

Linde facilitates photovoltaic cell capacity expansion in South East Asia

Linde has proven expertise in materials sourcing, logistics and permitting

Linde is the strategic gases and chemical partner for South East Asian photovoltaic cell manufacturers

Singapore, March 15, 2016 – Major photovoltaic (PV) cell manufacturers in South East Asia are expanding capacity and are partnering with technology company The Linde Group to quickly establish the reliable, high-quality supply chain they need as they extend material supply lines beyond their home countries. A case in point: Linde has been awarded multiple wins of gas and chemical supply for a number of world leading PV cell manufacturers' first plants in South East Asia. Linde not only provides materials, but also regional expertise in the form of engineering solutions and permitting guidance to deliver high-value advantages to customers in this competitive space.

Consolidation has quickly turned to expansion in the PV industry, and cell manufacturers are taking advantage of growth markets, local incentives and favorable trade terms by adding capacity in Thailand, Malaysia, India and other regional locations. In addition to building greenfield factories, manufacturers are faced with creating international material supply chains, navigating permitting and licensing in a new country, and building gas and chemical distribution systems, all of which are core competencies of Linde.

Linde offers a complete portfolio of gas and chemical products required for photovoltaic processes. Bulk gases used in the manufacture of PV cells are nitrogen (N_2), hydrogen (H_2), oxygen (O_2), argon (Ar), and in some cases, helium (He). Specialty gases used in PV manufacture are silane (SiH_4), ammonia (NH_3), nitrous oxide (N_2O), carbon dioxide (CO_2), methane (CH_4), hydrogen fluoride (HF), phosphine (PH_3) and diborane (B_2H_6). Operating with its subsidiary Asia Union Electronic Chemical Corporation (AUECC), which has manufacturing sites in China and Taiwan, Linde also provides a full range of wet chemicals, including high-purity aqueous acids, bases and etchants.

Andreas Weisheit, Head of Linde Electronics explains "Linde is the leading gas and chemical provider in the South East Asia region, with a long history in each of the individual countries in which we operate. Project windows are very short and customers need a materials supplier who can successfully execute sourcing, logistics and engineering solutions on aggressive timelines. Being close to our customers with the right resources means that Linde already has a multi-functional team in place on day one, and can help them ramp production as quickly as possible. Because of all we have to offer, we have become partners with PV manufacturers who have an immediate need for a well-functioning, reliable supply chain."

To safely store, handle, connect and distribute the gases and chemicals used in PV manufacture, detailed design considerations, which include local and global standards, and legal legislation, which is different in each particular country, must be taken into account. Linde experience with local permitting and licensing has benefitted customers needing to minimize their project timelines. Design codes, safety quantities, safety distances, package sizing, material handling techniques and emergency response accessibility are all considered when designing facilities and associated equipment in gas and chemical, source to point-of-use supply schemes.

Linde has the expertise to fully design greenfield gas and chemical facilities, including BSGS (bulk specialty gas systems), abatement and distribution piping networks, chemical CDM (chemical distribution modules) and specialized co-axial distribution piping. The Linde Engineering services division is based in Kuala Lumpur, Malaysia, supports Linde locally and globally and is currently active in executing multiple projects throughout the region. Linde can offer all molecules, full turnkey installation and all associated equipment and a complete point-of-use guarantee for all gases and chemicals used in the PV process.

About The Linde Group

In the 2015 financial year, The Linde Group generated revenue of USD 19.7 bn (EUR 17.944 bn) , making it one of the leading gases and engineering companies in the world, with approximately 65,000 employees working in more than 100 countries worldwide. The strategy of The Linde Group is geared towards long-term profitable growth and focuses on the expansion of its international business with forward-looking products and services. Linde acts responsibly towards its shareholders, business partners, employees, society and the environment in every one of its business areas, regions and locations across the globe. The company is committed to technologies and products that unite the goals of customer value and sustainable development.

For more information, see The Linde Group online at www.linde.com

Linde Electronics is an industry leader in gases for the electronics market—semiconductor, solar, display and LED. Linde Electronics helps electronics companies achieve their goals through a strong focus on quality and environmental leadership, its expertise, commitment to the industry through ongoing investments in processes, engineering, and on-site and localized solutions, a broad portfolio that includes environmentally sustainable and highly specialized and rigorously measured electronic specialty gases (ESGs), bulk/pipeline gases, equipment, and services, and through working closely with customers to better meet their evolving needs. For more information, visit www.linde-gas.com/electronics or contact electronicsinfo@linde.com.

Asia Union Electronic Chemical Corporation (AUECC), a Linde subsidiary, is a leading supplier of wet process chemicals to high-tech industries worldwide. AUECC is the first choice for wet chemicals among solar cell manufacturers. Its products support the photovoltaic wet process solutions for saw damage

repair, surface texturisation, surface cleaning and PSG removal and edge isolation. For more information, visit http://www.linde-gas.com/en/products_and_supply/electronic_gases_and_chemicals/wet_chemicals/index.html.

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