

#h2nw

PROVIDING HYDROGEN REFUELLING TO THE LIVERPOOL CITY REGION

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MARKET DEVELOPMENT MANAGER, CLEAN FUELS,
BOC UK & IRELAND



DELIVERING THE
HYDROGEN
ECONOMY

North West



The OLEV Hydrogen Bus and Filling Station Project Bringing Hydrogen Refuelling to Liverpool

Mark Griffin

‘Delivering the Hydrogen Economy’

Wednesday 05 June 2019



A Member of The Linde Group

THE LINDE GROUP

Introduction to Linde

Facts and figures.

Our company.

100+ We serve our customers in over 100 countries worldwide

The Linde Group

~ **65,000**
employees

Engineering Division

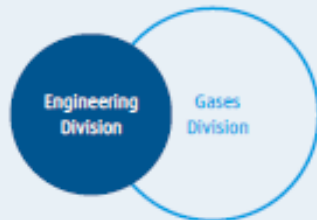
~ **7,000**
employees



Around 65,000 employees deliver value to our customers every day

Unique setup

Close to the customer with an integrated business model



Our business.

4,000+

plants have been delivered by Linde around the globe

3,000+

air separation units have been built in more than 90 countries

1,000 plants are operated by

10

Linde Remote Operating Centres worldwide

600+

air separation, hydrogen and CO₂ plants are operated by Linde

50 %

of our research projects also aim to achieve an environmental benefit

1,000+

process technology patents bear testimony to our innovative powers

-50 °C to +40 °C

our plants withstand the most extreme climatic conditions

Our achievements.

55 million t annual oxygen production capacity in Linde's air separation units installed since 2010

2.5 million tonnes in CO₂

savings since 2008 as a result of energy optimisation in our air separation units

5,500 t

of oxygen produced by our largest single air separation unit per day

25,000 m²

is the heating surface of one of our coil-wound heat exchangers

1,300 t

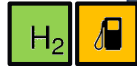
is the weight of one of our gigantic fully assembled coldboxes

Linde HRS Activity Globally

Europe



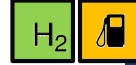
- 35+ public Linde H2 stations, 24 more in pipeline
- First H2 train project in Germany



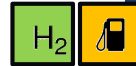
- Various further H2 fleet projects: buses, car sharing, FLT's
- Power-to-H2: Mainz** (Germany), Berlin (Germany)



USA, esp. California

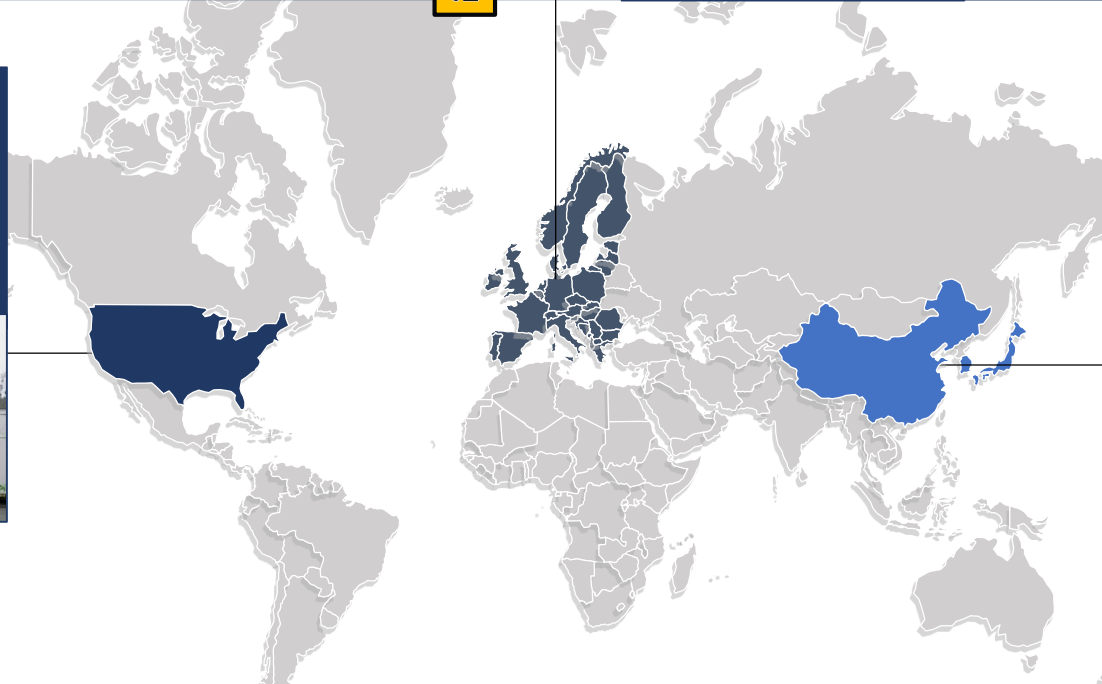


- H2 buses at AC Transit (CA, USA)
- FLT* at BMW Spartanburg (SC, USA)
- Public Linde H2 stations (CA, USA) (4 running, 4 in execution)



East Asia

- H2 bus projects (China)
- Component systems for 14 public H2 stations (Japan)
- 4 H2 stations for buses, taxis, passenger cars (Korea)



- Linde with strong project record globally with more than 100 HRS system installations in all H2 lead markets
- Net of HRS installations as demand foundation for Green H2 source investments

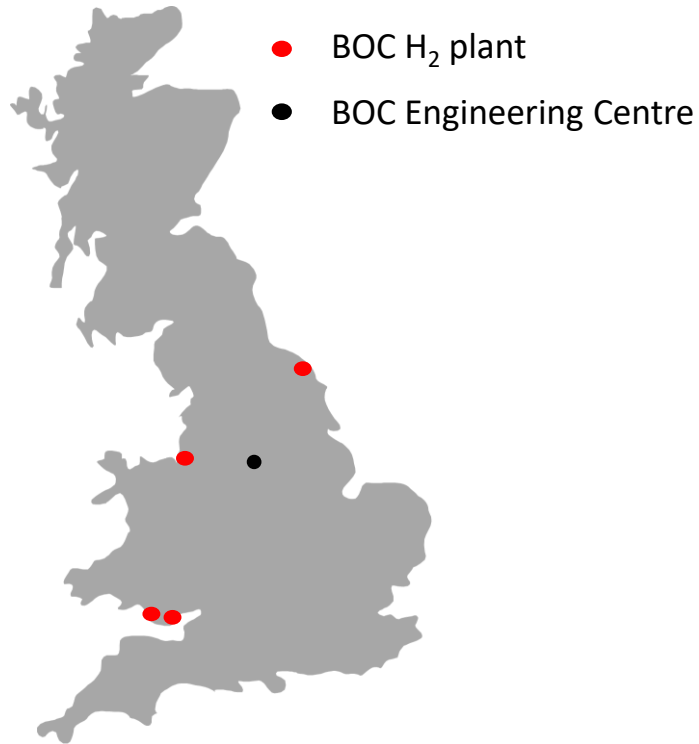
* FLT - fork lift trucks ** Energy park Mainz, largest scale electrolysis system installation globally (6.3 MW installed capacity)



BOC UK hydrogen capability

Strong network and experience of refuelling activities

Hydrogen production plants



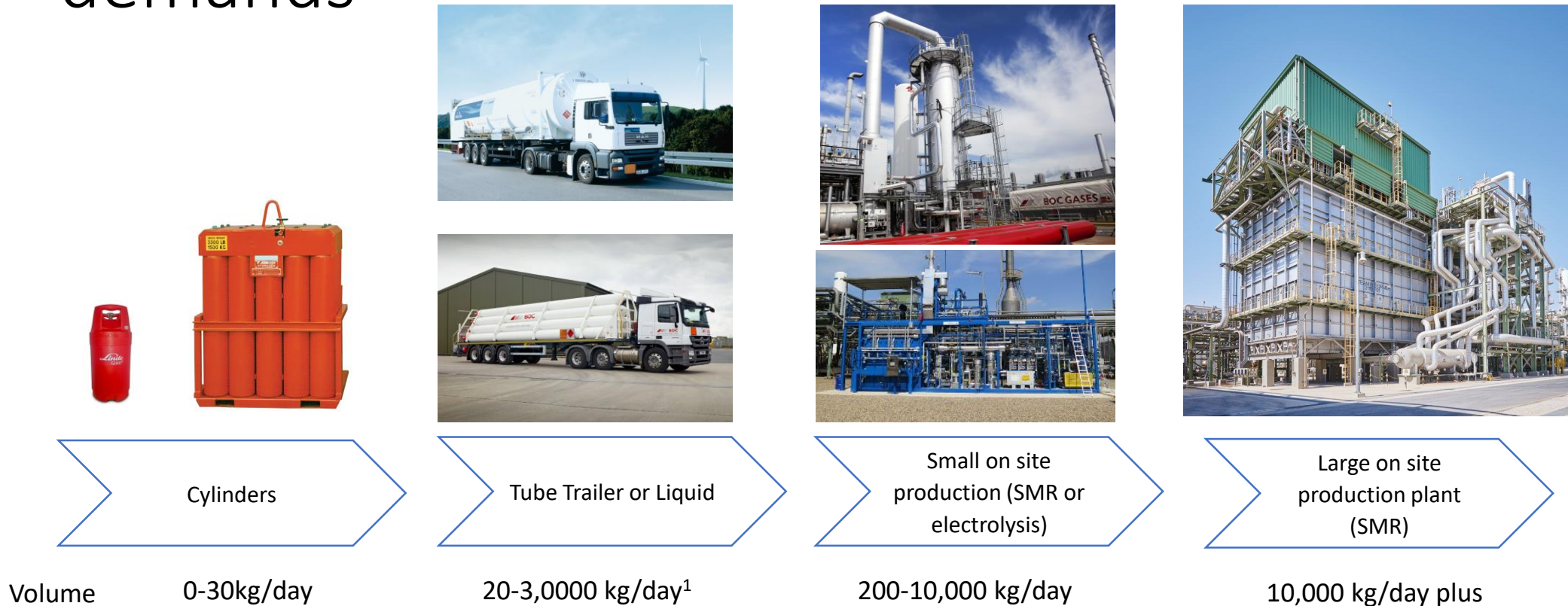
- Strong network of hydrogen plants
- Regional Operating Centre and Engineering team in Sheffield

Hydrogen refuelling activity



Hydrogen supply options

Full range of solutions for trials and operational demands



Ideal supply solution will depend on usage profile, duration, location and purity requirements

St Helens Hydrogen Overview

- No.2 H2 Plant commissioned in 1993
- Major refurbishment planned for 2020
- Bottom Fired furnace with 14 reformer tubes, Howar design
- H2 product:
 - Single pipeline customer
 - H2 trailers
 - H2 cylinders
- SMR process of High Temperature Shift, Pressure Swing Adsorption and H2 Compression, using a Natural Gas feed.
- Site team supported by the ROC (Remote Operating Centre) in Brinsworth
- Plant designed for capacity of 1600 Sm³h with H2 purity of 99.999% (1700 Sm³h with new reformer catalyst)



Reference Project : Bus Refueling Aberdeen

The H₂ bus refueling station in Aberdeen, Scotland supplies 10 Van Hool H₂ Buses, while maintaining a small footprint. The electrolyzers can power up to 20 buses a day and are designed to extend to H₂ car dispensers.

Key Information since opening in 2015
Over 90 tonnes of H ₂ delivered since 2015
Over 1,000,000 miles driven
Average of 200-250 Kg delivered nightly
Station availability of 99.6%



H ₂ Supply	Compressor	Dispenser	Start of Operation
3x Electrolyser	2x IC 90	2x 350bar Bus	2015

Upcoming Project : Buses Liverpool City Region

BOC as part of a consortium bid involving Arcola Energy, Mersey Travel, Liverpool City Region and Aberdeen City Council have been awarded funding to build a HRS at BOC St Helens to refuel a fleet of 25 ADL Double-Decker Hydrogen Buses

Key Information of Planned Project
Hydrogen Supplied by the existing SMR plant
Average daily demand of 500Kg per night
Project to be delivered in 2020



H ₂ Supply	Compressor	Dispenser	Start of Operation
SMR	2x IC 90	2x 350bar Bus	2020

Thank you for your attention



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