

Innovate Design Develop | Create value

An Independent View of Carbon Capture...

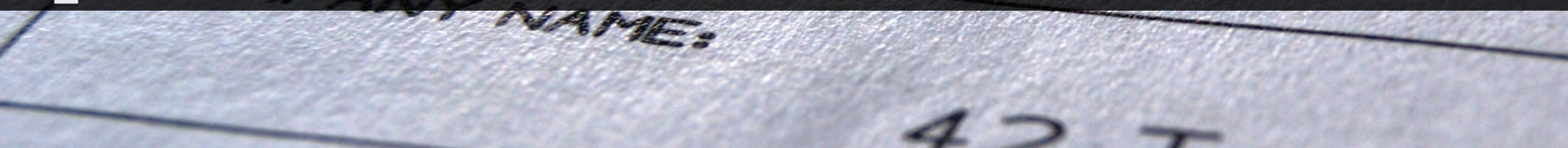
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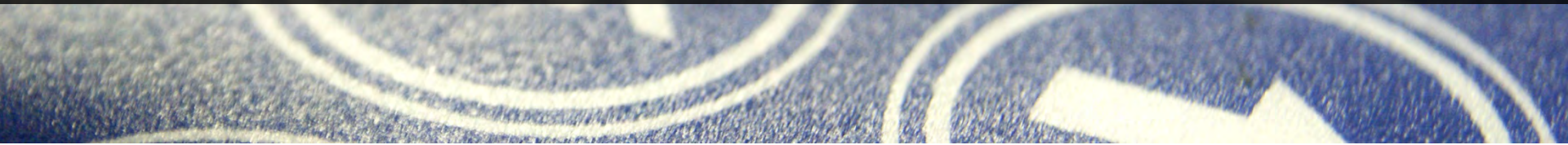
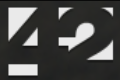
We identify business opportunities and develop products and processes through to manufacture



We work in partnership with our clients across a range of industry sectors



We are an experienced engineering and design team supported by a large network of specialists



Setting the direction



Finding the opportunity



Developing the solution



Making it happen

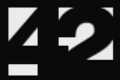


- Technology strategy
- Competitor analysis
- IP strategy
- Technology scouting

- Structured innovation
- Concept generation
- Feasibility studies
- Proof-of-principle

- Product development
- Process development
- Design for manufacture
- Verification and validation

- Regulatory approval
- Vendor selection
- Process automation
- Transfer to manufacture



Consumer



Healthcare

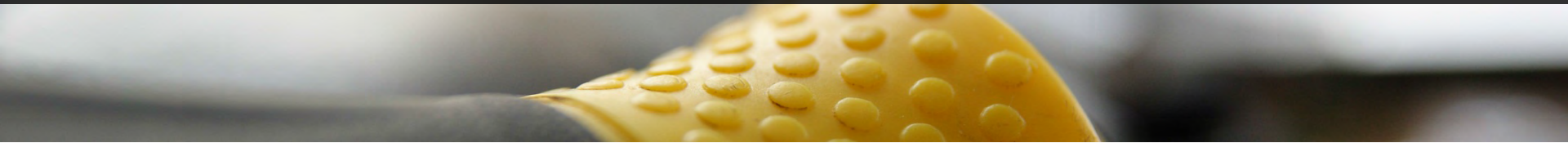
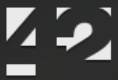


Industrial



Cleantech





Interactive products

- Innovative mechanisms
- Functional packaging
- Human interaction



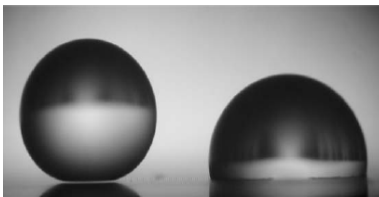
Advanced systems

- System analysis and modelling
- Complex electromechanical systems
- Sensing, control and algorithms



Manufacturing innovation

- Novel process development
- Design for manufacture
- Process automation

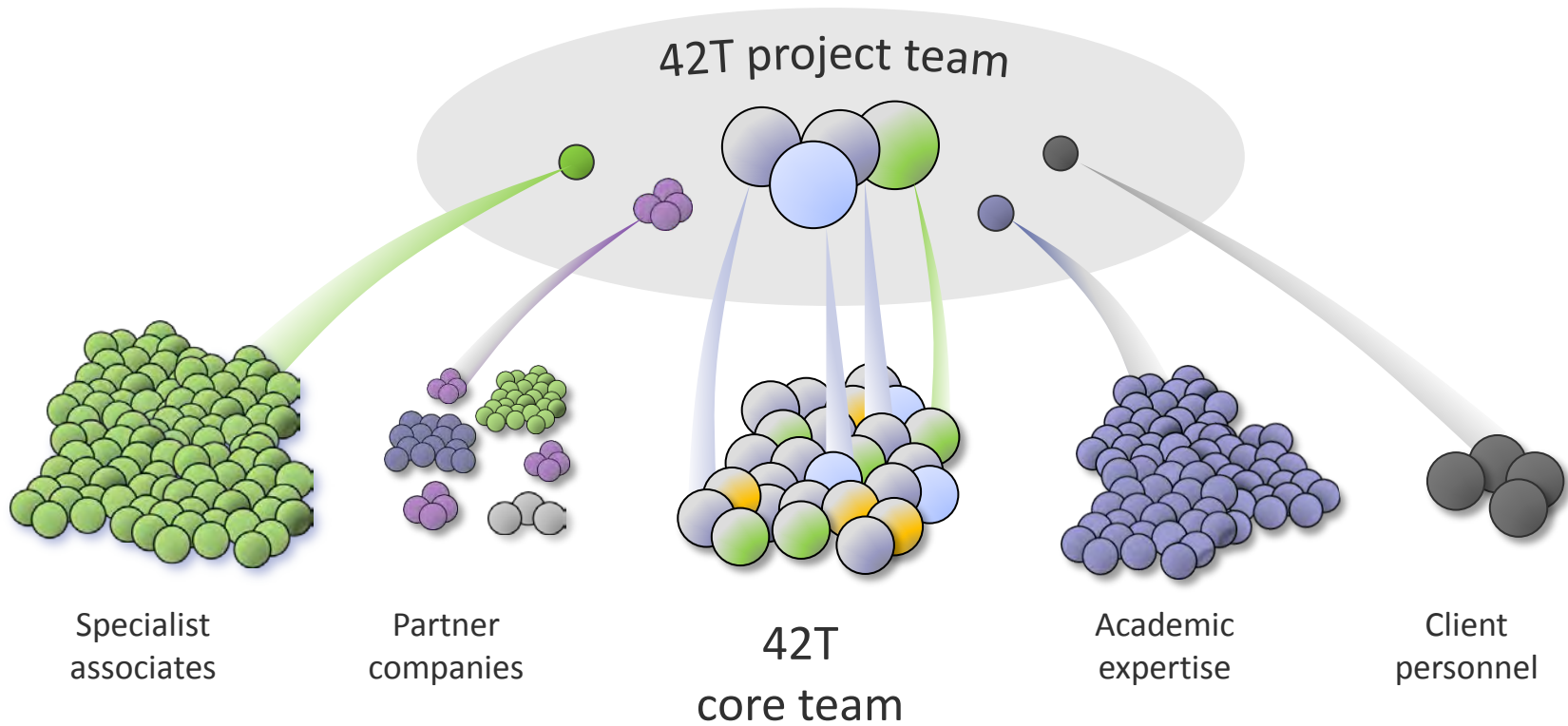


Fluid and thermal management

- Liquids, gases & powders
- Heating and cooling
- Energy efficiency

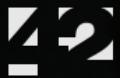


A tailored team to address the project need





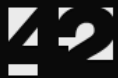
CCS has stalled. Why?



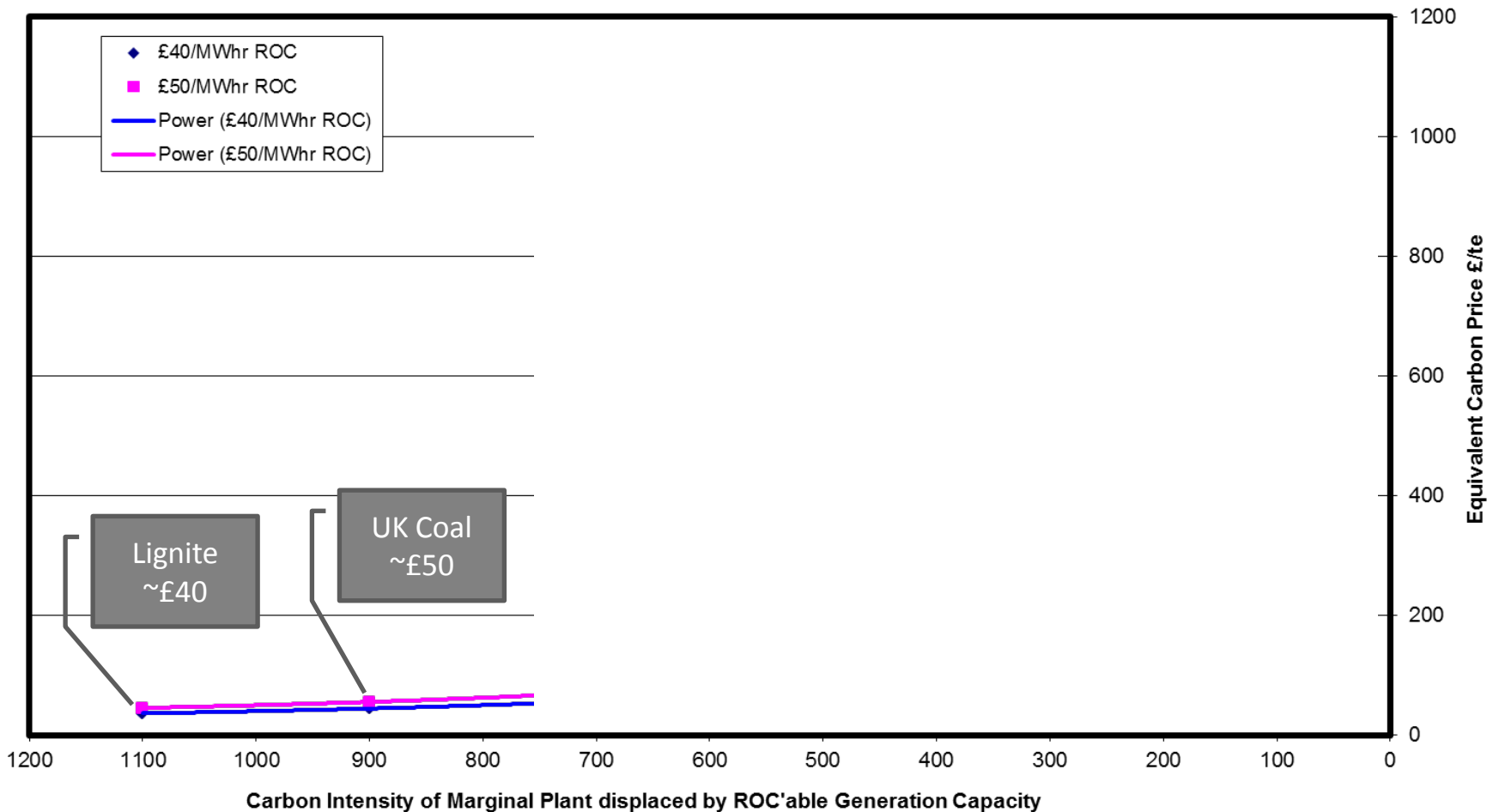
How does a rational generation business decarbonise?

Option	Challenge (to Generator)	Benefit (to Generator)	CO2 "Saving"
Onshore Wind	Limited sites. Not Flexible. CFD mechanism?	ROCs trusted Low Risk Indirect gas price link	~350 g/kWhr
Offshore Wind			
Biomass			
CCS			

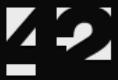
Pre EMR Onshore wind is the only way a board can meet its fiduciary duties. **Post** EMR.....?



Effective Carbon Price Required for 1.0 ROC or equivalent support (e.g. Onshore Wind Turbine)



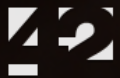
Move from ROCs to CfD will sensibly avoid asymptotes, but.....



Wind (used to be) is a gas price hedge

1. The marginal plant of dispatch is typically (and will soon always be) a CCGT
=> the spot electricity price is set by a CCGT
2. The marginal CCGT will generate at ~cost of gas consumed
=> the spot electricity price tracks the spot gas price
3. WTs get paid the electricity price + ROC(s)
=> Wind generators profit from higher gas prices
4. BUT post-EMR “CfD” wind will get a fixed revenue / MWhr
=> Wind projects that miss the ROC window may never be built

(Onshore) Wind has been the urgent imperative, until now....



CCS is not a “bridge” to a nuclear & renewable utopia

Climate scientists estimate we
~570Gte CO₂ left to emit



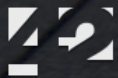
Vs.



Proven fossil
reserves equate to
2800 Gte CO₂

Nuclear and Renewables will only mitigate climate change if mankind has the self-discipline to consume <20% of current known reserves

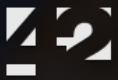
N&R **should** buy time for a global CCS roll-out....
However, N&R risk pushing up energy prices enabling recovery of previously uneconomic reserves



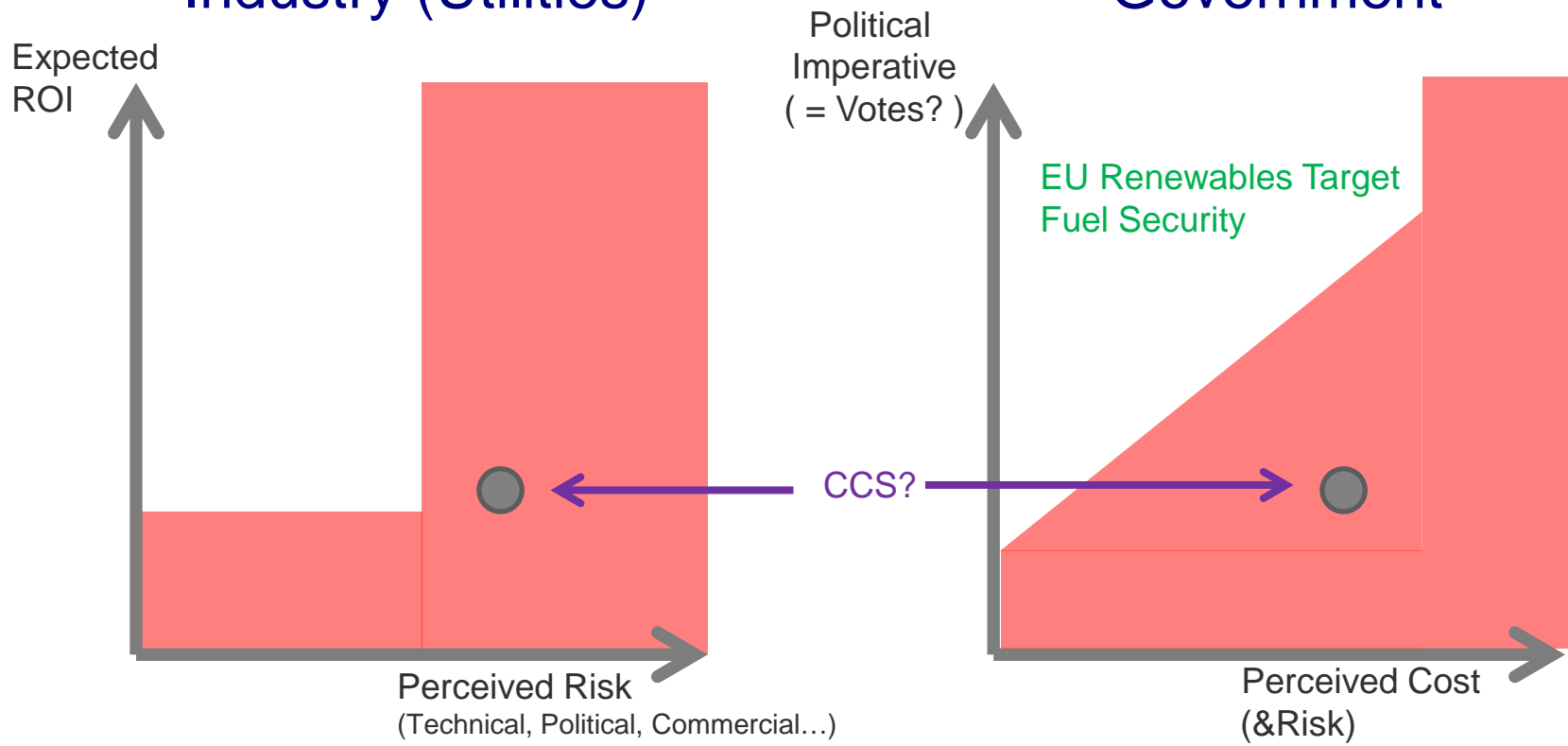
Imagine it's 2025 and you need ~1GWe low carbon power baseload. Onshore wind sites are fully developed and CfDs are working 'efficiently'

Option A: Offshore Wind	Option B: Carbon Capture
Need at least 3GWe of Offshore Wind @30% LF + CCGT backup	1GWe CCGT + CCS
Gas burnt eventually anyway?	Gas is burnt but CO2 is buried.
~ 50 - 100g CO2 /kWhr (CCGT runs inefficiently when not windy...)	~ 50-100gCO2 /kWhr (85% Capture)
CAPEX >£13bn (£4bn / GW wind) + ~£1bn CCGT	CAPEX ~ £3bn ~£1bn CCGT + £2bn CCS

CCS doesn't have to get much cheaper. The economics just needs to depoliticise.



Two critical stakeholders remain unconvinced: Industry (Utilities) Government



Perceived Risk and Political will remain the biggest barriers. Political risk is probably the biggest risk.