

Net-zero industries: Learnings from the UK experience

September 2020

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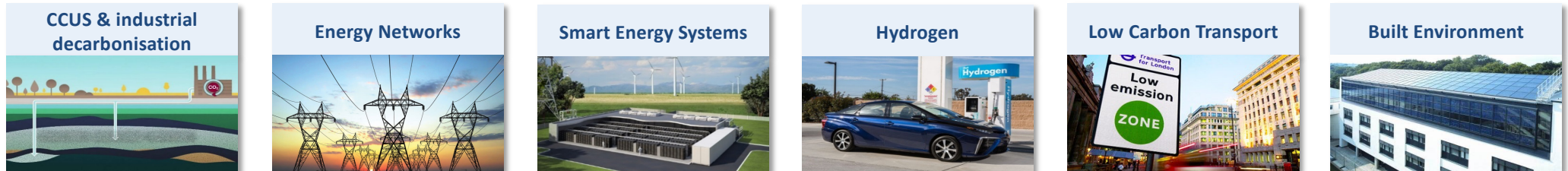
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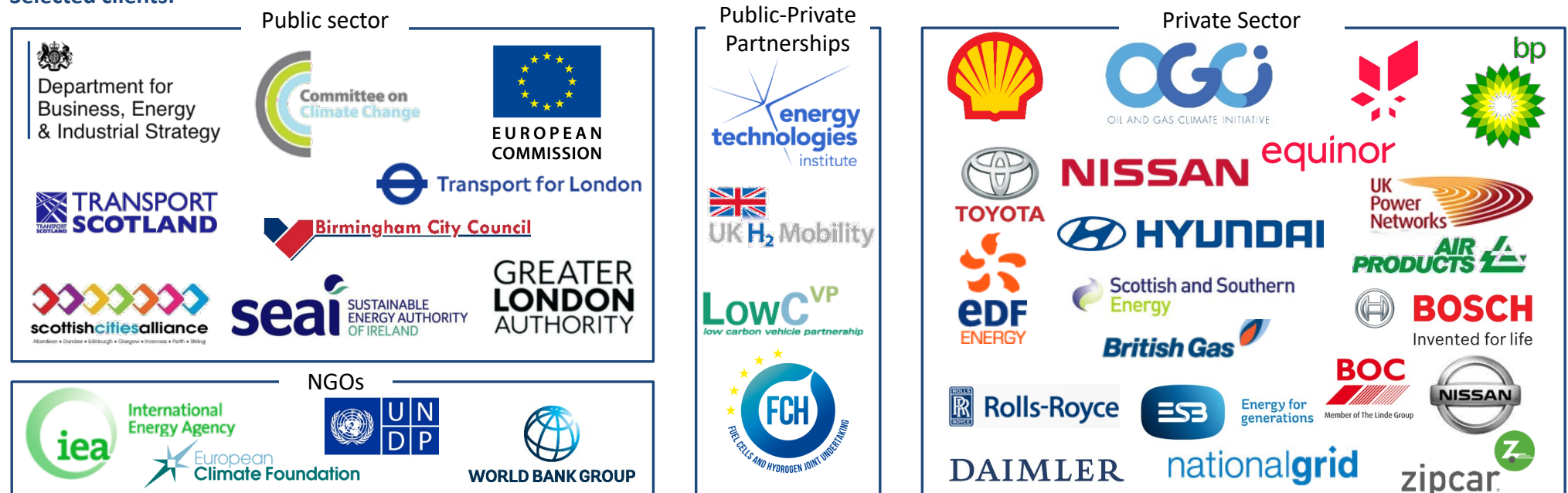
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Element Energy, a consultancy focused on the low carbon energy sector

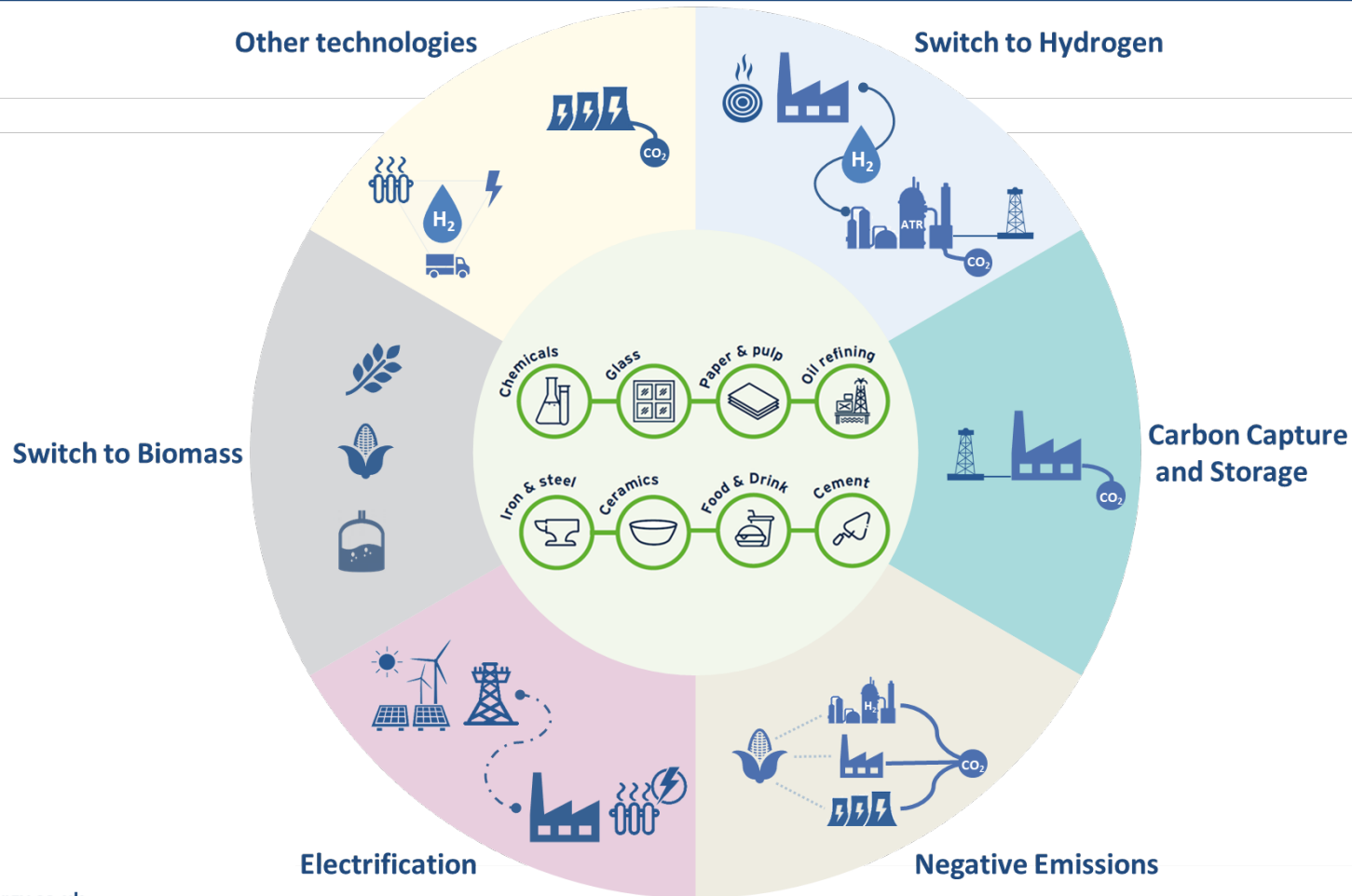
Element Energy covers all major low carbon energy sectors:



Selected clients:

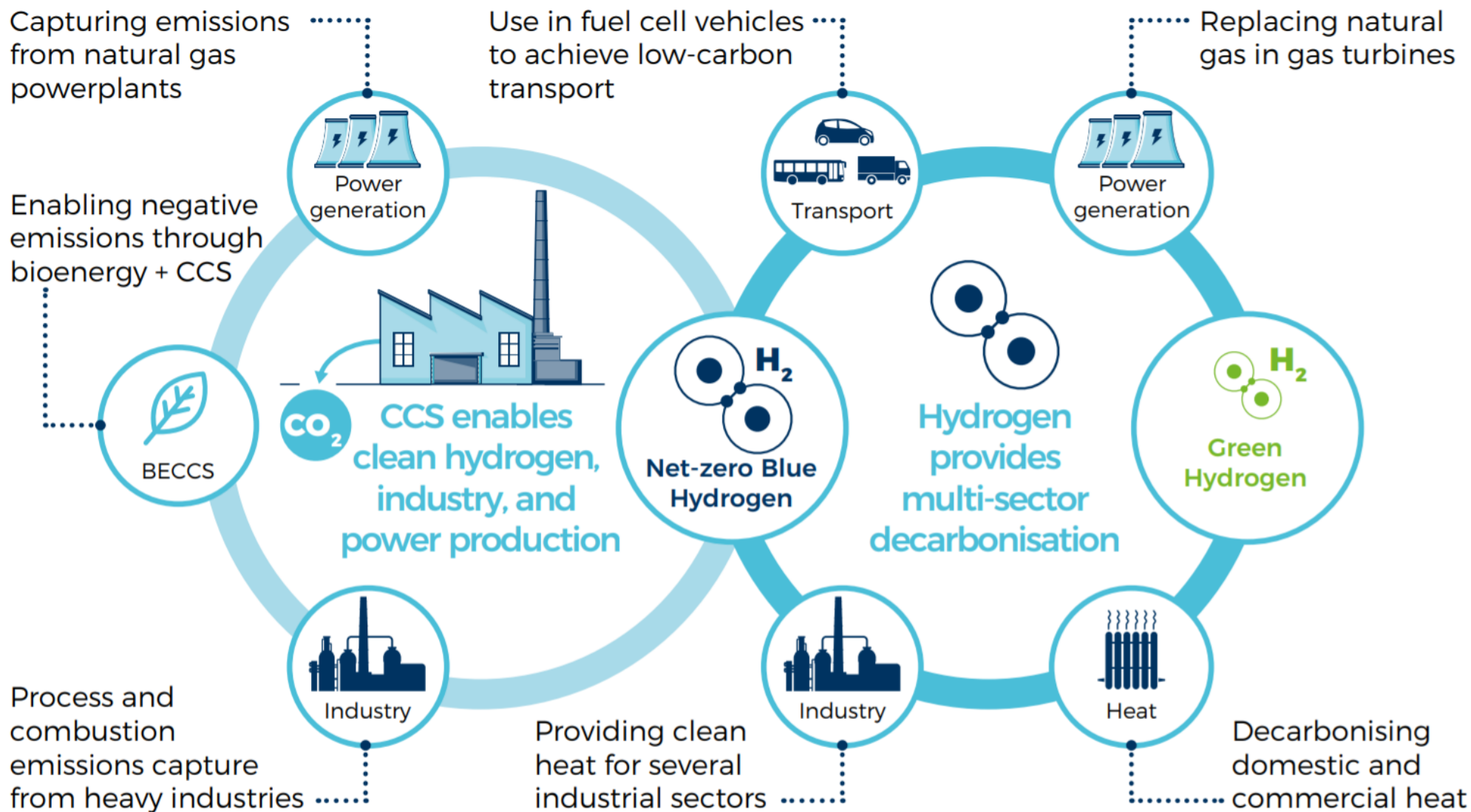


Hydrogen, industrial CCS and BECCS are needed to achieve net-zero industrial clusters

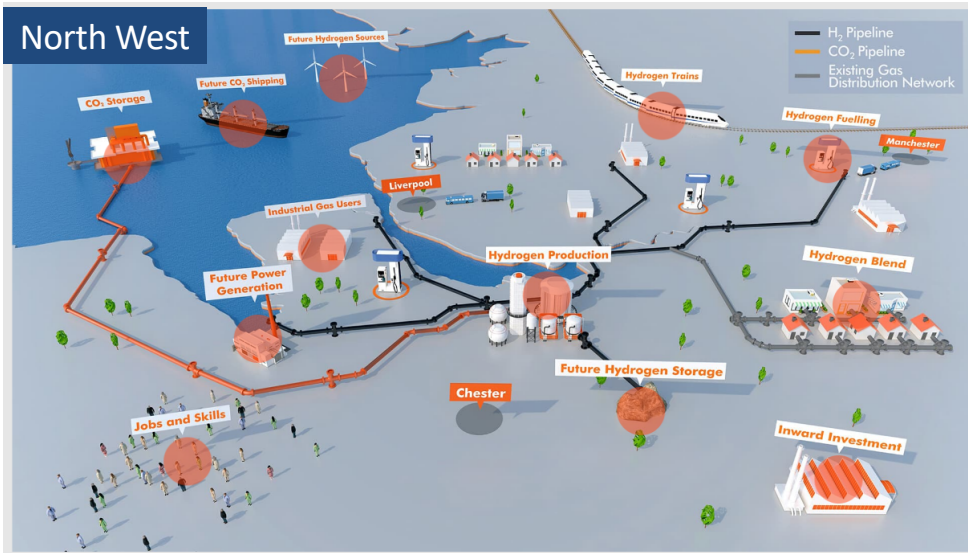


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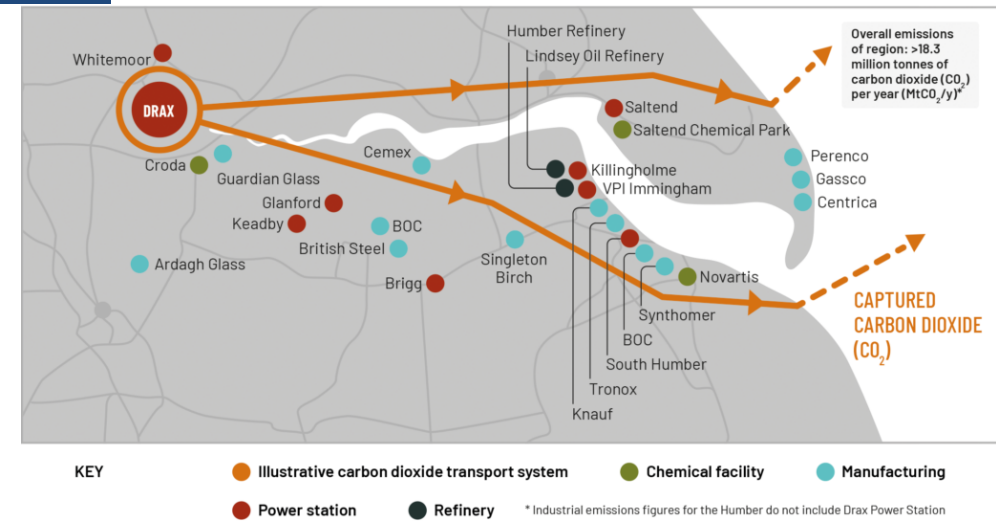


North West



Humber

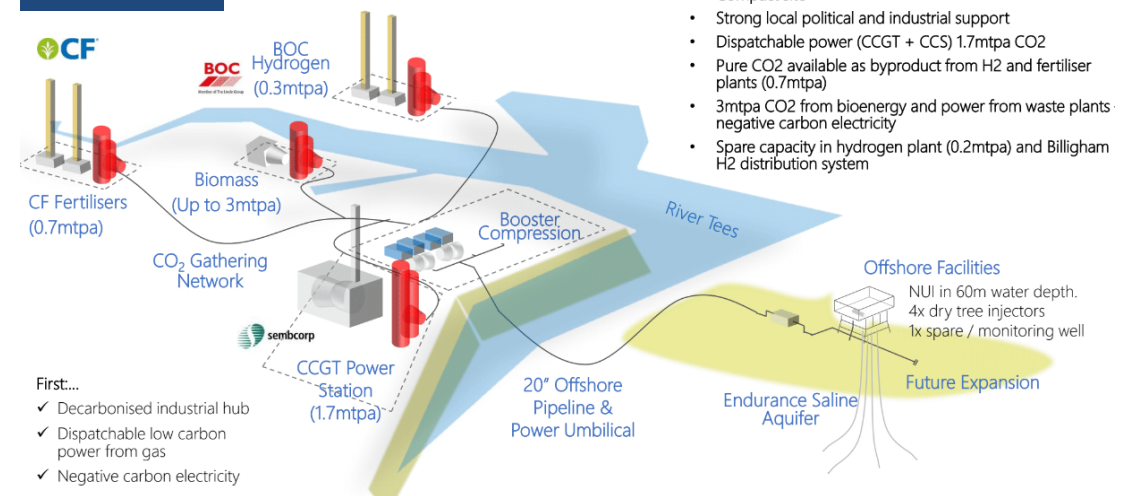
POWER STATIONS AND INDUSTRIAL PROCESSES IN THE HUMBER REGION



Scotland

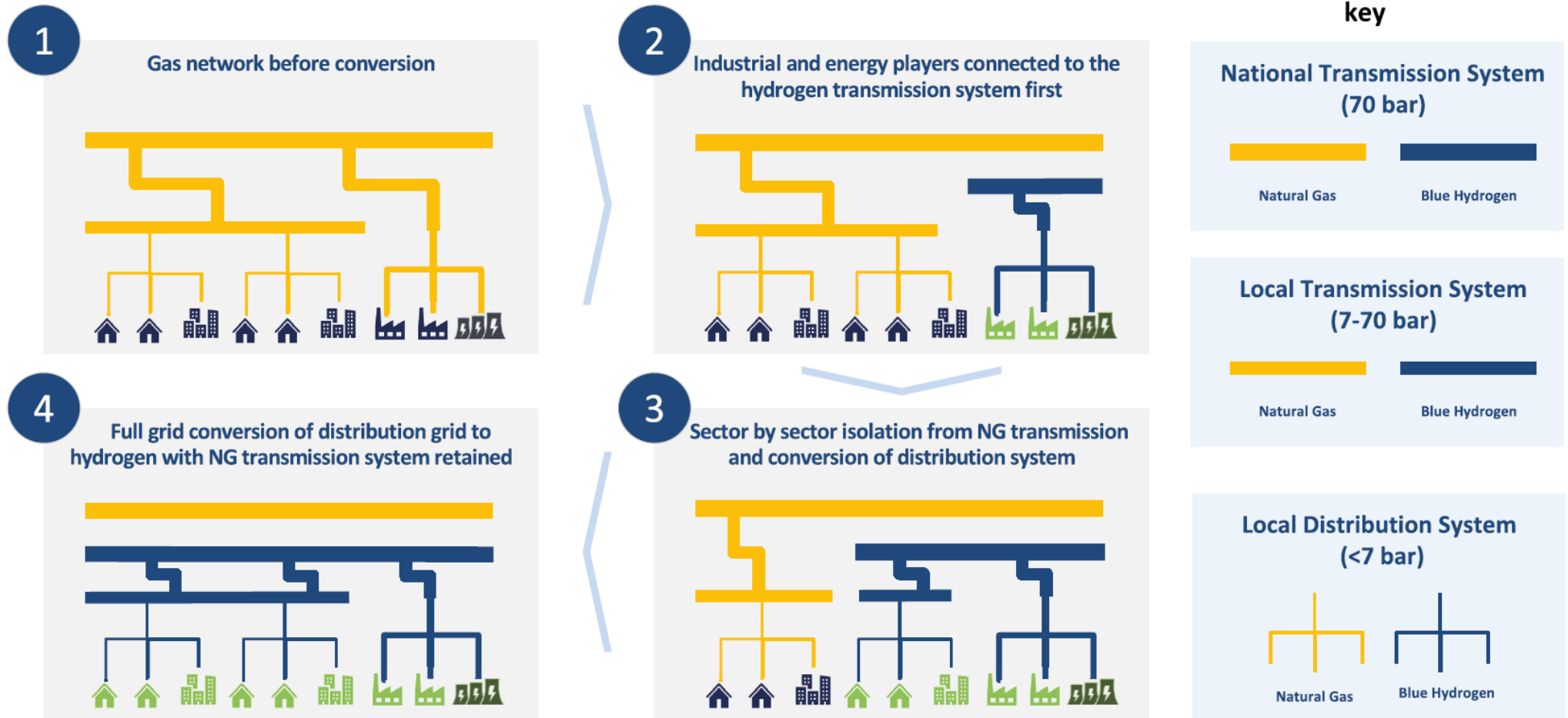


Teesside



<https://hynet.co.uk/>; <https://www.drax.com/energy-policy/capture-for-growth-zero-carbon-humber-report/#chapter-4>;
<https://pale-blu.com/>; Net Zero Teesside presentation, UK CCUS & Hydrogen Decarbonisation Summit, 4 Feb 2020

Energy intensive industries can enable the “hydrogen for heat” transition in Europe



Hydrogen for industry: no showstopper barriers were identified for hydrogen conversion; however, a wide range of industrial hydrogen equipment should be developed

Barriers	Enablers	Impacted equipment	Impact Rating
Technical	Radiative Heat Transfer – lower emissivity results in decreased radiant heat flux	Furnaces, Kilns	●
	Convective heat transfer – lower air requirement reduces the gas volume available to transfer heat.	Flue Gas Recirculation (FGR) increases gas volume, and is also beneficial elsewhere (e.g. NO _x emissions), equipment recalibration for indirect fired equipment.	●
	NO_x emissions – may be increased through higher flame temperature.	Technologies to mitigate this include Flue Gas Recirculation (FGR), steam addition and post-combustion treatment. Further work on low NO _x burners may also reduce emissions.	●
	Flue Gas Composition – e.g. increased moisture content with H ₂ might impact product quality	Product specific tests required for some direct heating applications to evaluate impact and any possible mitigating actions (e.g. adjusting combustion parameters).	●
	Gas Engine Conversion for CHP	Period of R&D, small scale and large-scale trials. May require full replacement with potential new design, rather than retrofit.	●
	Piping and fittings (leakage risks and embrittlement)	Materials and standards currently exist for hydrogen piping. Site distribution systems would need to be checked for hydrogen compatibility and replaced if incompatible.	●
	Hydrogen burner development , including materials	Burner materials currently exist, though further R&D by burner manufacturers is required.	●

Industry sector	Typical Equipment	Equipment Conversion Cost – Variation with Size (£ '000s)*		Conversion Cost for Typical Equipment (£ 000's)*	
		1 MW	10 MW	Example Size (MW)	Typical Cost
Food and Drink	Steam Boiler	170	690	20	1,040
	Oven	150	490	2	210
Chemicals	Steam Boiler	100	490	20	780
	Furnace	110	530	25	980
Vehicle Manufacturing	Hot Water Boiler	170	690	20	1,040
	Oven	150	490	5	340
	Direct Dryer	140	430	2	200
Basic Metals	Furnace	180	730	40	1,680
Paper	Direct Dryer	150	470	3	260
	Steam Boiler	190	750	20	1,140
Glass	Glass Furnace	200	800	25	1,390
Ceramics	Kiln	160	570	5	390
Lime	Lime Kiln	150	520	15	640
Other NM Minerals	Rotary Dryer	140	430	15	520
Elec and Mech Engineering	Hot Water Boiler	170	690	5	450
	Oven	150	490	3	260
	Steam Boiler	170	690	5	450

*All costs are in thousands of GBP

Several promising business models were identified for industrial carbon capture including hydrogen production – drawing on comparable existing policies

Contract for difference:

CfD on CO₂ price relative to market CO₂ price (e.g. EU ETS) to provide guarantee of revenue

Cost plus:

All properly incurred ICC operational costs are reimbursed through taxpayer funding

Regulated asset base:

Public regulation allows costs to be recovered through product prices e.g. of Hydrogen

Tradeable tax credits:

CCS tax credits awarded \$/tCO₂ to reduce firms tax liability (e.g. 45Q) or trade with other firms.

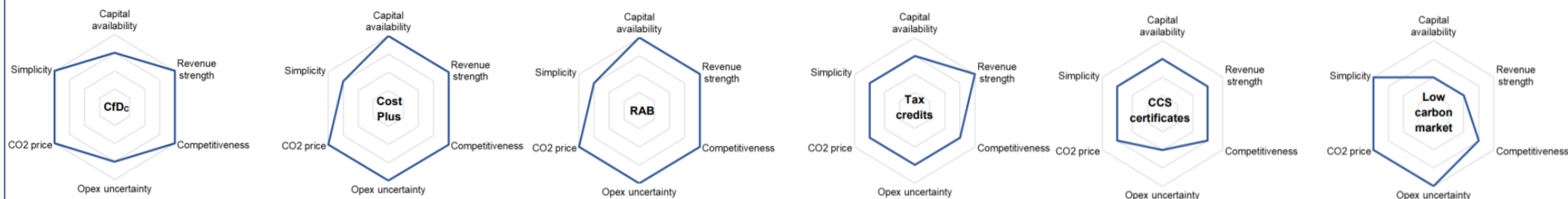
CCS certificates:

Certificates representing tCO₂ abated through CCS, which can be traded and emitters have an obligation.

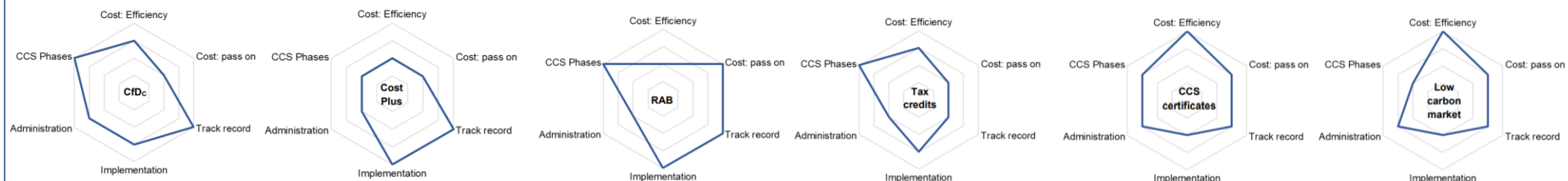
Low carbon market:

End-use regulation e.g. on buildings to create a low carbon market & achieve product premium

Acceptability to industry evaluation



Acceptability to government evaluation



Element Energy is a leading low carbon energy consultancy working in a range of sectors including industrial decarbonisation, carbon capture utilisation and storage (CCUS), hydrogen, low carbon transport, low carbon heat, renewable power generation, energy networks, and energy storage. Element Energy works with a broad range of private and public sector clients to address challenges across the low carbon energy sector.

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