Glass Futures™

A Global industry in need of local solutions

Aston Fuller, General Manager

Wednesday 16th November 2021

airto
driving growth and innovation

Department for Business, Energy & Industrial Strategy

EX TERRA LUCEM

UK Research and Innovation

INDUSTRIAL STRATEGY

LIVERPOOL CITY REGION
COMBINED AUTHORITY

METRO MAYOR
LIVERPOOL CITY REGION

STRATEGIC INVESTMENT FUND

THE GLOBAL CENTRE OF EXCELLENCE FOR GLASS
IN R&D, INNOVATION AND TRAINING

Aston Fuller

Studied Mechanical Engineering

Joined Ardagh Glass in 2010

- Worked as Batch and Furnace Supervisor
- Moved to Capital projects manager 2015
- Also dealt with site Energy Management

Then moved into R&D in 2018

Joined Glass Futures as General Manager in Jan 2020

Fell in love with Glass - 2012

- Always been passionate about sustainability
- Interested in Energy systems
- Always been attracted to innovation and entrepreneurship

Who We Are

We were built by the glass industry, for the global glass industry
to create the Global Centre of Excellence in St Helens, UK
to make glass the low carbon material of choice.

Non-Profit, Membership Organisation

Research and Technology Organisation

Leading the global shift to sustainable manufacture

Glass Futures™

Global Centre of Collaboration: St Helens, UK

- 30T/day glass R&D capability
- Batch Plant currently out for tender
- Technology development in the real world
  - Rolled plate machine
  - IS Machine
  - Refractory testing facility
- Benchmark low-carbon fuels:
  - —Natural Gas
  - —Hydrogen
  - —Electric
  - —Bio-fuels
- Open-Access across **all sectors**
- Commissioning: 2023

Glass is at the fore front of a changing world

The world requires huge changes across glass and its supply chain

We presented at COP26 and had a fantastic reception, where the key themes of the week were:

- Collaboration
- Working across the supply chain
- Building partnerships for change
- $100Bn per year climate finance from Developed Countries

Global CO2 Targets are aggressive!

Bold Commitments

- BT (15 September 2018) net zero carbon business by 2045
- Verizon (22 April 2019) net zero by 2035
- British Airways (11 October 2019) net zero by 2050
- Ikea (27 November 2019) 'climate-positive' by 2030
- Microsoft (16 January 2020) net zero by 2030, with an additional goal of removing all carbon emitted since it was founded in 1975
- AstraZeneca (22 January 2020) carbon-negative by 2030, and net zero operational carbon emissions by 2025
- Sky (4 February 2020) net zero by 2030
- BP (12 Febraury 2020) net zero by 2050
- Mitie (20 February 2020) net zero by 2025
- Cemex (21 February 2020) net zero concrete by 2050
- O2 (03 March 2020) net zero network and operations by 2025
- Barclays (30 March 2020) net zero by 2050
- Shell (20 April 2020) net zero by 2050
- CMS (24 April 2020) net zero by 2025
- Jacob's Engineering (24 April 2020) net zero by 2030
- Total (5 May 2020) net zero by 2050
- University of Manchester (29 May 2020) net zero investment portfolio 2038
- Tetra Pak (11 June 2020) net zero value chain by 2050
- Unilever (14 June 2020) net zero by 2039
- British Land (23 June 2020) net zero portfolio by 2030
- Barrett Developments (30 June 2020) net zero by 2040
- Lucozade Ribena Suntory (01 July 2020) net zero value chain by 2050
- M&G Real Estate (13 July 2020) net zero operational emissions by 2030 and net zero across its real estate portfolio by 2050
- Apple (21 July 2020) net zero by 2030
- Capgemini (24 July 2020) net zero operations and supply chain by 2030
- Novo Nordisk (04 August 2020) net zero by 2030
- HMRC (01 September 2020) net zero by 2040
- Ikea (02 September 2020) climate positive by 2030
- PwC (15 September 2020) net zero by 2030
- IAG (11 September 2020) net zero carbon emissions by 2050
- Japan Airlines (11 September 2020) net zero by 2050
- Qantas (11 September 2020) net zero by 2050
- Finnair (11 September 2020) carbon neutrality by 2045
- American Airlines (11 September 2020) net zero by 2050
- Cathay Pacific (11 September 2020) net zero by 2050
- Iberia (11 September 2020) net zero by 2050
- Malaysia Airlines (11 September 2020) net zero by 2050
- Qatar Airways (11 September 2020) net zero by 2050
- Royal Air Moroc (11 September 2020) net zero by 2050
- Royal Jordanian (11 September 2020) net zero by 2050
- S7 Airlines (11 September 2020) net zero by 2050
- Sri Lankan Airlines (11 September 2020) net zero by 2050
- Fiji Airways (11 September 2020) net zero by 2050
- Facebook (15 September 2020) net zero value chain by 2030
- Nespresso (17 September 2020) carbon neutrality by 2022
- Arup (22 September 2020) net zero 2030
- Spirax-Sarco (22 September 2020) net zero by 2040
- LafargeHolcim (22 September) net zero by 2050
- NHS (01 October 2020) net zero by 2040
- Aviva Investors Pension Scheme (02 October 2020) net zero by 2050
- BT Pension Scheme (08 October 2020) net zero by 2035
- HSBC (09 October 2020) net zero financed emissions by 2050
- City of London Corporation (12 October 2020) net zero by 2040
- John Lewis (19 October 2020) net zero by 2035
- Dentsu International (22 October 2020) net zero by 2030
- Lime (23 October 2020) net zero by 2030
- Equinor (03 November 2020) net zero by 2050
- KPMG (09 November 2020) net zero by 2030
- Tesco (16 November 2020) net zero by 2035
- Henkel (18 November 2020) net zero by 2040 under Amazon's Climate Pledge
- Diageo (23 November 2020) net zero operations by 2030
- Vodafone (23 November 2020) net zero by 2040 and net zero carbon emissions from operations by 2027
- Coca-Cola European Partners (07 December 2020) net zero by 2040
- Glencore (07 December 2020) net zero by 2050
- Canary Wharf Group (09 December 2020) net zero by 2030
- WHSmith (11 December 2020) net zero emissions by 2025
- PepsiCo (14 January 2021) net zero by 2040
- BBC (14 January 2021) net zero by 2030
- Aviva Investors Real Assets (January 2021) net zero by 2040
- CDL (03 February 2021) net zero operations by 2030
- Avantium (4 February 2021) net zero operations by 2030
- Centrica (25 February 2021) net zero by 2045
- Aviva plc (1 March 2021) net zero operations, supply chain by 2030 and investments by 2040
- Burger King (19 April 2021) net zero operations by 2030
- Fora (19 April 2021) net zero by 2030
- Mulberry (19 April 2021) net zero by 2030
- Nestle (19 April 2021) net zero by 2050
- Visa (19 April 2021) net zero by 2040
- Whitbread (19 April 2021) net zero by 2040
- WPP (19 April 2021) net zero by 20430
- Dell (20 April 2021) net zero by 2050
- Co-op (5 May 2021) carbon neutrality across own-brand food and drink by 2025
- Highland Spring (4 June 2021) net zero by 2040
- Burberry (14 June 2021) climate positive by 2040

Rate of Change

The power of computing is exponentially rising – The efficiency of Glass production is plateauing

Siemens Regenerative furnace -1861

Owens bottle making machine - 1902

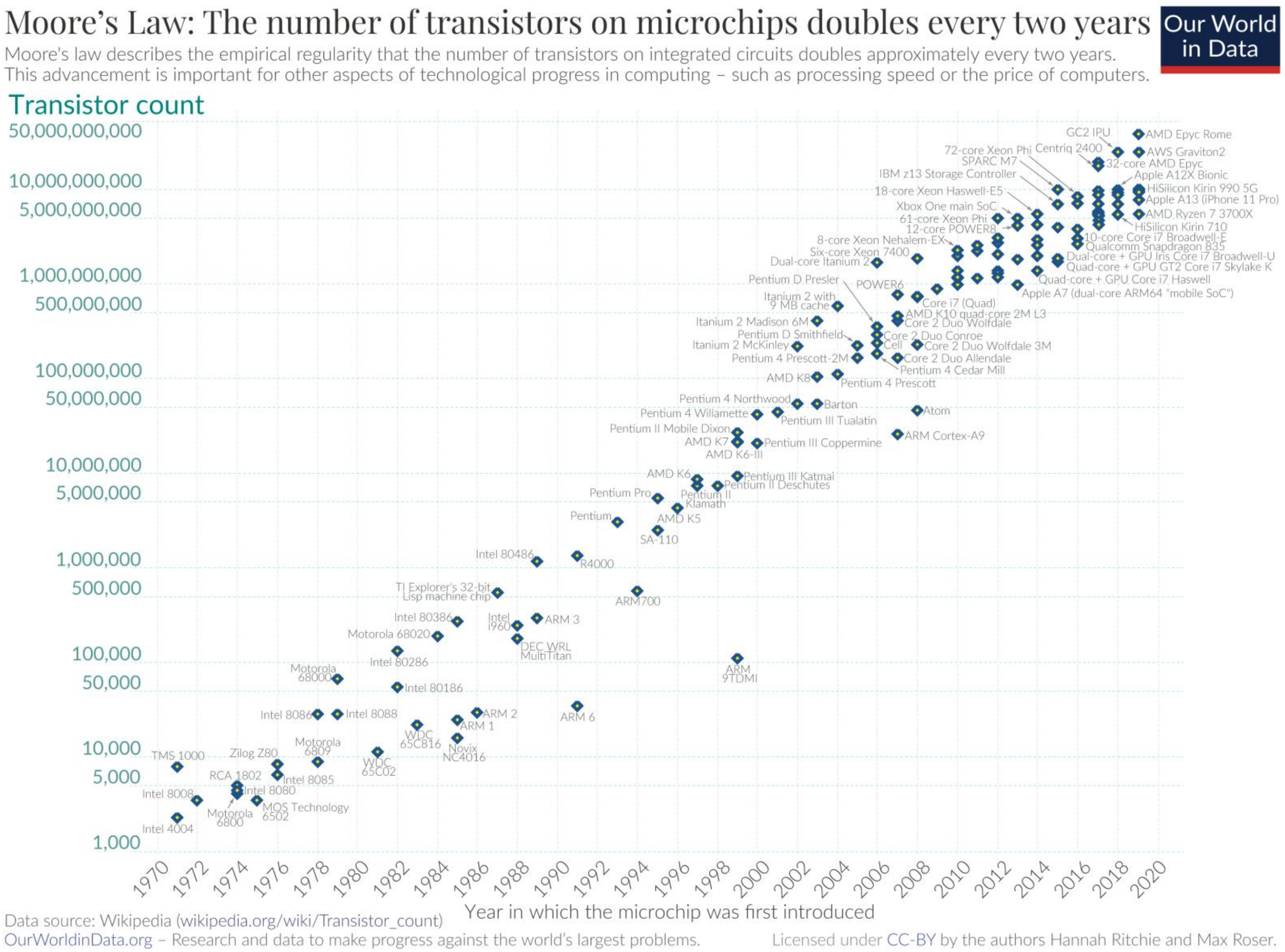
Pilkington Float Process – 1952

Electric Melting - 1950s

Oxy-fuel combustion – 1970s

AI/ML & Big Data - ?

Hydrogen melting - ?

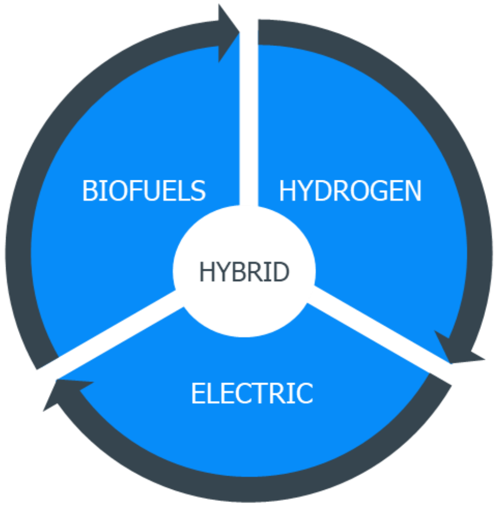


Industrial Fuel Switching Programme

- £7.1m BEIS funded project
- Key first major project started in Jan 2020
- Partners from industry, supply-chain and academia

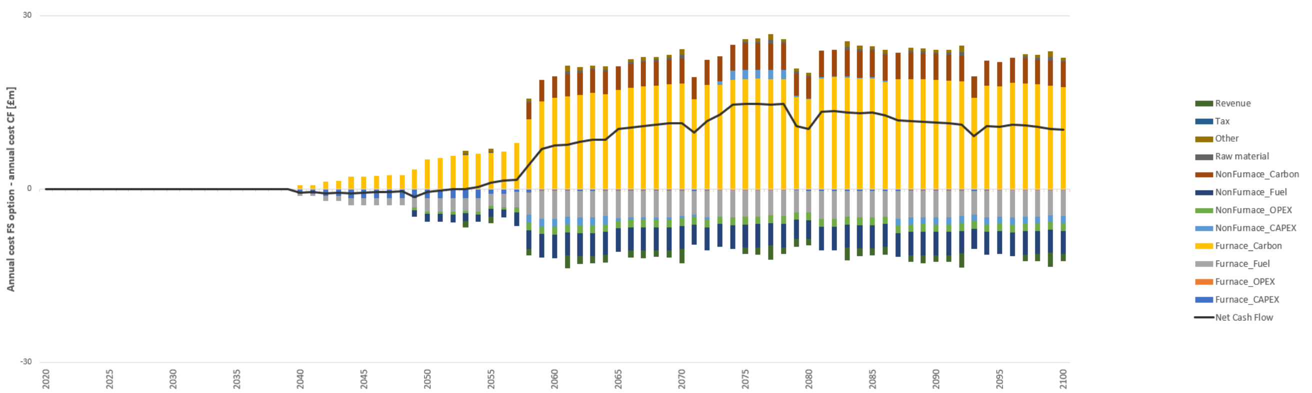
- Hugely successful Bio-fuel Trial @Encirc – Derrylin
  — 100% Biofuel for 3 weeks – 90% CO_2 Reduction!
- Running a set of combustion trials at Liberty Steel
- Looking across the techno-economics in industry for fuel switching

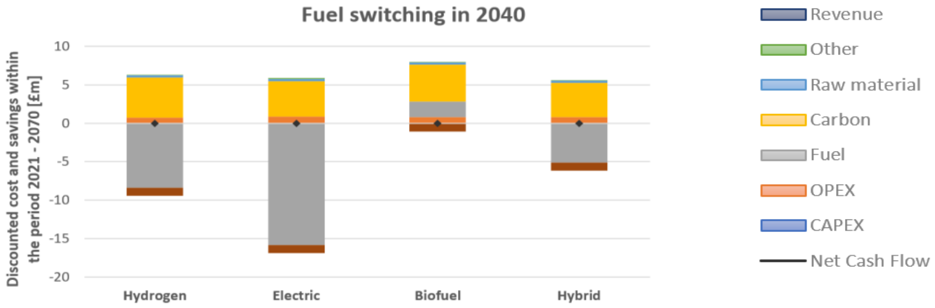
- Results will be published in March 2022



Modelling The Economics of Green Combustion

Cash flow relative to no fuel switching (£m)





Fuel / CO2 price projections (£/MWh LHV or £/tC
All costs are in 2018 £

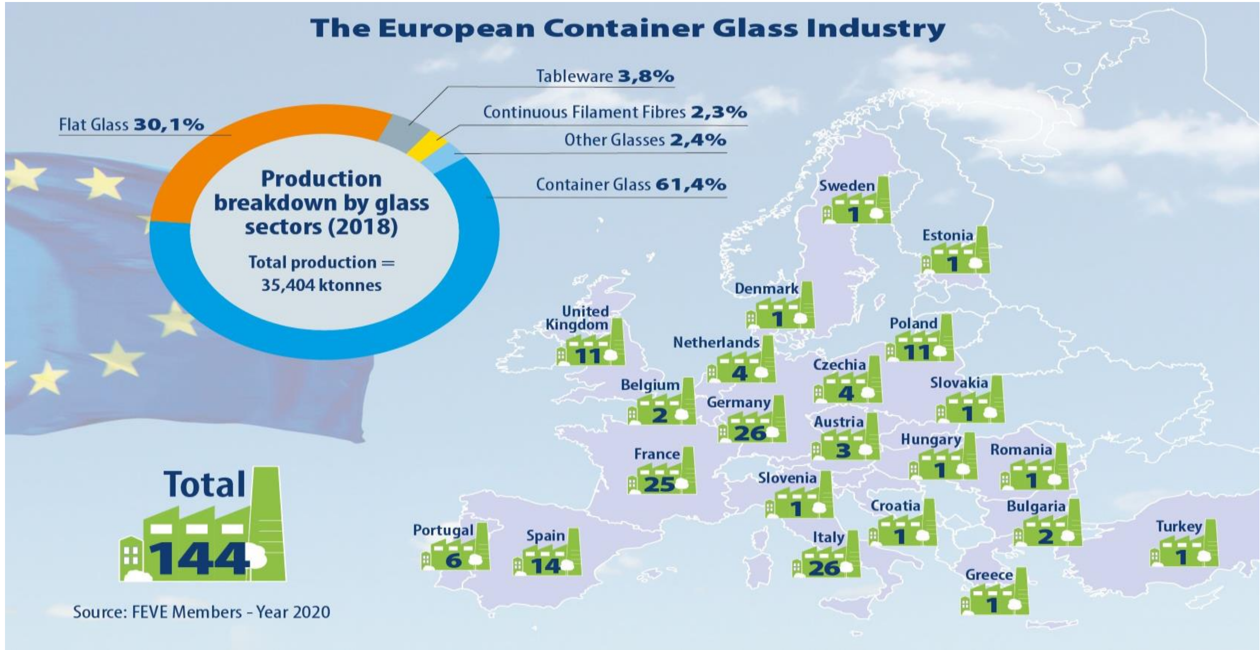
Fuel	Source
CO2	BEIS 2020 - low
CO2	BEIS 2020 - medium
CO2	BEIS 2020 - high
Gas	BEIS 2020 - low
Gas	BEIS 2020 - medium
Gas	BEIS 2020 - high
Coal	BEIS 2020 - low
Coal	BEIS 2020 - medium
Coal	BEIS 2020 - high
Hydrogen	CCC 2020 - blue H2 - medium
Hydrogen	CCC 2020 - green H2 - mediun
Hydrogen	CCC 2020 - green H2 - low
Electricity	BEIS 2020 reduced - low
Electricity	BEIS 2020 reduced - medium
Electricity	BEIS 2020 reduced - high
Electricity	BEIS 2020 - low
Electricity	BEIS 2020 - medium
Electricity	BEIS 2020 - high

Key Findings

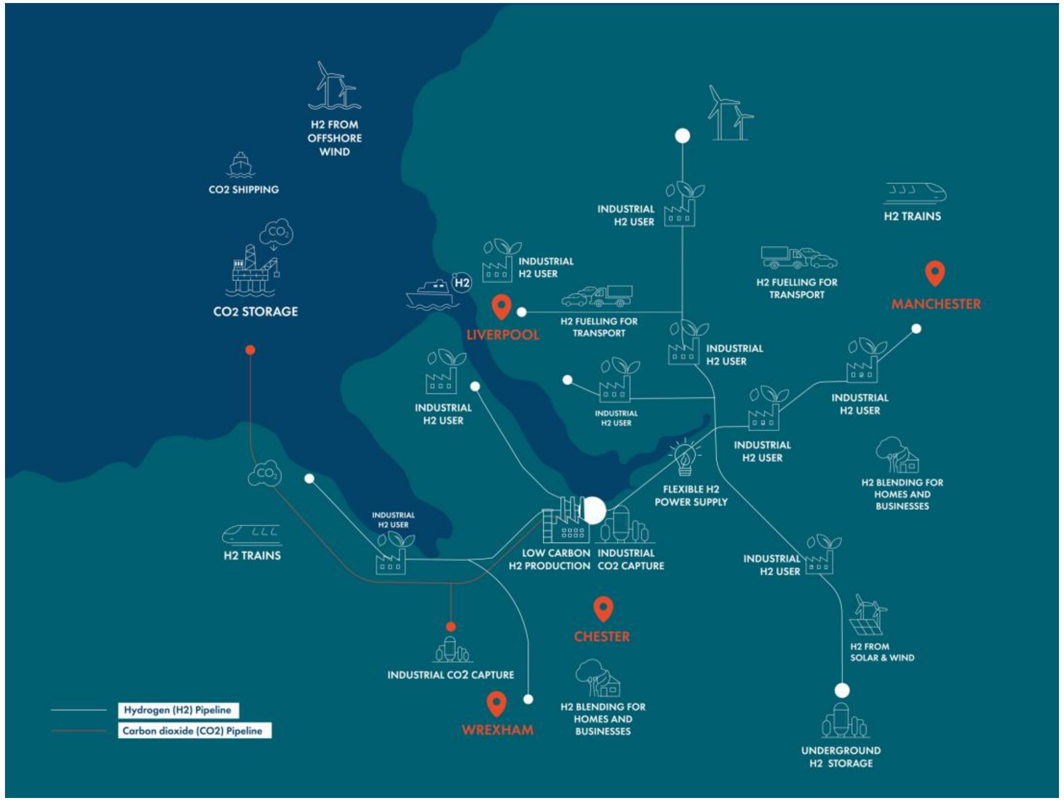
- Must look at a site – not an industry!
- Future energy pricing is very difficult to predict
- Energy predictions are currently national across the board
- Without major incentives – generally 2040 will be the time period when major changes happen
- The number of site specific variables is very important!
- Furnaces are being built at the moment:
  - These will run for 20+ years!
  - Change in fuel costs over time?
  - Change in CO2 cost over time?
  - Regional influences on energy usage?

Global industry!

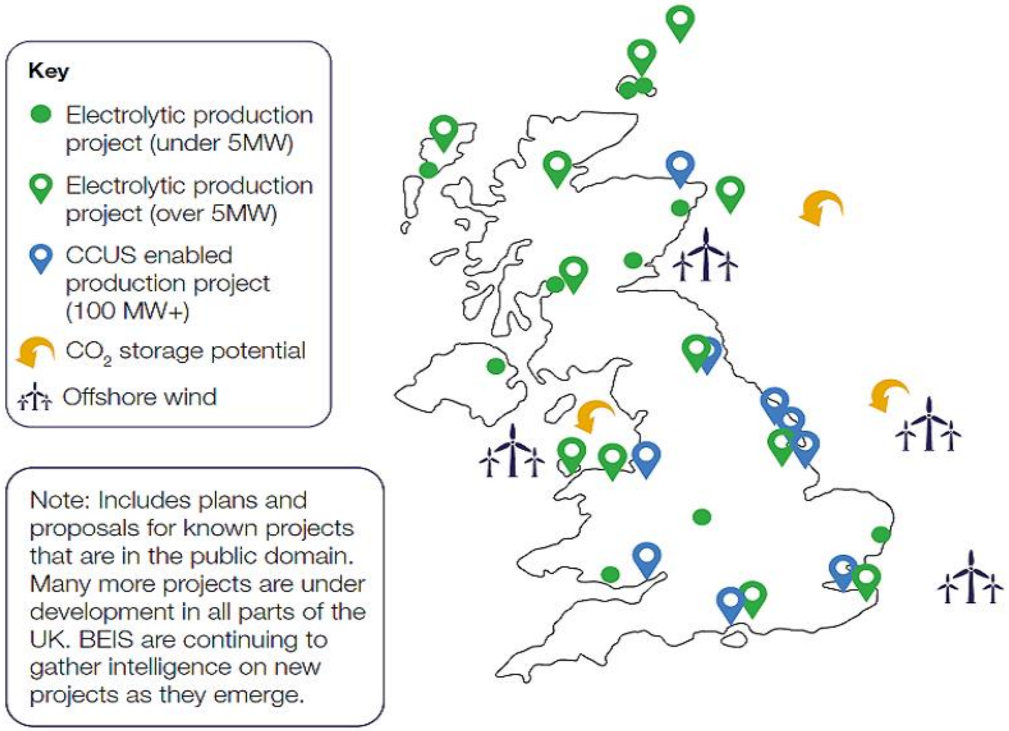
- Majority of the Global Glass industry furnaces:
  - — Regenerative
  - — Gas fired
  - — Economically well understood
  - — Thermally highly efficient
  - — Small amounts of electrical boost
- Production is generally local
  - — Lots of import/export
  - — Still locally serving markets in every continent
- International material and price fluctuations effect everyone together, but more and less depending on local material availabilities



The Hydrogen Economy – A regional solution



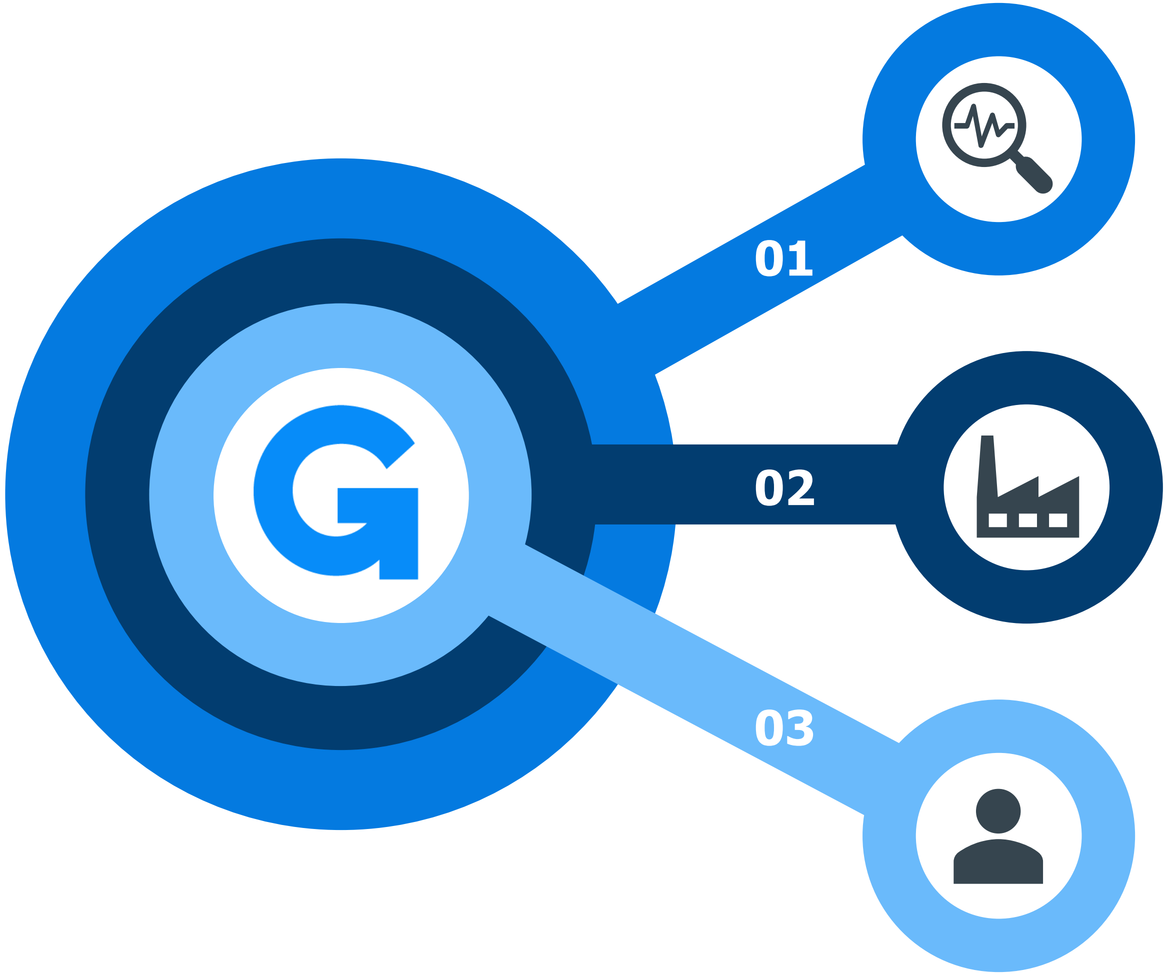
HyNet – North West UK



UK BEIS Proposed H2 strategy

https://www.gov.uk/government/publications/uk-hydrogen-strategy/uk-hydrogen-strategy-accessible-html-version

Hydrogen timelines?



01 The Early Adopters

Large scale H2 capacity available from 2025 onwards

Regional only

02 The Mass Users

2035-2040 sees big industrial clusters bring access to more users

Close to industrial regions

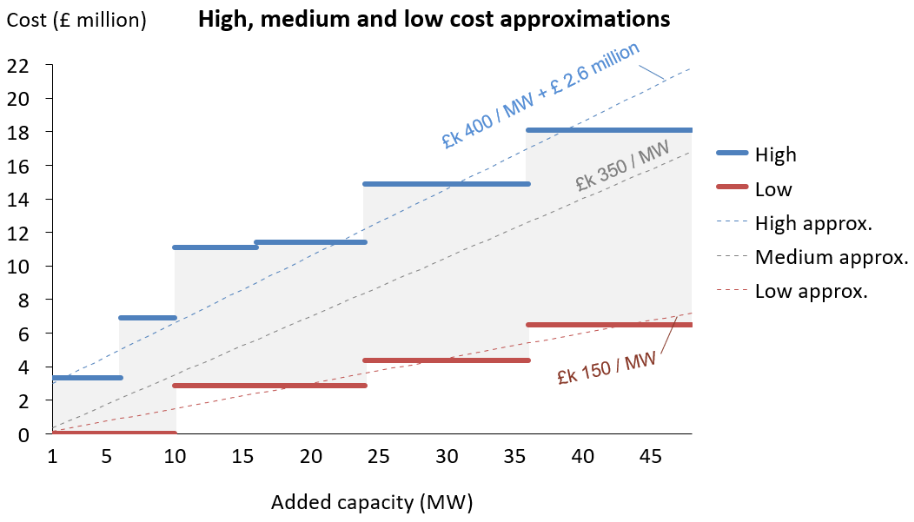
03 Remote Access

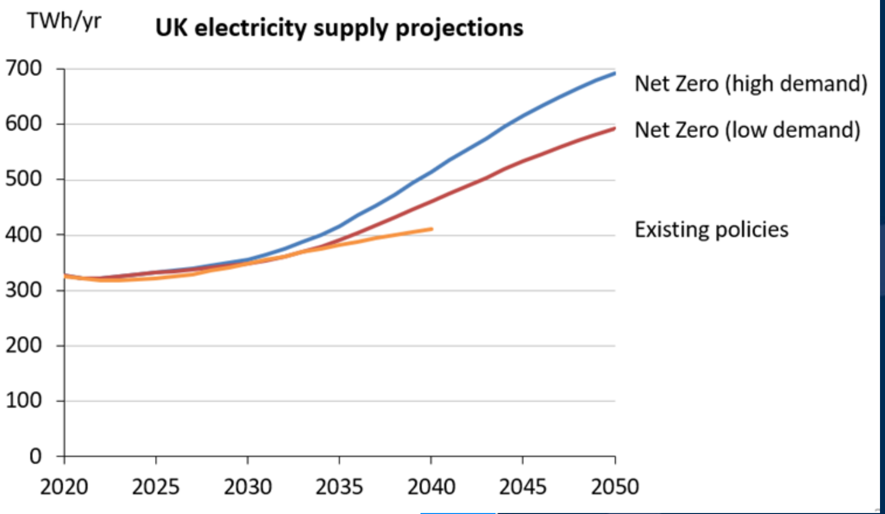
Places far away from production may not see H2 until 2070

Likely not feasible until >2100

Techno-Electro-Economics

- We studied the cost of electrical melting, with two key considerations:
  - Capex
  - Opex
- Price certainty for electrical systems regionally:
  - National nuclear decisions
  - Hydro-electric production
  - Renewable uptake of the region?






elementenergy

Electric melting infrastructure implications in the UK

A Report for

Glass Futures Ltd

May 2021

Element Energy Limited
Suite 1, Bishop Bateman Court
Thompson's Lane
Cambridge CB5 8AQ
Tel: 01223 852499

A Problem Shared

- Working Across materials is vitally important

- Glass Futures is funded by the "Transforming Foundation Industries" Challenge Fund in the UK

- Glass shares its problems with:
  - Brick Makers
  - Steel manufacturing
  - Chemical processing
  - Plastic recycling

- Everyone has to make huge changes sooner rather than later – We must look across other sectors!

The Big Problem

The decisions we must make as an industry rely on long term confidence

There is a huge amount of uncertainty in this space currently

How does the industry change its model to keep pace with the change of society?

“Collaborate”

Verb

1. work jointly on an activity or project.

2. cooperate traitorously with an enemy.

Key Technology Themes

Raw materials & circular economy enablers

Demonstrating improved strength yet light weight, functional coatings

Driving very high recycled content, not just from cullet

Secure supply chains and more business intelligence

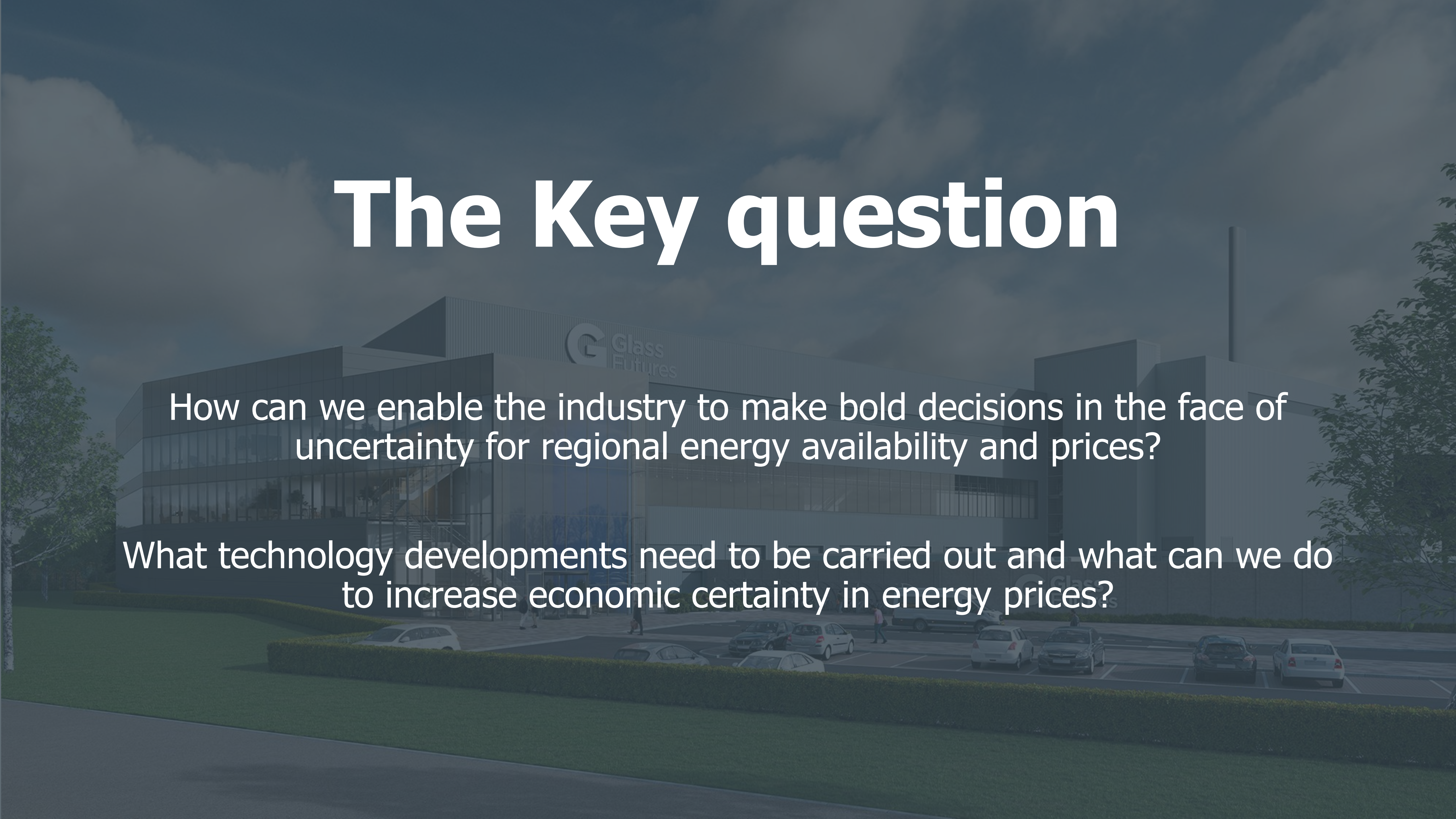
Industry 4.0 for production systems implementation

Low carbon fuels and enablers to drive low carbon manufacturing, faster

If we do not work together, there will be a smaller glass market with fiercer competition, driving down profitability and further stifling innovation.

If we do work together, we can grow the glass market, have healthy competition, increase profitability and accelerate innovation.

Glass Futures membership is Open to all and Growing, Fast…



The Key question

How can we enable the industry to make bold decisions in the face of uncertainty for regional energy availability and prices?

What technology developments need to be carried out and what can we do to increase economic certainty in energy prices?

Thank you

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