs
- Welding work on aluminium components such as heat exchangers and cold boxes

Consumables

- Procurement and replacement of consumables such as molecular sieves, adsorbent materials and catalysts

Inspection and diagnosis

- Review of the condition of the plant and of essential components
- Heat exchanger lifetime prognosis (LIBAS®)
- Assessment of plant safety equipment
- Plant assessments

Case study: Maintenance and repair.
Heat exchanger.

Starting point

Vacuum-brazed plate-fin heat exchangers are a key component of many Linde plants. All Linde plate-fin heat exchangers of your plant are designed so that they do not have to be replaced during their entire lifetime if operated according to specifications. However, changes in the plant's operation or in the load of the heat exchanger often mean a deviation from the original design. In these cases, a dependable assessment of the heat exchanger's reliability and safety must be made.

Our solution

With LIBAS®, Linde has developed a system which is able to reliably calculate the lifetime of the heat exchanger on the basis of its geometry and real load data. The system is based on the combination of thermo-fluid-dynamic simulation with a finite-element analysis and has been extensively validated by practical tests.

Result

The calculation – based on the defined operating scenarios – serves as a starting point to determine whether the heat exchanger meets the requirements of the changed situation, or whether it should be replaced during the next planned downtime. That way, an unplanned downtime and possible safety risks during operation are minimised, and the unnecessary replacement of a heat exchanger that meets the changed requirements can be prevented.

Training. First-hand know-how.

LINDE PLANTSERV™ is the link to the latest standards and findings from our own technology development. At the same time, we can rely on experiences that are based on the installation of more than 4,000 plants worldwide. With the help of our trainings, you can leverage the entire know-how of Linde Engineering directly for the instruction of your operating personnel.

Your benefits

- Direct access to the latest information and findings
- Instructions and trainings based on long practical experience

Our service offer

Instruction of the operating personnel
(on site or at Linde Engineering facilities)

- Operator Training Simulator (OTS) – classroom-based and using digital simulators
- Trainee programme

Case study: Training.
Air separation plant.

Starting point

A chemical company from the Middle East wanted to ensure that its employees operate the plants optimally and efficiently at all times.

Our solution

To ensure efficiency, we have agreed upon a training-hours budget with our customers from which they can flexibly call up our offer. The training can take place directly at the customer's site as well as in our technology center in Pullach, Germany. It contains, for example, basics (e.g. process and plant components), operational management (e.g. start-up and shutdown) as well as troubleshooting and plant maintenance.

Result

Thanks to our training offer, the operating staff is enabled at all times to ensure a high availability, efficiency and safety of the plant. New employees, especially, can be prepared quickly and comprehensively for their assignment.

Support on plant operations. Professional contribution to improvements and troubleshooting.

The reality of plant operation in a changing environment constantly poses new questions and leads to new tasks. Increasing pressure from competitors demands continuous improvements and optimisations in order to reduce operating cost. Requirements concerning operational and environmental safety are constantly being tightened. Problems that occur suddenly call for a quick response in order to ensure plant operation.

Our engineers are on call to support you comprehensively concerning these issues. Based on long experience in plant design and operation, improvements can be implemented quickly and reliably.

Your benefits

- Direct access to our global expertise
- Support for solving actual problems
- Identification of improvement potential

Our service offer

Service package with five modules
- Engineering services
- Fixed-price audits
- Spare part management
- Training
- Linde Information Services

Plant assessments
- Assessment for potential enhancements
- Savings potential on annual energy costs

Operational support
- Remote operating monitoring
- Support for commissioning preparations, commissioning, start-up and shutdown operation
- Support for sudden operating problems

Case study: Support on plant operations. Petrochemical plant.

Starting point

An operating company is concerned about high energy costs and wants to achieve a significant improvement with as little effort as possible.

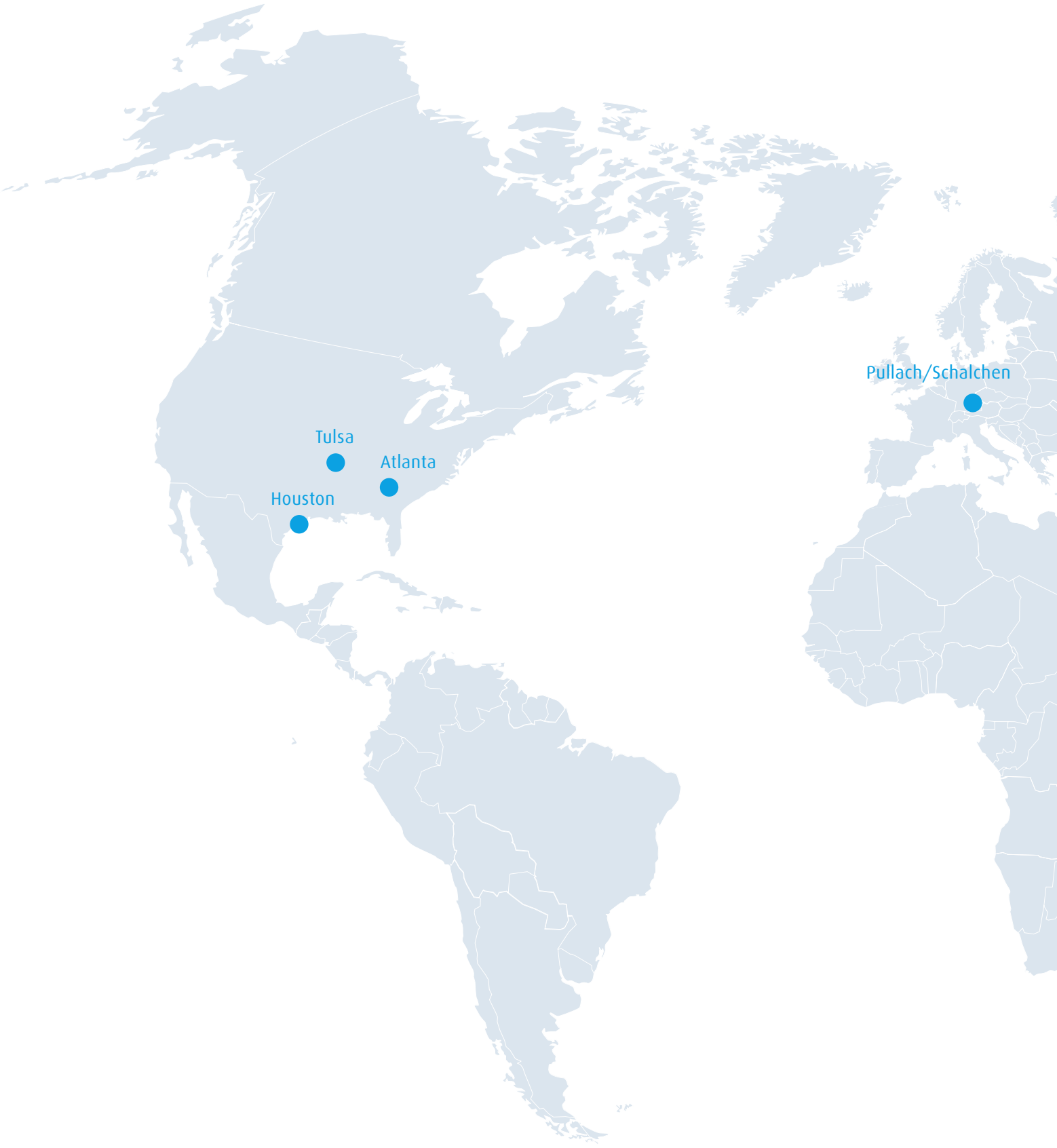
Our solution

In close cooperation with the plant's operating personnel, experienced Linde engineers inspected the condition of the plant and its corresponding energy systems. During this plant audit, which lasted several days, our experts pointed out process control strategies, equipment, control settings and operation strategies that were leading to an increased demand for energy and utilities. Subsequently, suggestions for potential improvement were made and a first assessment of the investment needs was presented. Based on these findings, it was possible to implement some measures right away, while others led to more in-depth studies. Taking the expected cash flow of measures into account, the company then decided to carry out moderate modification measures.

Result

Even after reviewing the first results, it was already possible to reduce the energy demand by simply changing a few control settings and operation strategies. Flanked by moderate investments, the total energy demand of the plant was reduced by more than 10 %.

At home all over the world. Our service locations and contacts.



LINDE PLANTSERV™ ensures that you have an experienced partner for plant operation by your side during each phase of your plant's life-cycle – no matter where in the world you need our support. Please find a list of contacts on the next page. They are looking forward to hearing from you – and to a possible cooperation.

Your contacts for the coordination of our global activities

Region	Service Area	Name	Phone	E-mail
Headquarter Germany	Revamp & Technical Services	Michael Weinschenk	+49 89 7445-4277	customer-services@linde-le.com
	Spare part management	Robert Vetter	+49 89 7445-2763	spare-parts@linde-le.com
	Services for Adsorption Plants	Thomas Jecke	+49 89 7445-2786	customer-services.psa@linde-le.com
North America	Revamp & Technical Services	Frank Maupay	+1 281 717-9080	frank.maupay@linde.com
	Spare part management	Magver Infante	+1 281 717-9075	customerservice.lena@linde-le.com
	Hydro-Chem	George Forster	+1 770 345-2222	hydrochem@linde-le.com
Middle East	All Services	Senthil Nayagam	+966 13 3610875-102102	senthil.nayagam@linde.com
India	Revamp & Technical Services	Suneel Koul	+91 265 305-6290	suneel.koul@linde.com
	Spare part management	Muthuraman Swaminathan	+91 265 334-6347	muthuraman.swaminathan@linde.com
China	All Services	Weiwei Zhao	+86 571 8501-9396	weiwei.zhao@linde.com

You are planning changes? We would like to show you what is possible.

In the area of plant operation, there are numerous parameters by which you can optimise performance, energy balance and costs. If you decide to take improvement measures, we're ready to support you in order to achieve the best possible result for you. Just get in touch with your personal contact. Together, we will develop the best solution for your task.

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Collaborate. Innovate. Deliver.

Linde's Engineering Division is a leading player in the international plant engineering business. Across the globe, we have delivered more than 4,000 plants and cover every step in the design, project management and construction of turnkey industrial facilities. Our proven process and technology know-how plays an indispensable role in the success of our customers across multiple industries – from crude oil, natural gas extraction and refining to chemical and metal processing.

At Linde, we value trusted, lasting business relationships with our customers. We listen carefully and collaborate closely with you to meet your needs. This connection inspires us to develop innovative process technologies and equipment at our high-tech R&D centres, labs and pilot plants – designed in close collaboration with our strategic partners and delivered with passion by our employees working in more than 100 countries worldwide.

From the desert to the Arctic, from small- to world-scale, from standardised to customised builds, our specialists develop plant solutions that operate reliably and cost-effectively under all conditions.
You can always rely on us to deliver the solutions and services that best fit your needs – anywhere in the world.

Discover how we can contribute to your success at www.linde-engineering.com

Get in touch with our LINDE PLANTSERV™ team:
Phone: +49 89 7445-3380, e-mail: customer-services@linde-le.com

Core competencies at a glance

Plant engineering
- → Air separation plants
- → LNG and natural gas processing plants
- → Petrochemical plants
- → Hydrogen and synthesis gas plants
- → Adsorption and membrane plants
- → Cryogenic plants
- → Carbon capture and utilisation plants
- → Furnaces, fired heaters, incinerators

Component manufacturing
- → Coldboxes and modules
- → Coil-wound heat exchangers
- → Plate-fin heat exchangers
- → Cryogenic columns
- → Cryogenic storage tanks
- → Liquefied helium tanks and containers
- → Air-heated vaporisers
- → Water bath vaporisers
- → Spiral-welded aluminium pipes

Services
- → Revamps and plant modifications
- → Plant relocations
- → Spare parts
- → Operational support, troubleshooting and immediate repairs
- → Long-term service contracts
- → Expert reviews for plants, operations and spare part inventory
- → Operator training

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