

THE LINDE GROUP

*Linde*

Bright ideas.

Delivering smarter LED manufacturing  
through innovative gas technology.

# Offering LED manufacturers a full range of bulk and special gases for maximum flexibility and efficiency.

The adoption of solid state (LED) lighting is growing rapidly, driven in particular by applications such as LCD TV backlighting and low-power general illumination. To accommodate this expanding market, LED manufacturers need large quantities of nitrogen, high-purity ammonia, hydrogen and metal organics. They also need a flexible supply partner to support rapid, cost-effective increases in production.





Linde established the first ultra pure ammonia plant in China

## Reliable partner

We supply the full range of bulk and special gases required for LED manufacturing. As material requirements evolve, we are also committed to developing robust delivery solutions supported by a flexible and reliable supply chain for maximum productivity improvements. For example, we established China's first ultra-pure ammonia plant.

We complement our electronic materials portfolio and global supply chain with turnkey capabilities for larger LED fabs. These on-site facilities ensure a continuous, monitored and flexible supply of gas. Standardised and modular designs give you the added benefit of maximum cost efficiencies and reliability. Our offering includes:

- High flow ultra-high purity ammonia supply
- On-site hydrogen generation
- SPECTRA-N on-site nitrogen generators

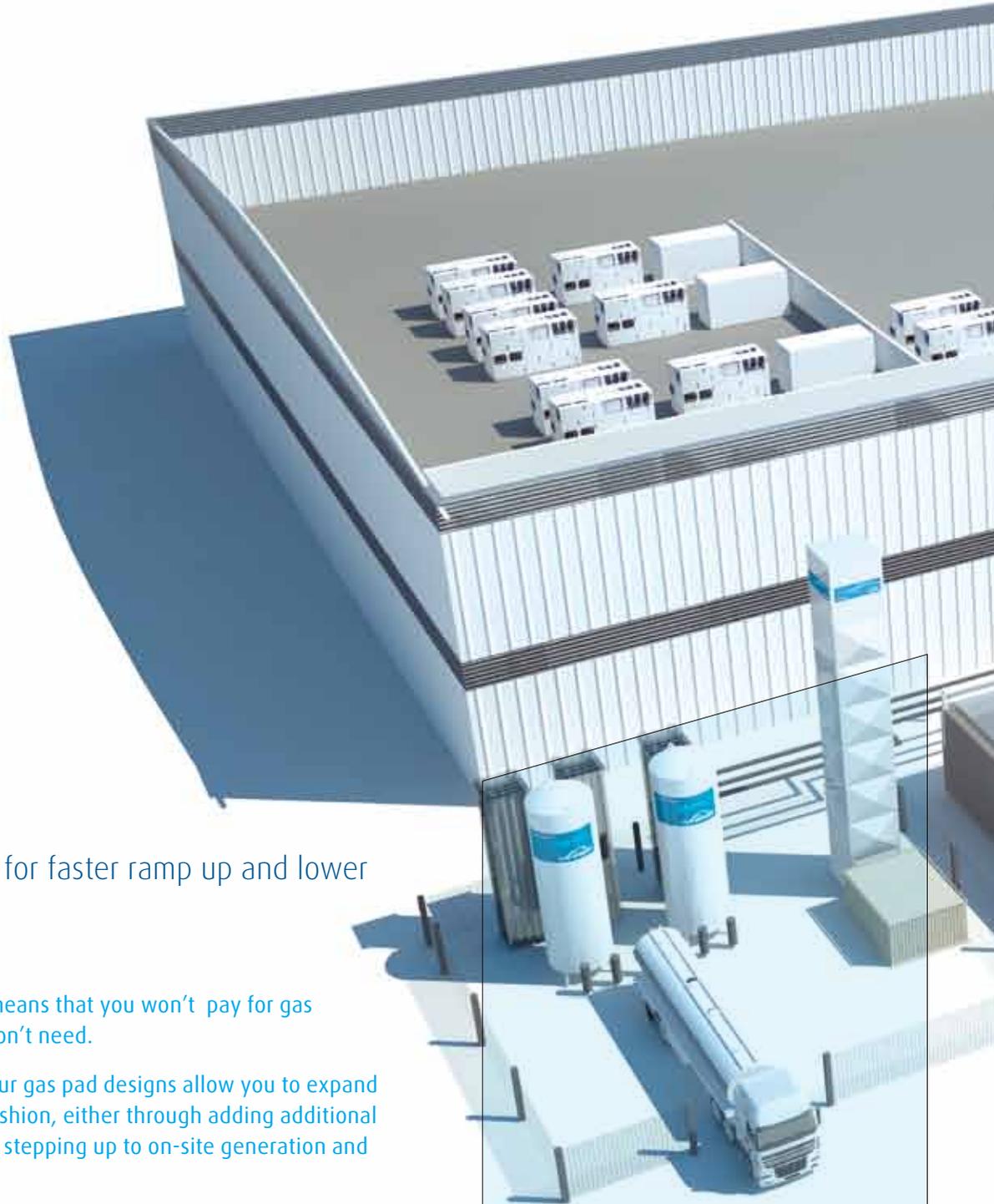
## Materials for LED Solid State Lighting manufacture

Although requirements may vary from one process to another, the following table shows the main bulk and electronic special gases used in the LED manufacturing process:

### Linde bulk and electronic special gases supply

Bulk gases	Electronic special gases
Nitrogen	Ammonia
Hydrogen	Argon
	Dopants (Boron / Phosphorus)
	Etching gases (eg $CF_4$ , $NF_3$ , $SF_6$ )
	Silane

# Benefit from our global turnkey gas capabilities.



Expandable systems for faster ramp up and lower up-front costs.

Linde's turnkey expertise means that you won't pay for gas system capacity that you don't need.

As you install more tools, our gas pad designs allow you to expand in an economic, modular fashion, either through adding additional tank and trailer capacity or stepping up to on-site generation and other bulk solutions.

#### MOCVD Tools\*

Up to 25

25 - 100

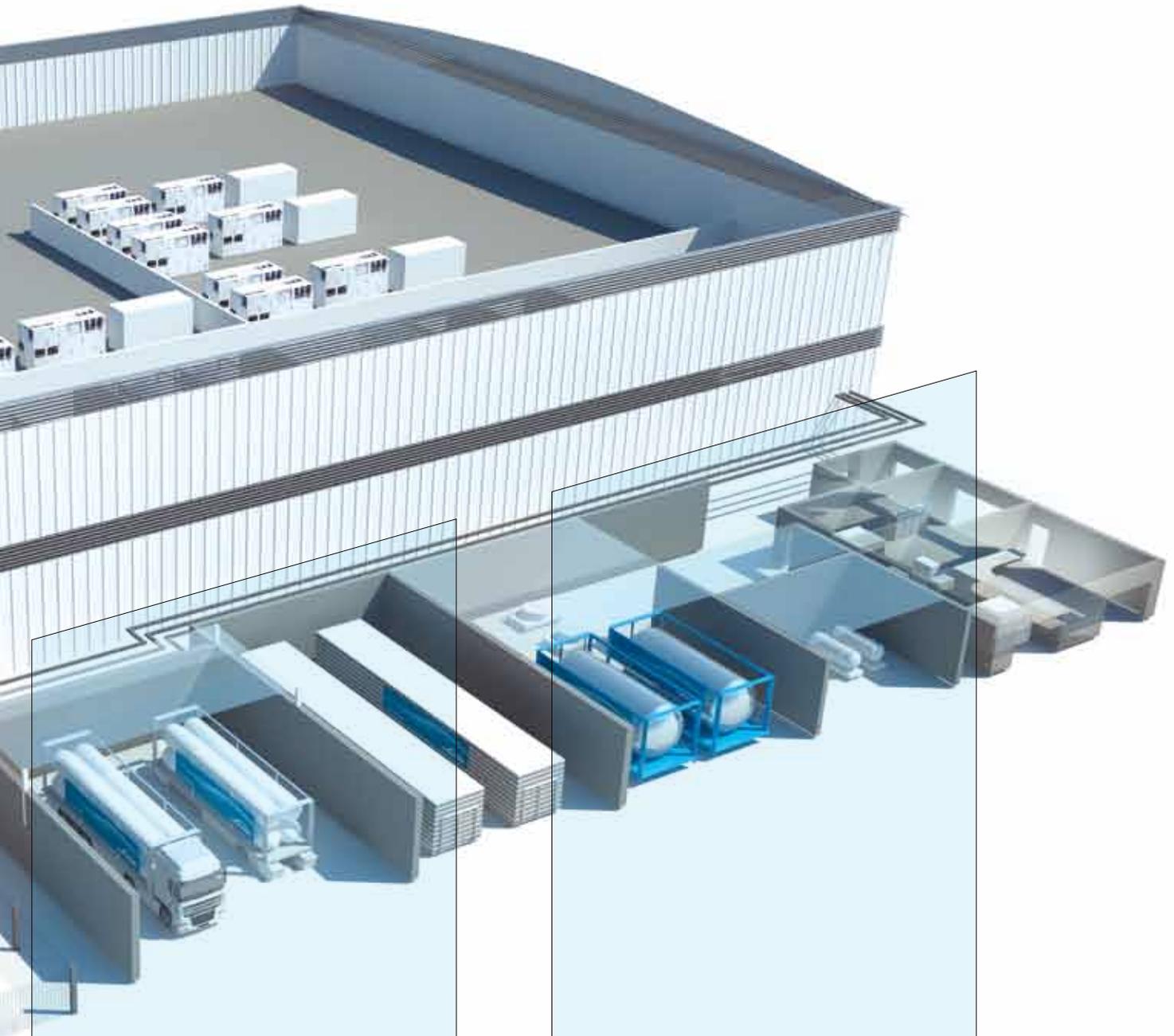
Greater than 100

#### Nitrogen

Liquid supply from bulk tanks

On-site nitrogen generator

\* Indicative fab scale - contact Linde for detailed discussion of your gas needs.

**Hydrogen**

Compressed gas trailer  
(up to 3,500 Nm<sup>3</sup>)

On-site hydrogen generator

**Ammonia**

Drums (500kg)

ISO container (13,000kg)

On-site ammonia purification

# Reliable on-site solutions for nitrogen, hydrogen and ammonia purification.

Our on-site generators are optimised to keep your total cost of ownership as low as possible. All our generators combine the benefits of patented technology, integrated engineering design and highly flexible operation. In addition, our on-site gas generators give you the benefit of continuous delivery, seven days a week, 24 hours a day.



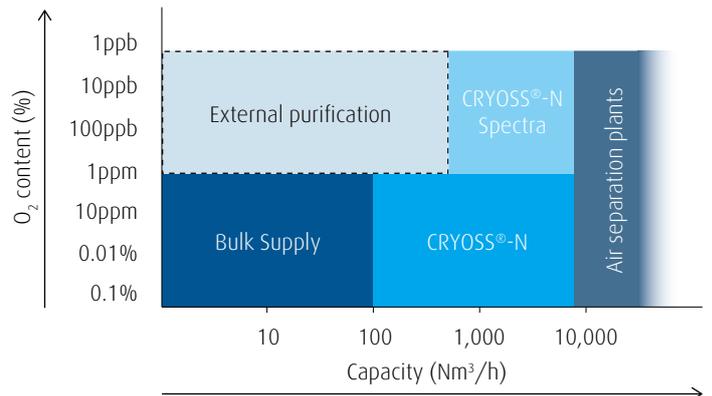
You can rely on Linde's experts to deliver low cost, reliable and scalable solutions for:

- Ammonia purification
- Hydrogen generation
- Nitrogen generation

**Typical bulk gas requirements for a large LED fab**

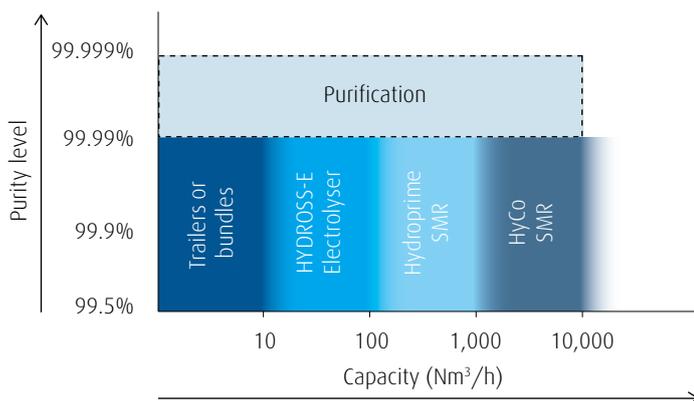
Gas	Output range	Purity
Ammonia	1,000 - 5,000 litres per minute	99.99999% (N7.0)
Hydrogen	100 - 1,000 Nm <sup>3</sup> per hour	99.999% (N5.0)
Nitrogen	Up to 4,000 Nm <sup>3</sup> per hour	99.999% (N5.0)

**On-site nitrogen generation**



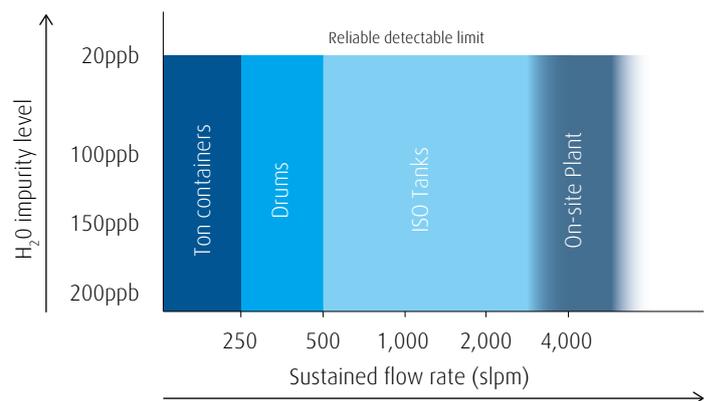
- Ultra-pure gaseous and liquid nitrogen with less than 1 part per billion (ppb) impurities without the need for an external purifier
- Cost effective solution with much lower power consumption than conventional nitrogen generators
- Excellent turndown capabilities to meet facility ramp-up requirements
- Continuous remote operation with uptime exceeding 99.8% under normal operating conditions

**On-site hydrogen generation**



- Linde has more H<sub>2</sub> plant engineering experience than any other gas company
- Depending on the available feedstock, Linde can offer an optimum H<sub>2</sub> generation solution based on electrolysis of water, steam methane reforming or methanol cracking
- Production capacities from 15 to 1,000s of Nm<sup>3</sup> per hour
- Purity from industrial grade to 99.999% or higher
- Purification options to parts per billion of critical impurities
- Packaged and modular plants provide supply redundancy and rapid start-up; backed by 24/7 remote monitoring and operations

**On-site ammonia purification**



- One of the largest Ammonia purifiers in Asia, Linde offers a full range of ultra-high purity delivery solutions
- Multiple container sizes and state-of-the-art gas flow control systems
- Extensive experience in the complex thermodynamics of NH<sub>3</sub> vapourisation and vapour-phase delivery.
- Sustained flow capacities from 250 to 2,500 slpm per system
- On-site distillation plant based on a proprietary design for continuous and cost-efficient supply

# Linde Electronics. Innovation - Service - Leadership

**Leading.** Linde Electronics is part of The Linde Group, the leading gases and engineering group of companies with almost 50,000 employees working in approximately 100 countries worldwide.

Linde's mission is to enable smarter, lower cost and more sustainable electronics manufacturing through innovative technologies and solutions.

We believe in the concept of zero accidents and incidents, striving to create a safe and effective working environment for our people and our customers.

We wish to ensure long term customer satisfaction and loyalty by consistently providing products and services that meet each customer's expectations for quality.

We develop and promote technologies, products and services that are environmentally sustainable.

To find out more about Linde Electronics, visit us online or send us an email:

[www.linde-gas.com/electronics](http://www.linde-gas.com/electronics)  
[electronicsinfo@linde.com](mailto:electronicsinfo@linde.com)

## Linde Electronics Sales Offices

### North America

North America (Linde) +1 (0)908 329 9700  
+1 (0)800 932 0624

### Asia

China (Linde Lien Hwa) +86 (0)21 6105 9888 ext 9456  
India (BOC India) +1 (0)800 345 6789  
Korea (Linde) +82 (0)2 780 9331  
Malaysia (MOX-Linde) +60 (0)379 554 233  
Philippines (Linde Philippines Inc.) +63 (0)2 702 7500  
Singapore (Linde Gas Singapore) +65 (0)6861 3678  
Taiwan (BOC Lien Hwa) +886 (0)2 2786 6000  
Thailand (Thai Industrial Gases) +66 (0)2 338 6253

### Europe & Middle East

France (Linde) +33 (0)4 72 47 66 10  
Germany, Continental Europe & Middle East (Linde) +49 (0)89 7446 1122  
Italy (Linde Gas Italia) +39 (0)029 037 31  
United Kingdom & Ireland (BOC) +44 (0)800 02 0800

For all regions not listed, please refer to [www.linde-gas.com/electronics](http://www.linde-gas.com/electronics) or contact us at [electronicsinfo@linde.com](mailto:electronicsinfo@linde.com)