Integrating Engineering, Innovation & and Policy

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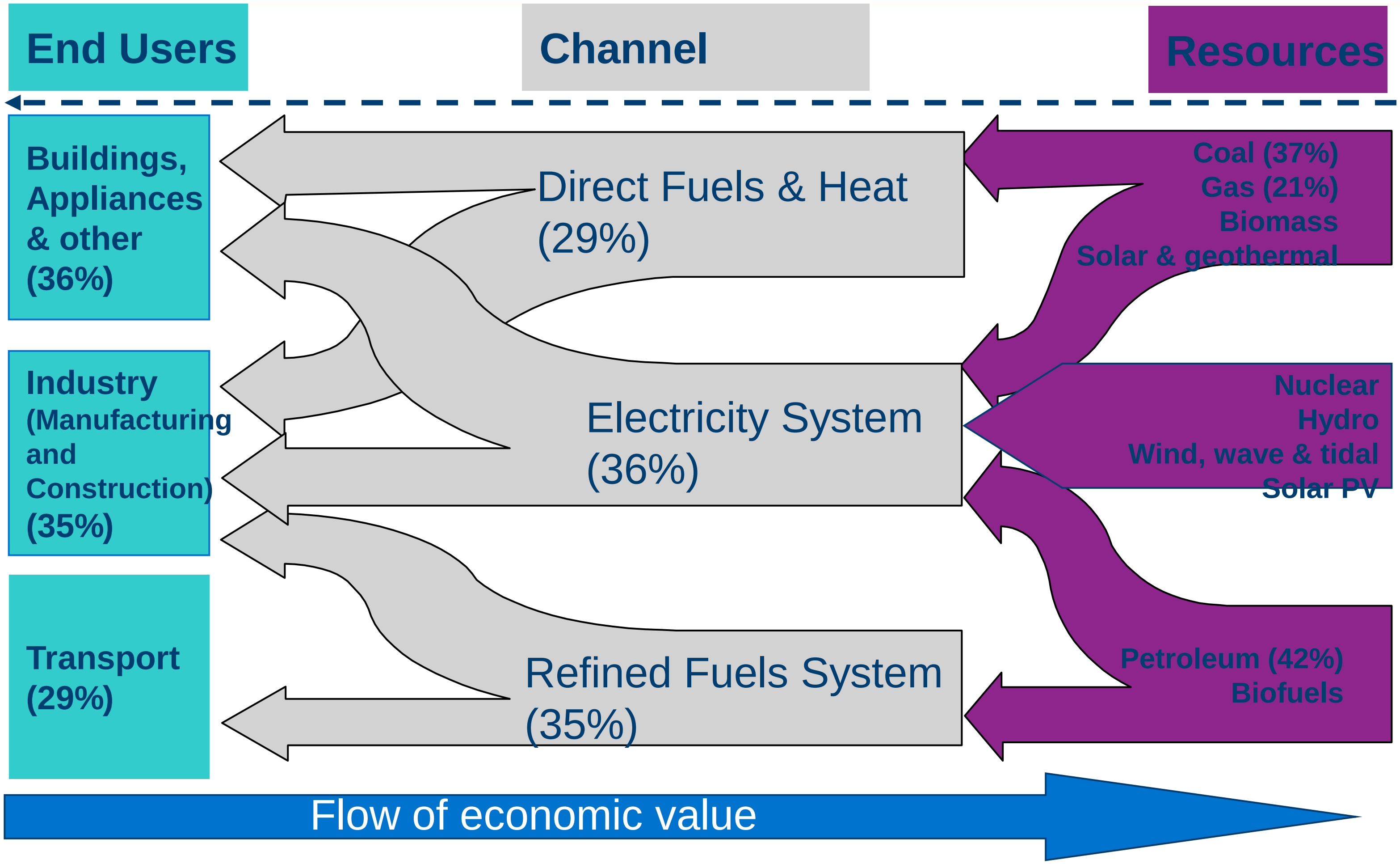
Imperial College Side Event: Innovating Climate Mitigation Technologies Post-2012, Doha, November 2012

Technology, Innovation and policy: the positive agenda

- Investment required is *many trillions of dollars*
- *New technology* is required to achieve deep emission reductions
- *Innovation* is required to bring down the costs
- *Markets* will be required to justify and offer returns to this investment
- *Policy* will be an important driver of all three

The high-level structure of energy-CO2 systems – *which end-use markets, which channels, with what resources ..*

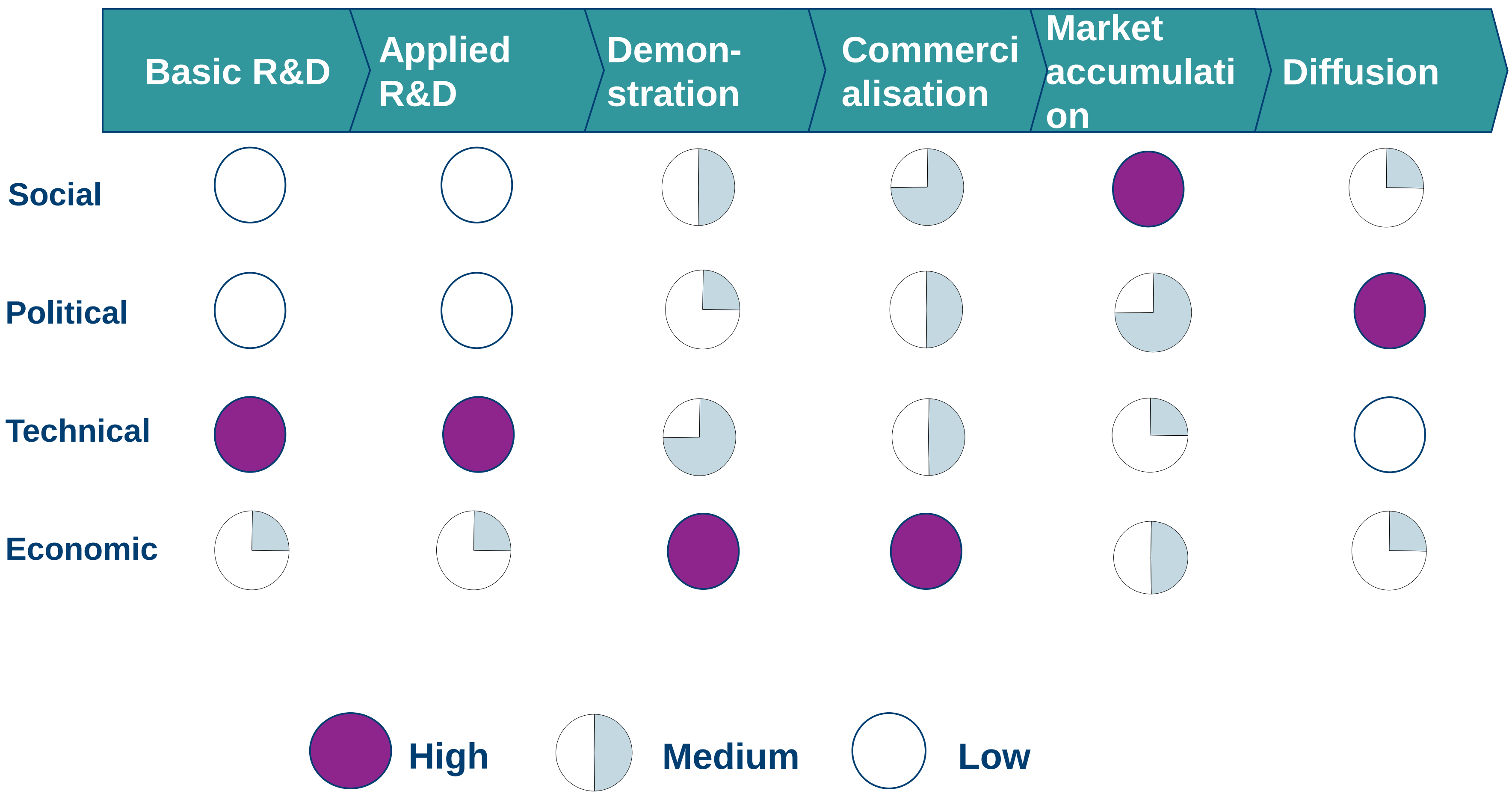


Technology: ‘For every complex problem there is an answer that is simple – and wrong’ (in this case, two)

“Technology is the answer” - but technology development is a very complex process and the policy solutions are not simple:

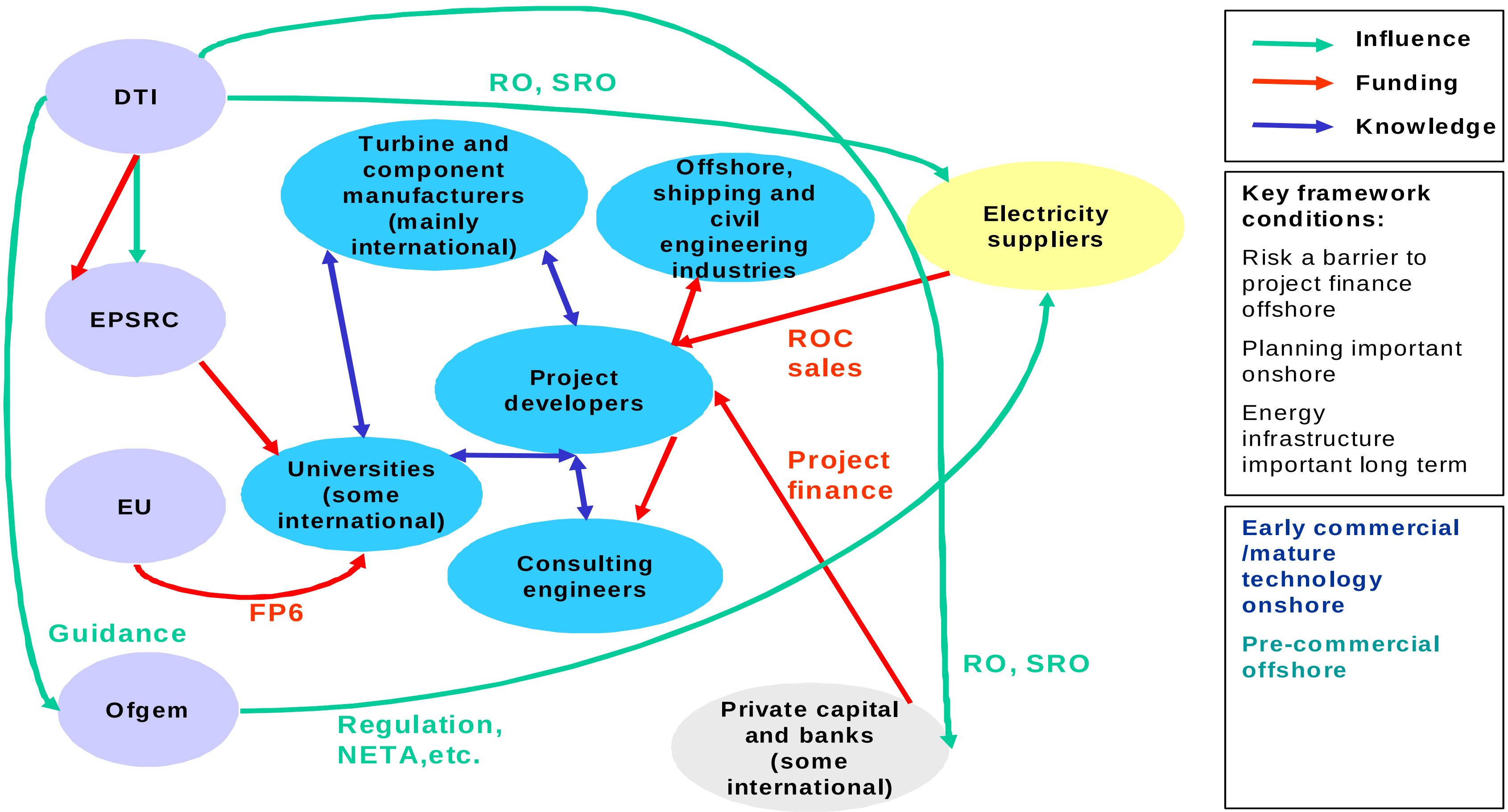
- *Public R&D investment by governments* to develop technologies has mixed history and faces serious institutional dilemmas
  - ‘picking winners’ – or not
  - mutual programme dependencies (the ‘exit’ problem)
  - cooperation vs competition
  - policy displacement
- *Even where market pull forces are important*, it is a long way to actual large-scale industrial innovative risk-taking, which ideally would need
  - perfect R&D markets
  - long term certainty and policy stability on environmental pricing
  - Good communication between government, research, and industry
- ‘Market-led’ innovation particularly difficult in context of ‘public goods’

There are extensive barriers to investment that differ along the innovation chain



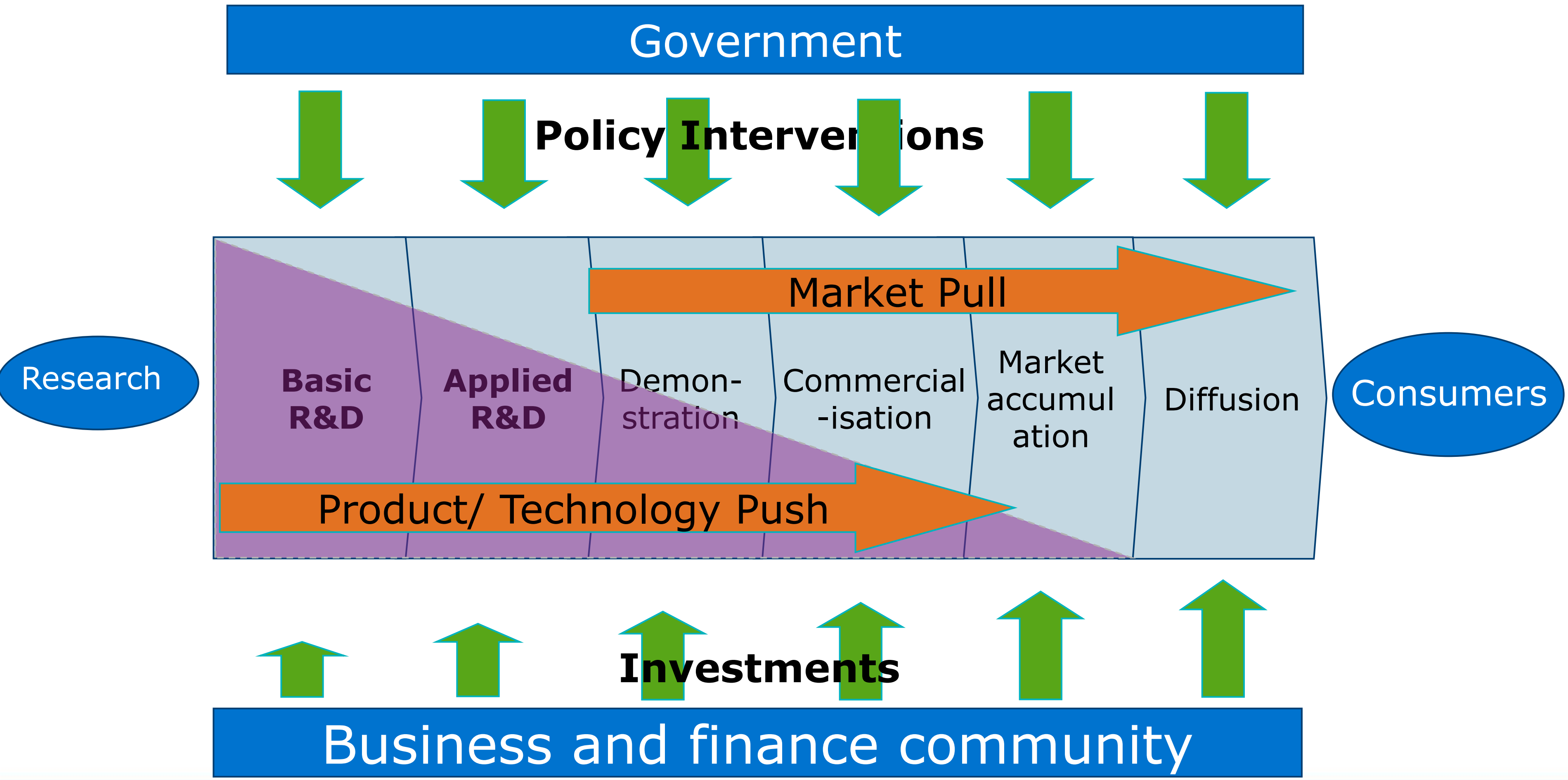
‘For every complex problem, there is also an answer that is complex – and unuseable’

Simplified ‘innovation systems map’ for wind energy in the UK



Source: Foxon et al., UK Innovation Systems for New and Renewable Energy Technologies: Drivers,

Integrated perspectives: technologies have to traverse a long, expensive and risky chain of innovation to get from idea to market



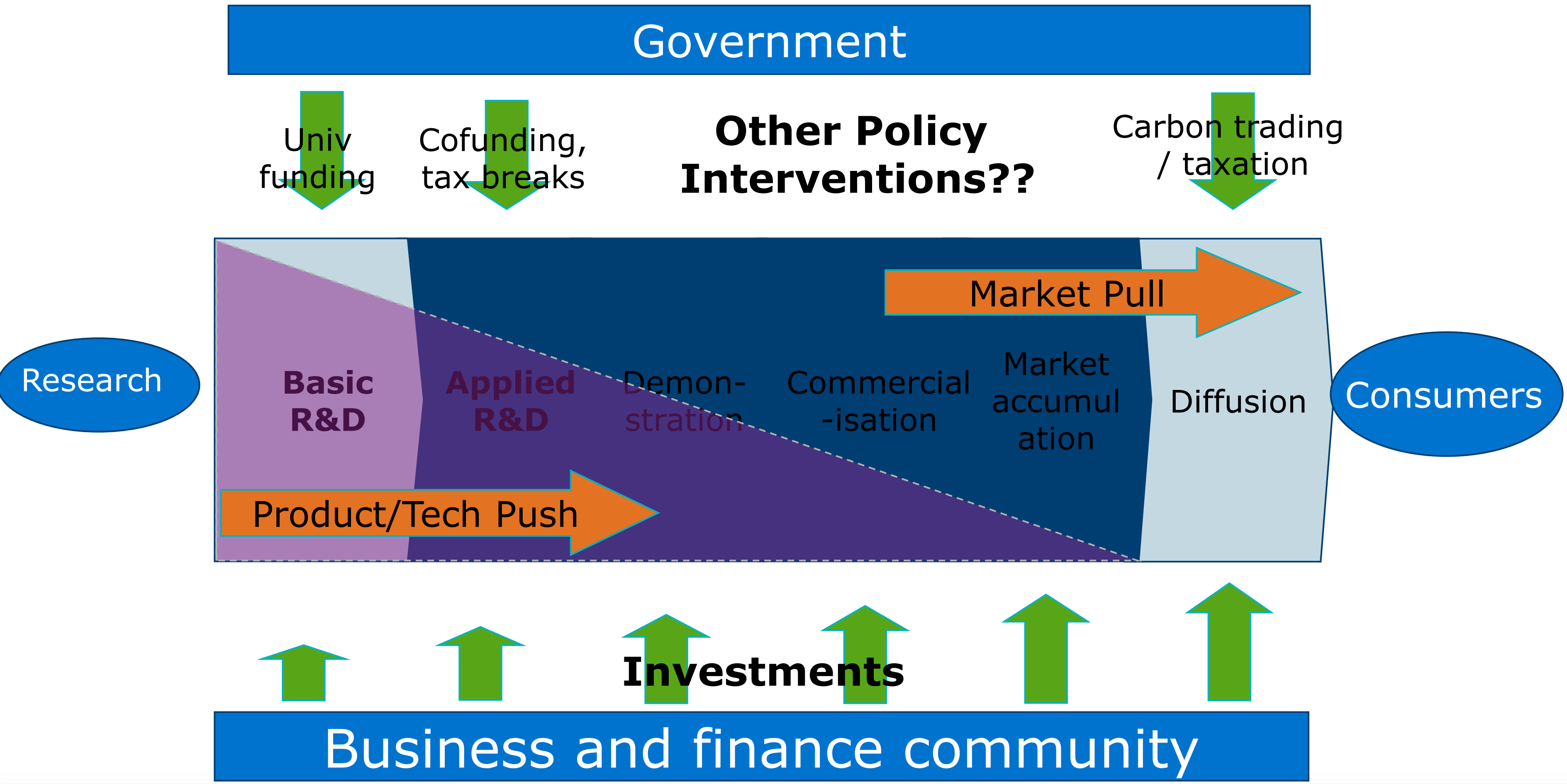
Source: Foxon (2003) adapted by the author

A wide range of low carbon technology groups exist, at various stages of the innovation chain

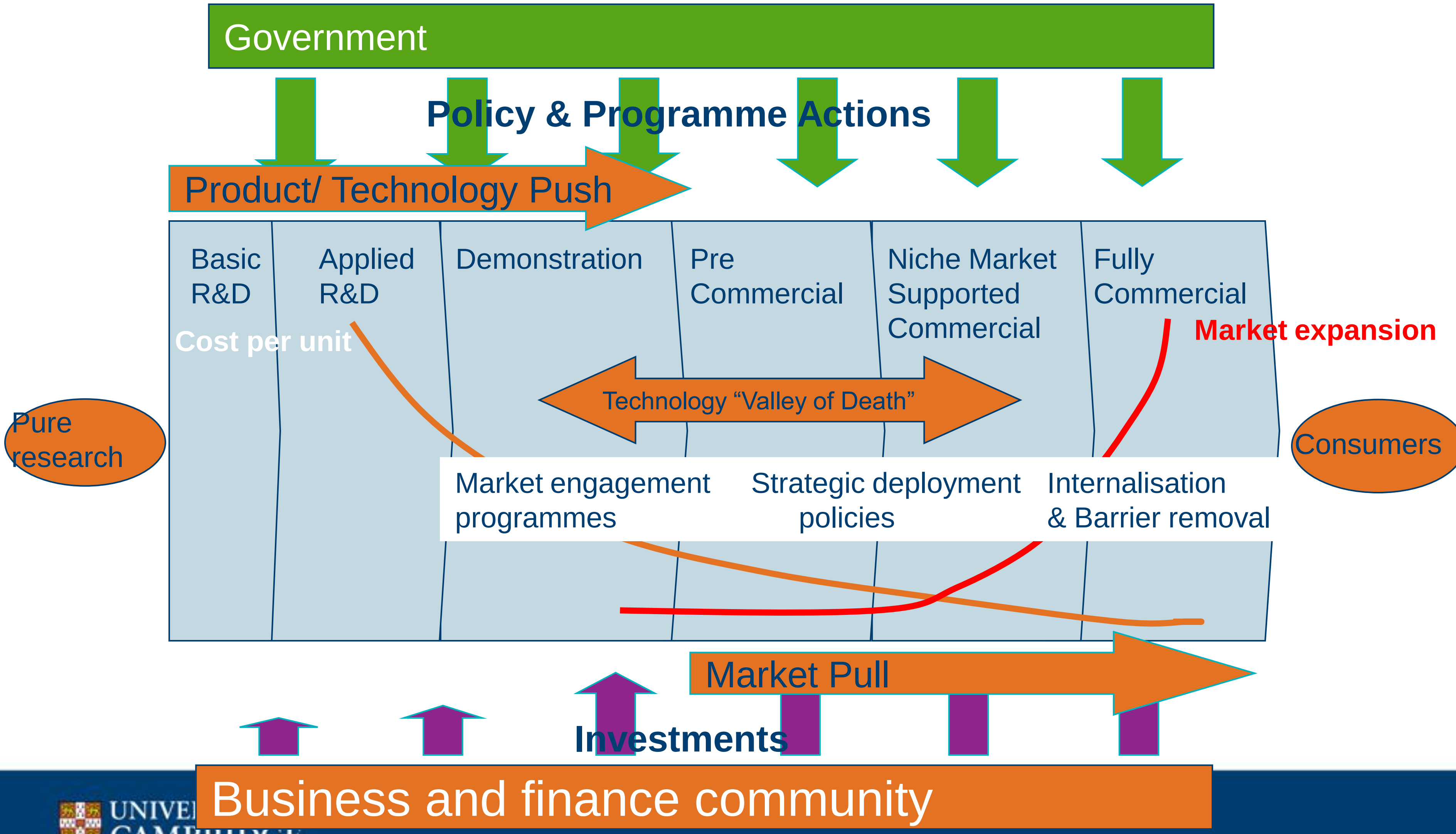
	Basic R&D	Applied R&D	emon-stration	Commercial -isation	Diffusion
Energy Supply	• Solar Photo-conversion	• Fuel Cells • Advanced CHP • Fusion	• Wave • Ultra-high efficiency CCGT	• Offshore Wind • Biomass (Electricity) • Solar PV	• Nuclear Fission • Onshore Wind • Biomass (Heat)
Energy Demand	• Process Replacement	• Product Replacement	• Process Improvement	• Product Improvement	• Buildings Services and Fabric
Enabling	• Hydrogen Production	• Hydrogen Distribution	• Smart Metering	• Chemical / fuel cell electric storage	• HVDC Transmission
Transport	• Fuel cell ‘hypercars’	• Ethanol (Ligno-cellulose)	• Fuel Cells	• Syngas Fuels	• High efficiency powertrains • Biodiesel • Ethanol (starch/sugars)

Market theory mostly blind to the innovation *process*

– competitive forces assumed to generate innovation from the government ‘no-go zone’ in between R&D and diffusion – but clearly some combination of tech push and market pull

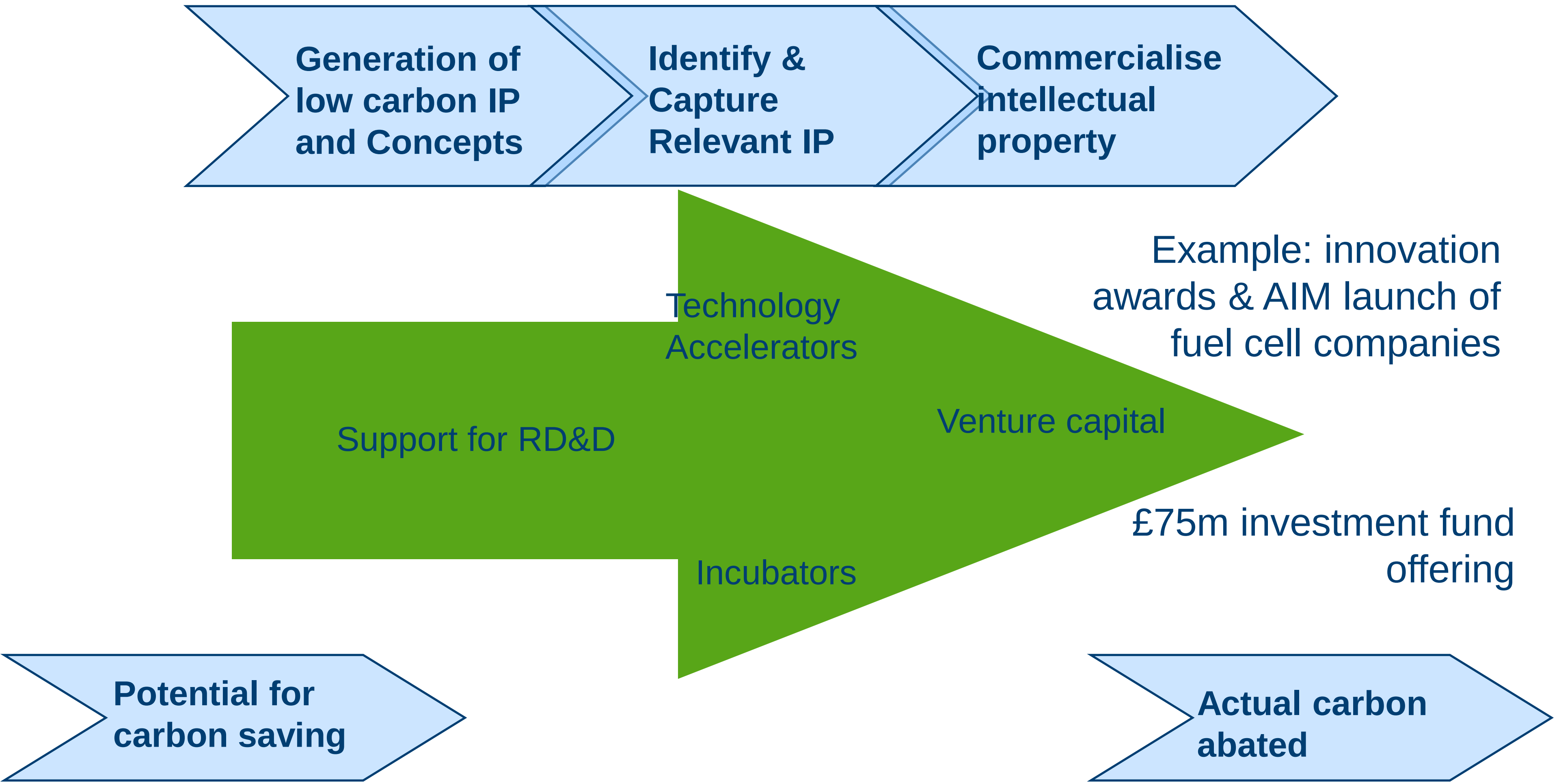


Diverse policies of market engagement and strategic deployment needed to traverse the innovation chain

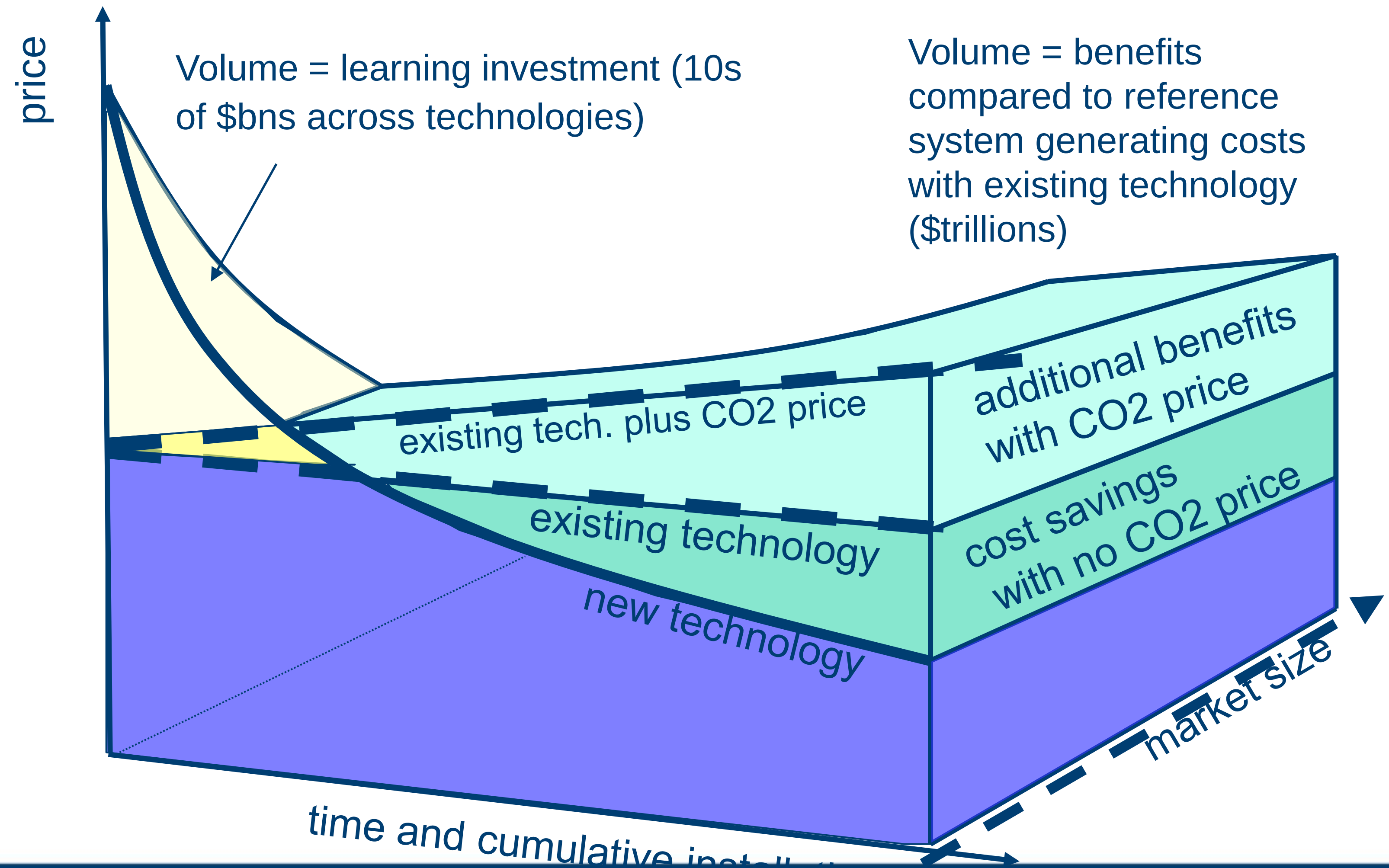


Even ‘market engagement’ requires a mix of instruments

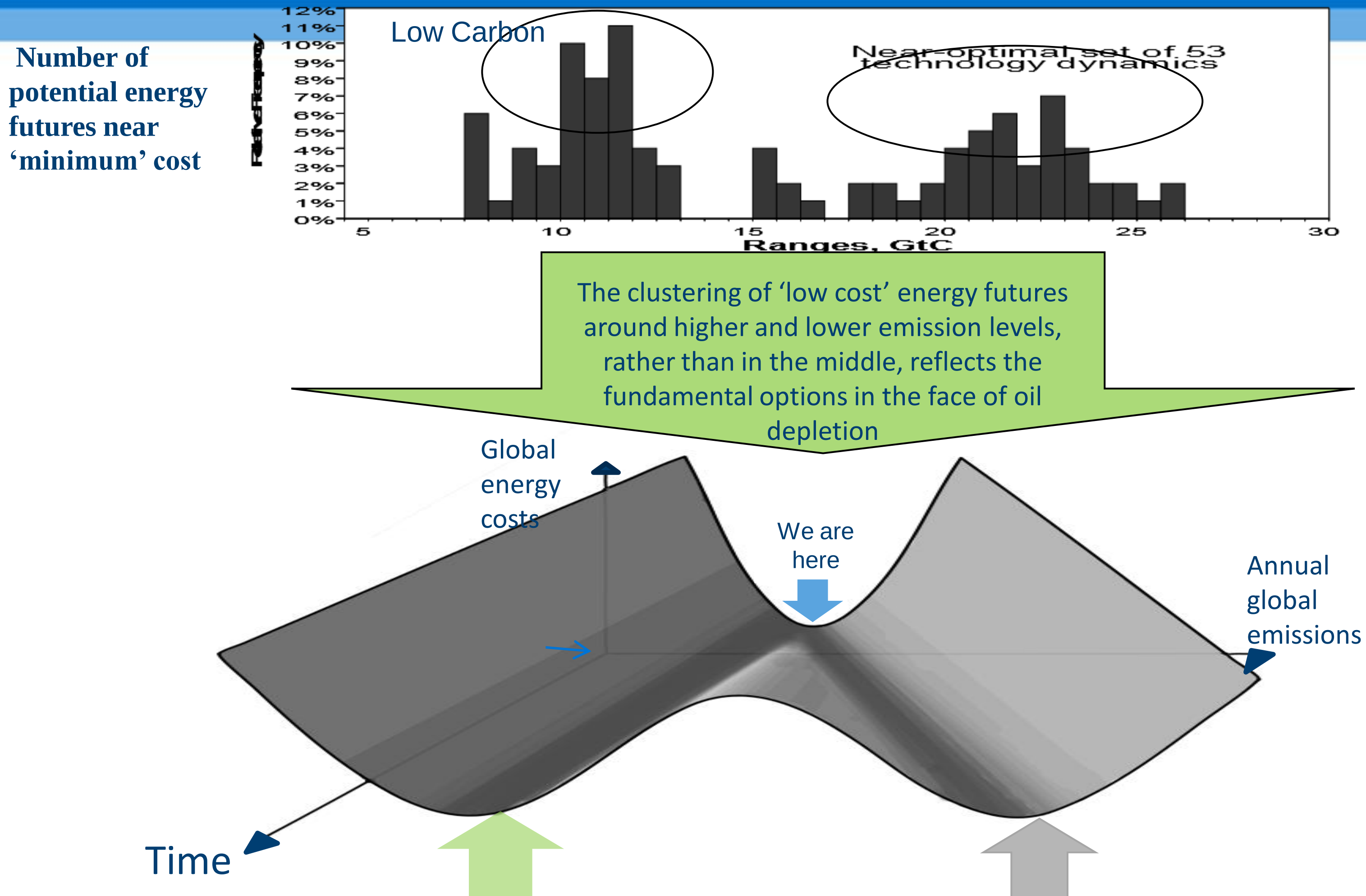
Carbon Trust support for innovation commercialisation



Strategic challenge is to invest through the innovastion chain alongside strengthening carbon price to deliver the new industry



Two kinds of energy futures …. Which are we building?



Low carbon futures

- High efficiency
- Low-carbon electricity

High carbon futures

- Continued dependence on fossil fuels
- Unconventional & synthetic oil in transport

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