# An Industry Perspective: Significant Challenges and Potential Costs of CCS

# An Introduction to INEOS

INEOS is a global manufacturer of petrochemicals, specialty chemicals and oil products. It comprises 15 businesses each with a major chemical company heritage.

2012 Sales $43bn

15,000 employees*

51 manufacturing plants in 11 countries*

54 million tonnes of chemicals capacity

- A leading global Chemical Company

20 million tonnes of refinery products (400,000 bbls/day)

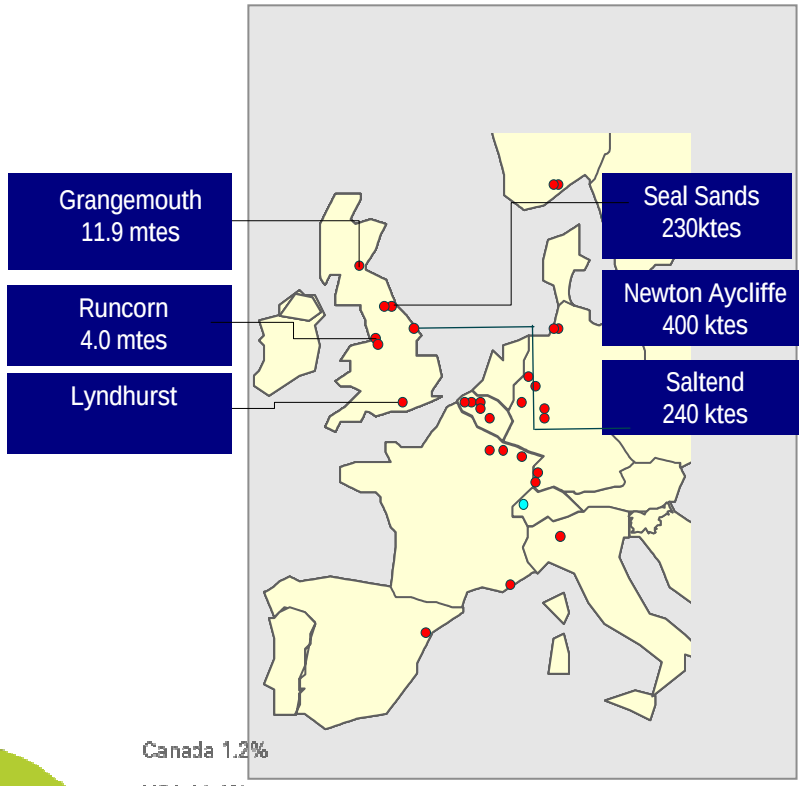
- Largest refinery in North Britain

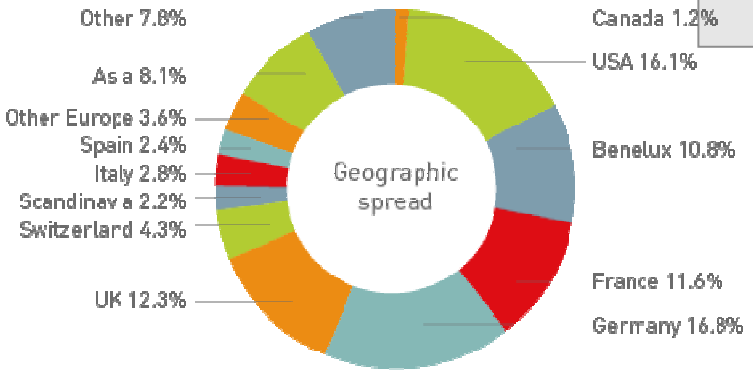
- * excl. joint ventures

# INEOS in the UK

- Second largest private company in the UK
- 6 Sites
- 9 businesses
- 3800 employees (25%)
- 1000 Contractors
- Investing in Skills
- Major supplier to UK manufacturing
- 19% of our turnover



# INEOS at Grangemouth

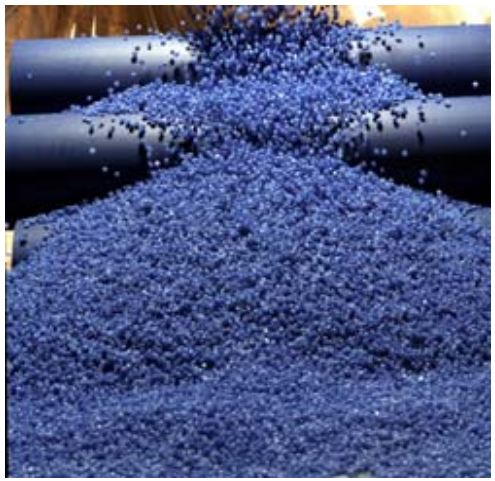
- The Grangemouth site occupies almost 1700 acres of land – that's equivalent to  around 640 football pitches – and contains over 4000 km of pipework
- It is home to Scotland's only crude oil refinery
- The site employs 1350 people directly
- Is a fully integrated refining and petrochemicals complex, linked to the North Sea via the Forties Pipeline System and downstream customers by pipeline, ship, road and rail.

# Grangemouth products

- ethylene
- propylene
- butadiene
- polyethylene
- polypropylene
- ethanol

- LPG
- gasoline
- jet fuel
- diesel
- home-heating oil



- Grangemouth is INEOS' largest manufacturing site
- Grangemouth's employees manufacture the bulk of Scotland's fuels
- Grangemouth produces over nine million litres of clean fuels every day (ULSP & ULSD)
- Grangemouth produces some 1.5 million tonnes of chemical products every year

INEOS

# Grangemouth Energy Consumption - Context

Energy Consumed = 60,000 TJ per year
= 1.5 million Fuel Oil Equivalent Tonnes

Average Domestic Household = 1.96 FOET / year (Heating, Water, Cooking & Lighting)

Site roughly equivalent to Cities of Glasgow, Edinburgh & Aberdeen, plus Falkirk

Associated $CO_2$ emissions:

- DIRECT = 3.3 million tonnes per year
- INDIRECT = 0.7 million tonnes per year (3rd Party CHP)
- TOTAL = 4 million tonnes per year (~0.8% Total UK emissions)

# 1. Energy Strategy

Typically energy contributes around 70% of refining and 30% cracker variable costs

- Equates to around €1M / day cost for power, steam and fuels
- Energy efficiency is routine part of all of our operations

Majority of fuels consumed are indigenous.

Fuel switching from oil to gas has already been incorporated

- but can require significant capital investment to replace the heaters.

Backing out indigenous gas does not make sense as it would either need to be:

- Exported – requires separation to meet spec (OOM capital cost £250M)
- Flared – lose heat content and generates same amount of CO2

# 2. Carbon Capture and Storage

# Site Emissions in perspective

Refineries are recognised as a large CO2 emitters – producing ~6% of total European Industrial CO2 (Petrochemical industry ~3%)

But this is small in comparison with the power sector with ~78% of emissions

Refinery emits CO2 through fuel burning process furnaces, production of hydrogen (required for conversion processes) & utilities (onsite CHP plants)

From a multitude of dispersed & small sources spread over a large area

Making end of pipe recovery logistically and technically difficult as well as expensive.

Refinery process heater stacks 13, flares 3

Power station boiler combined stacks 4

Chemicals process boiler and furnace stacks 17, flares 9

Flue gases are normally low CO2 concentration 3-12% v/v CO2

# CO2 capture technology

From major feasibility studies there are 3 options for CO2 capture

## Post combustion

- Does not require any change to the combustion technology
- Existing absorption technology can capture large volumes of low concentration CO2
- Requires removal of flue gas impurities / contaminants (DeNox & DeSOx processes)
- Large utility consumption would require installation of new utility plants for the additional energy demand

## Pre-combustion

- Decarbonising the fuel to produce hydrogen for combustion & concentrated CO2 for removal before combustion.
- Process available but complex and expensive installations
- Requires retrofitting/new heaters to burn pure hydrogen, at considerable expense

## Oxy-fuel combustion

- Replaces combustion air with pure oxygen, eliminating nitrogen from the flue gases & increases CO2 concentration
- Not widely used by industry and has significant technological challenges
- Requires retrofitting heaters to burn pure oxygen, complex and expensive

# Carbon Capture Facilities

Elements of Carbon Capture Scheme:

- 2 kilometres of ducting, with maximum cross-sectional area of 9 square metres
- Power demand of blowers to move flue gas ~25MW
- SOx and NOx Removal Facilities (to avoid excessive degradation of the amine)
- Amine absorber columns (x4) and regenerator columns (x2)
- CO2 dehydration and compression facilities
- Additional Utilities:
  - 480 tonnes per hour of Steam
  - 72 MW of Power
  - Would require another Biomass CHP of approximately the same size.

# Carbon Capture Costs

Capital Costs for Equipment:

- Gathering, DeNOx, DeSOx, $CO_2$ removal, drying & compression = £400m (OOM)
- Additional Biomass CHP for Steam & Power requirements = £250m (OOM)

Operating & Maintenance Costs for Carbon Capture:

- CO2 Capture Facilities = £16m pa. (at 4% TIC)
- Biomass CHP, incl. Fuel = £85 – 135m pa.

# Carbon Transport & Storage

Technical Feasibility – various studies & scale up projects underway.

Legislation:

- Cross-Country Pipeline Regulations under review to include $CO_2$ pipelines
- Monitoring of Storage and Liability Costs

Access – geography dependent, but Grangemouth Site probably advantaged.

- Scotland access to North Sea Infrastructure
- Proximity of NTS pipeline, proposed for reverse flow of $CO_2$ from Central Scotland

Costs:

- Transportation:
  - Capex = £20m (assuming local tie-in to existing infrastructure)
  - Opex = £6 – 13 per tonne
- Storage Costs: £4 – 6 per tonne

# Overall CCS Costs

Capital Investment:

- Capture = £650m (OOM)
- Transport = £20m (OOM)
- Storage = nil

Opex:

- Capture = £85 – 135 m pa.
- Transport = £15 – 30 m pa.
- Storage = £10 – 15 m pa.

CO2 Emissions Reduction:

- 2.4 million tonnes per annum

**Cost of $CO_2$ Reduction (10 year payback; 7% DR) = £84 – £113 per te**

# CO2 capture challenges

- lack of ground space
- treatment of specific impurities
- high reliability requirements
- low retrofitting impact
- additional energy consumption
- untested technology
- results in high cost

Norway abandon development of full-scale CO2 capture at Mongstad oil refinery.

20 Sept 2013

“At both the national and international level, the development of technologies to capture and store CO2 has taken longer, been more difficult and more costly than expected," Oil and Energy Minister Ola Borten Moe.