



BOC CO<sub>2</sub>



A Member of The Linde Group

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## CO<sub>2</sub> is commonly obtained during the manufacture of fertilisers (ammonia), bioethanol and alcohol

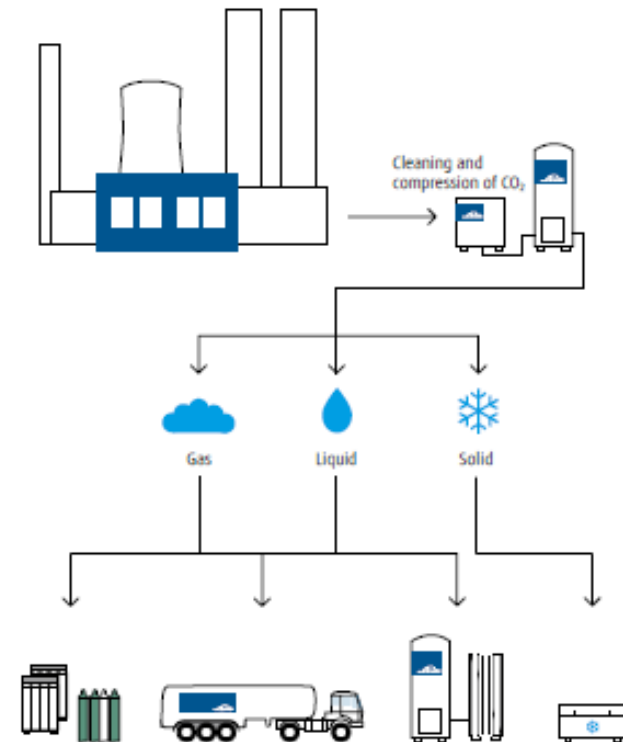


### Production of ammonia based fertilisers

- The majority of UK CO<sub>2</sub> comes from ammonia production
- Ammonia is a raw material mainly used in the manufacture of fertilisers
- Ammonia is synthesised from hydrogen (from natural gas) and nitrogen (from the air)
- Carbon dioxide (which can damage the iron catalyst used in the ammonia synthesis) is removed from the process and cleaned

### Production of bioethanol and alcohol

- Bioethanol and alcohol is produced through a sugar fermentation process
- Fuel crops are grown specifically for energy use and include maize, corn and wheat crops. The waste CO<sub>2</sub> can be captured and cleaned
- CO<sub>2</sub> is a by-product during fermentation of alcohol and can be captured, cleaned and re-purposed. This is the source of the raw CO<sub>2</sub> feed gas at BOCs plant in Manchester

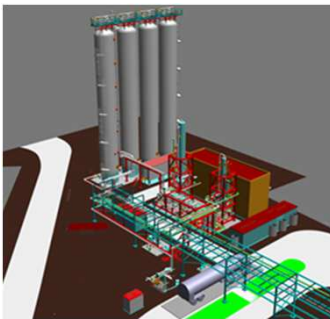


CO<sub>2</sub> extraction and distribution

## Building a CO<sub>2</sub> purification plant at Cargill



- BOC has built its first carbon dioxide purification plant in the UK, in Trafford Park, Manchester
- Leading food company Cargill provides the raw CO<sub>2</sub> feedstock
- It takes waste CO<sub>2</sub> and after purification converts it into food and beverage grade liquid CO<sub>2</sub>
- The waste CO<sub>2</sub> is a by-product of Cargill's wheat fermentation process
- The facility includes **1,200 tonnes of bulk liquid storage**
- The plant started supplying CO<sub>2</sub> to BOC customers in mid 2017
- BOC investing in the UK to provide CO<sub>2</sub> for UK customers



Plan of the new CO<sub>2</sub> plant



Installation of the new CO<sub>2</sub> plant



Installation of the CO<sub>2</sub> storage

## Security of supply



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- Security of supply is critical for CO<sub>2</sub> customers and significant business has been secured over recent years by demonstrating BOC's ability to deliver
- Recent events in the UK and Europe have demonstrated how fragile the broader CO<sub>2</sub> supply chain remains, with all four large CO<sub>2</sub> suppliers invoking force majeure in June/July 2018
- BOC in the UK and Ireland now benefits from having our own CO<sub>2</sub> liquefaction plant and access to a broader European Linde CO<sub>2</sub> supply network
- Imports can support during periods of constrained product supply as was the case earlier this year when Billingham underwent an unplanned shutdown (CO<sub>2</sub> was imported from as far as Spain and Romania)
- BOC's European supply is from a range of sources that are not all reliant on ammonia production
- BOC has made several investments over recent years to improve supply chain security, not least in our own CO<sub>2</sub> liquefaction plant but also in maintaining strategic storage capacity at Scunthorpe
- For several years BOC has been paying a retainer to a European haulier for short-notice utilisation of tankers for the collection of CO<sub>2</sub> from Europe in the event of a shortage of product in the UK
- BOC site storage of CO<sub>2</sub> is frequently reviewed to support security of supply for bulk, Cryospeed & Cylinder gas customers



Importation of CO<sub>2</sub> from Europe using third party hauliers



ISOs used to collect CO<sub>2</sub> from Europe



Linde Abello CO<sub>2</sub> plant, Salamanca, Spain