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# Building towards a commercial reality

## Accelerating CCS in the UK

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March 14th 2012

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# System level strategic planning
# Technology development and demonstration

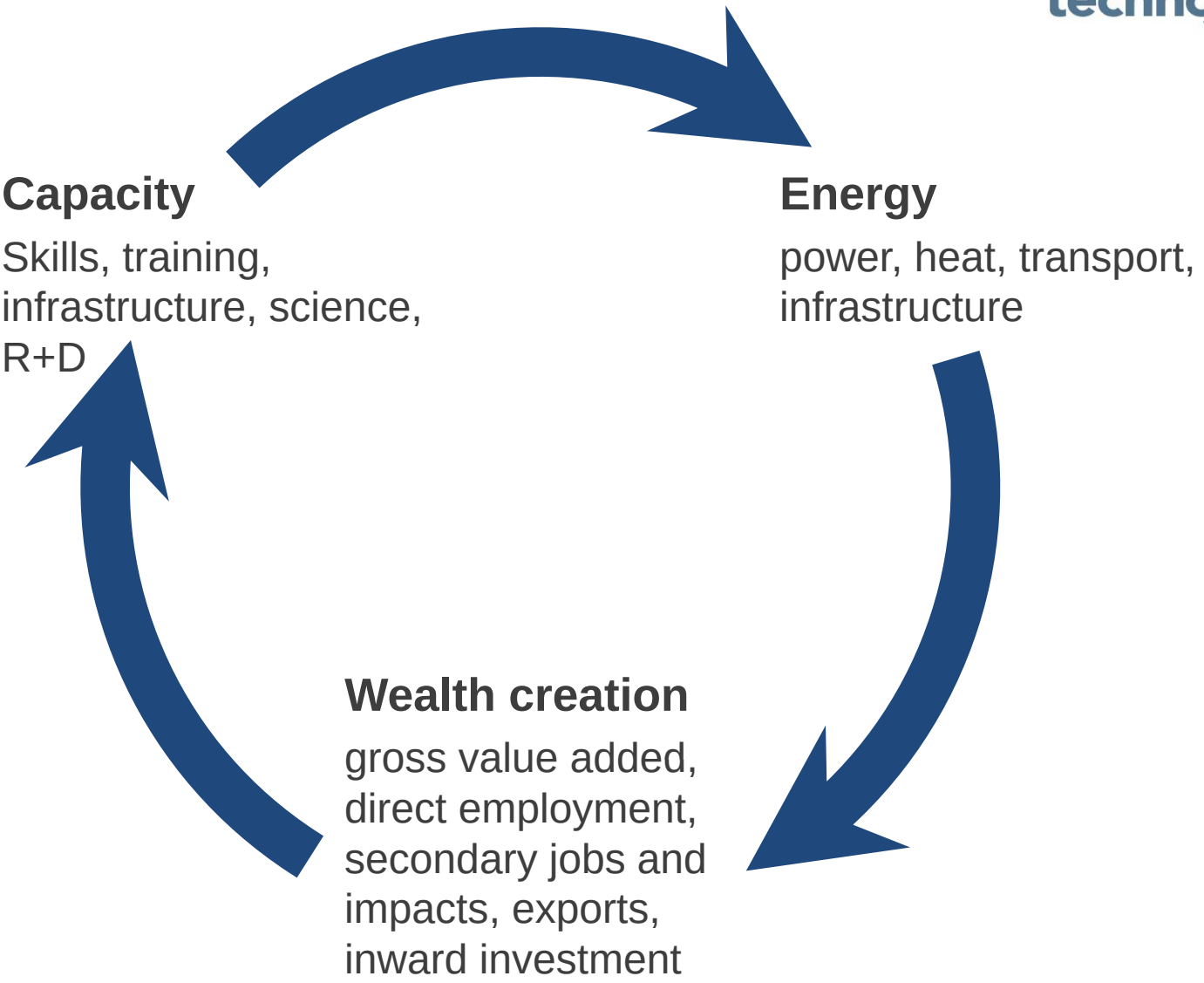
Informs effective decision making

Underpins national energy systems policy

Develops capacity, technology and engineering

Increases investor confidence

# Making energy policy work for the UK

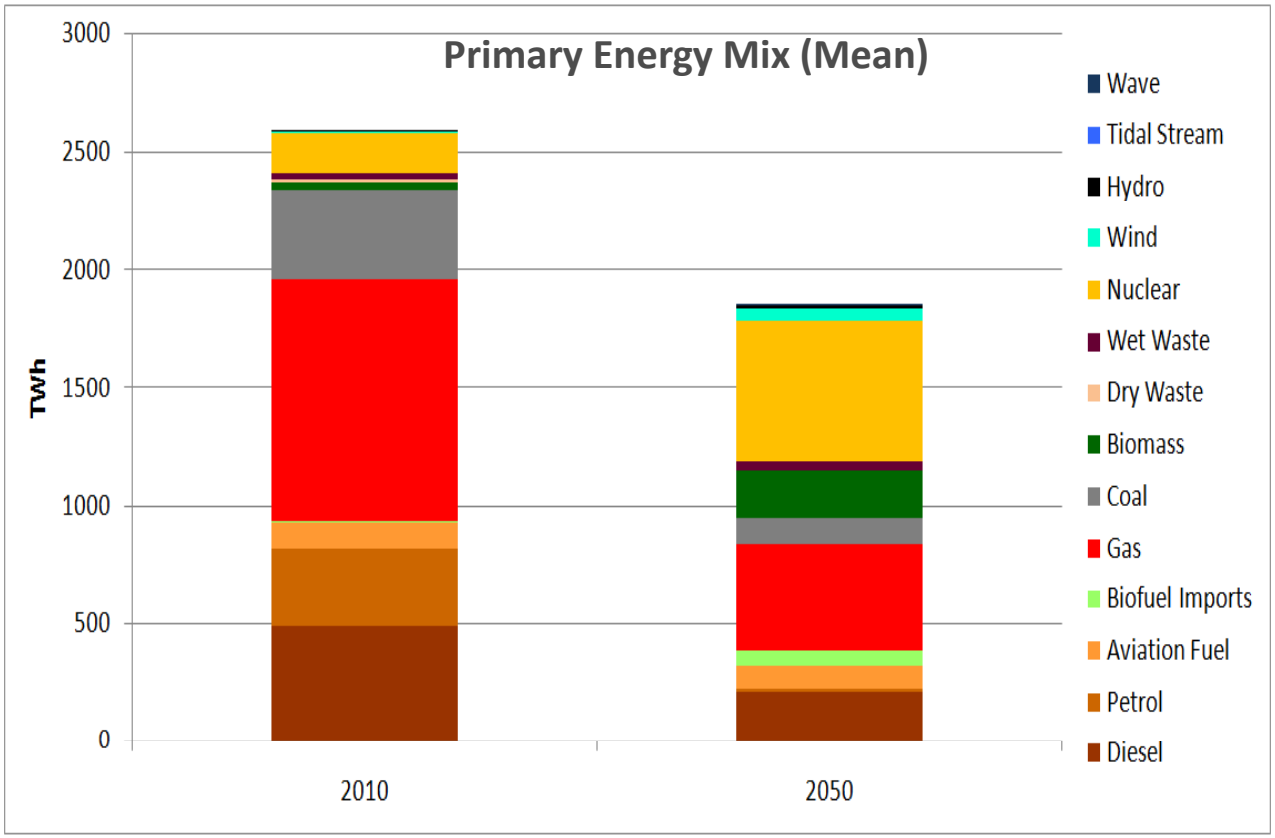



# A national energy system design tool
# Integrating power, heat, transport and infrastructure searching for the lowest cost solution

# Getting to 2050 ....

## UK primary energy diversifies
## Nuclear and gas are pillars - 50% of energy imported

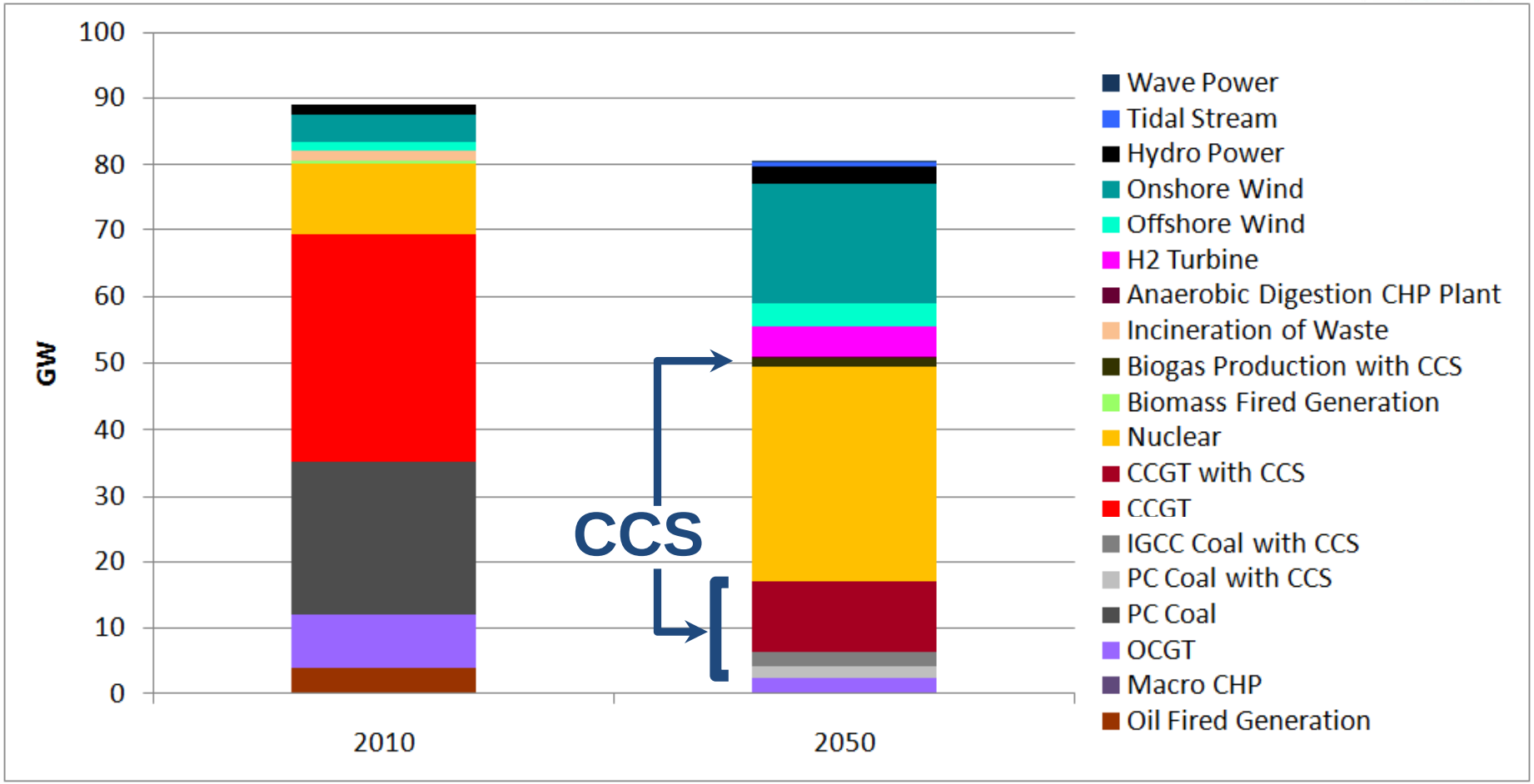
- Increasing role for nuclear and renewables
- Fossil fuel persists with CCS in power and as gas in heavy vehicles
- Biomass, onshore wind, hydro and imported biofuels become fully exploited
- Wet wastes must be used effectively – includes conversion to biogas
- Increased range and number of key assets




Electricity 2010 = 365TWh, 2050 = 440TWh

# UK 2050 power generating capacity

## ~20% of capacity uses CCS

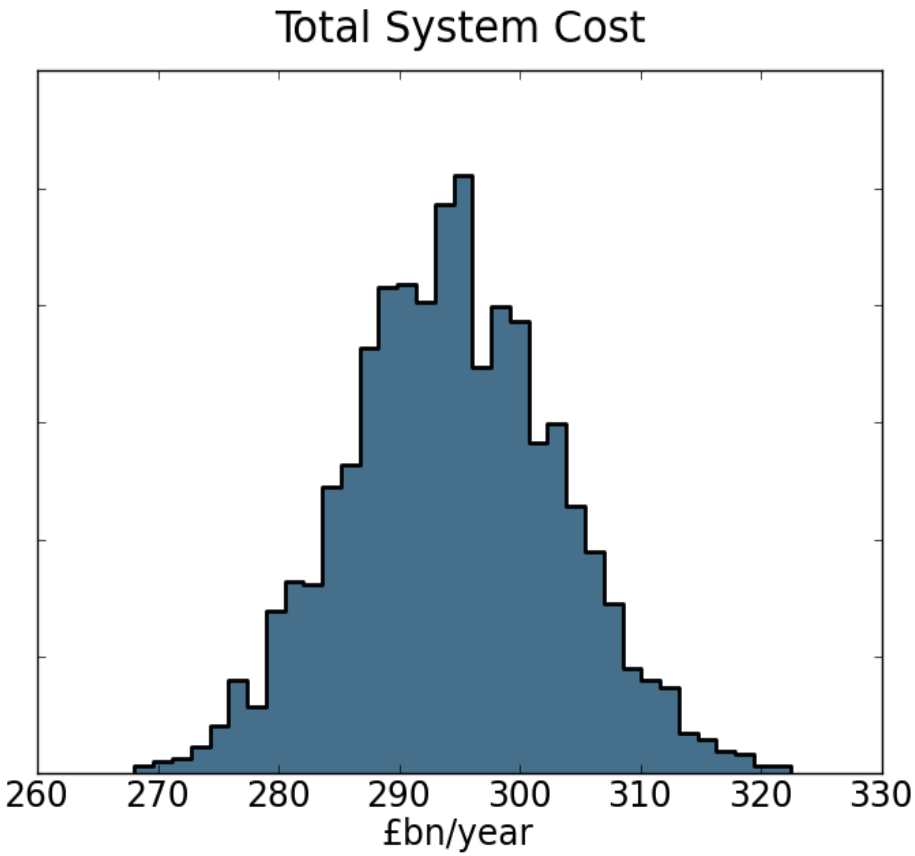


# 2050 abatement cost is <1% GDP

## Biomass and CCS are key levers, nuclear is part of the 'base platform'

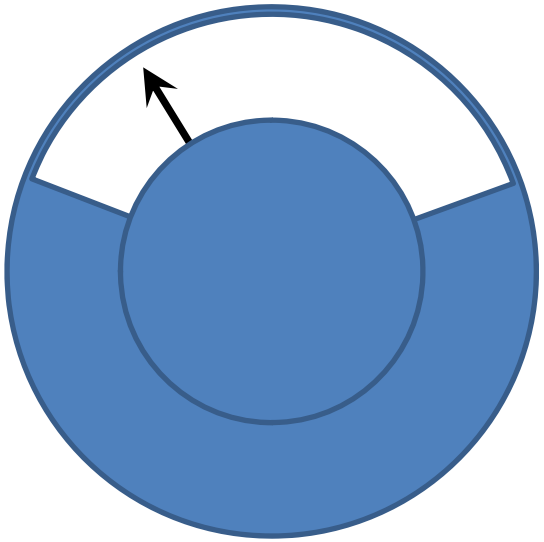
| £2010(Mean)/year | |
|---|---|
| Total system cost | £294bn |
| | |
| Abatement cost | £26bn (0.7% GDP) |
| Average cost | £51/tCO2 |
| Marginal cost | £360/tCO2 |
| | |
| No biomass | +£44bn |
| No CCS | +£42bn |
| No nuclear | +£4bn |
| | |
| No tech devt* | +£106bn |

*Assumes current technology cost/performance



# Effective national policy needs to focus on things which will ‘move the dial’

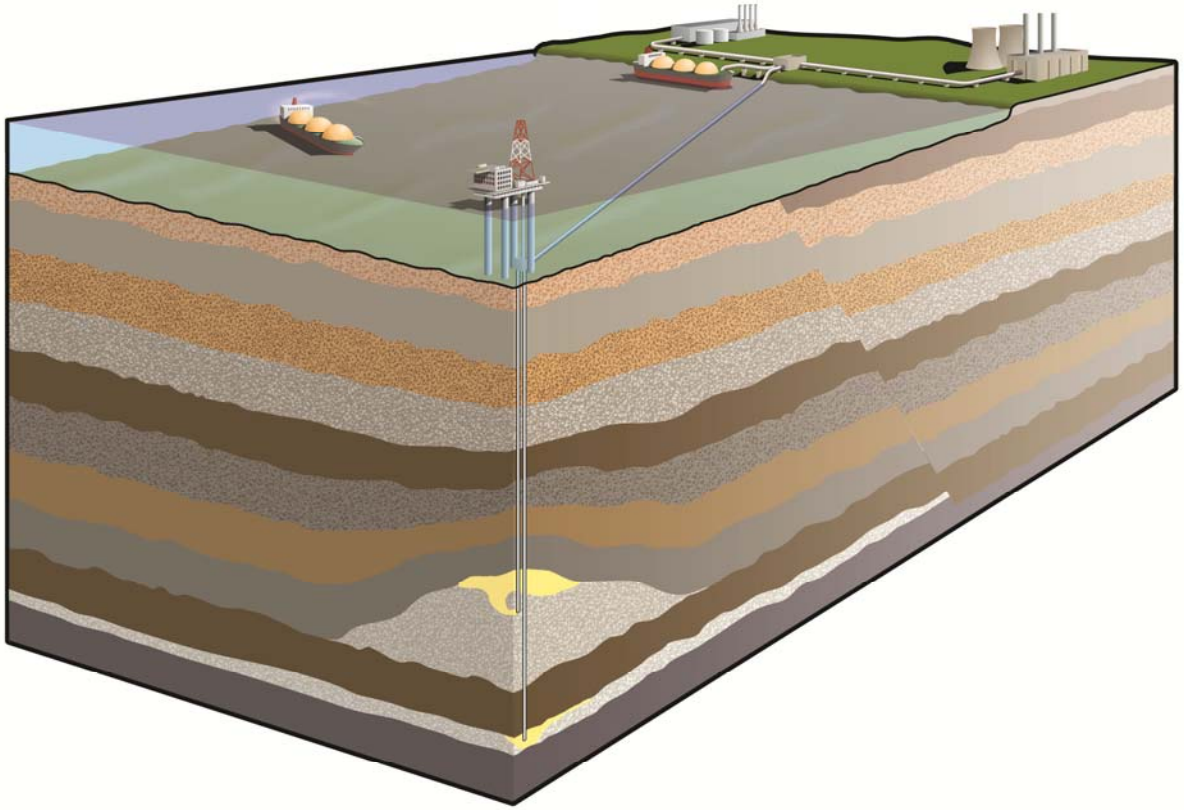
- Focus on the ‘big levers’ is crucial to maximise impact of scare resources - money, skills, supply-base and time
- Investment  in innovation is critical to reduce costs
- Engagement of industry and consumers is essential
- ETI view immediate development priorities for 2050 as ...
  - Efficiency (technology, consumer demand, storage)
  - Nuclear
  - CCS
  - Bioenergy
  - Offshore wind
  - Gas for transport



# CCS

## A key lever - particularly combined with bioenergy
## Long development time requires early start

- Potentially very wide use
  - Power
  - Hydrogen and ‘Synthetic Natural Gas’ (SNG) production
  - Heavy industry
- ETI investing over £60m in enabling CCS for coal, gas and biomass
  - Improved separation technologies
  - Storage appraisal
  - Transport system design tools



# Early demonstration start is essential

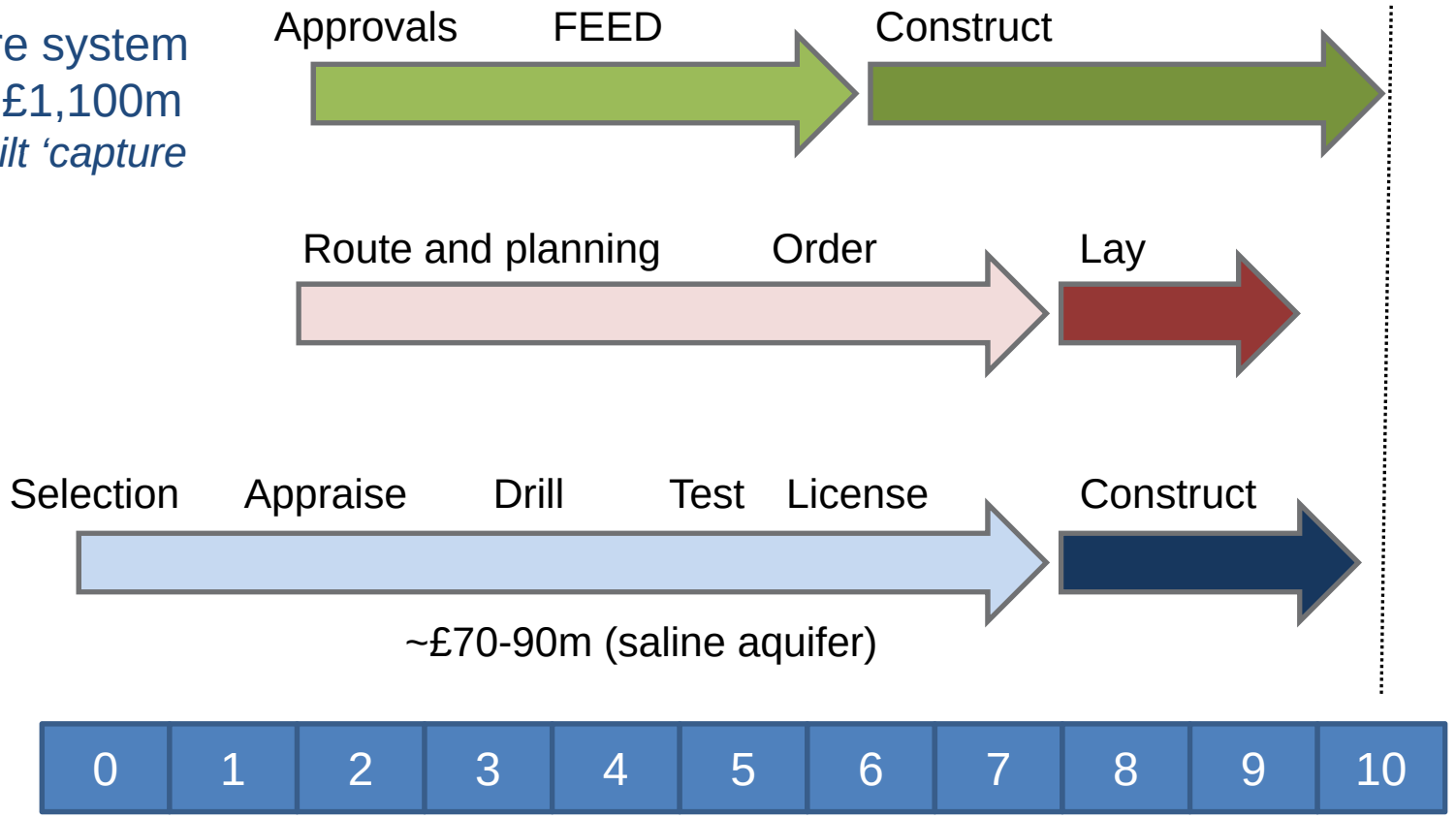
## Longest lead time item is the most uncertain - storage

Power and Capture system (IGCC 700MW) ~£1,100m

*Gas plant can be built 'capture ready'*

Transport system £130-300m

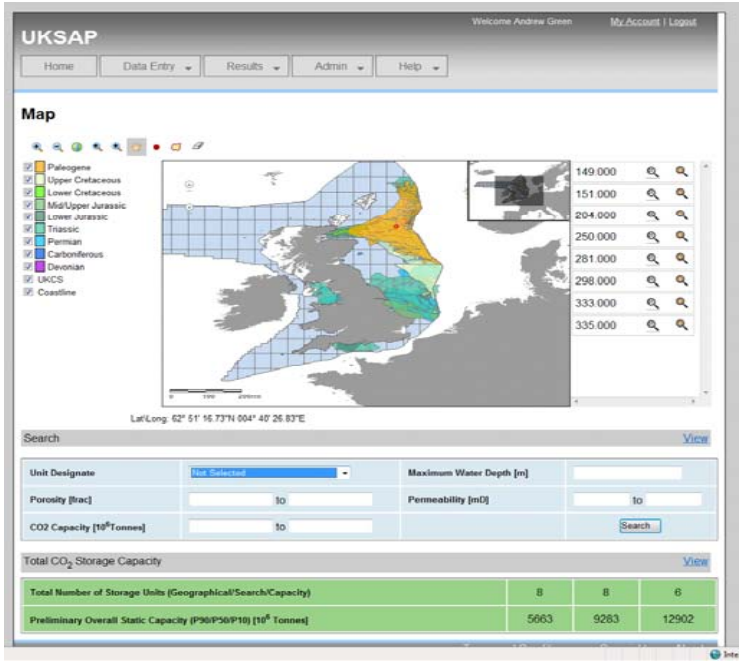
Storage system £140-250m



# UK CO2 Storage Appraisal Project

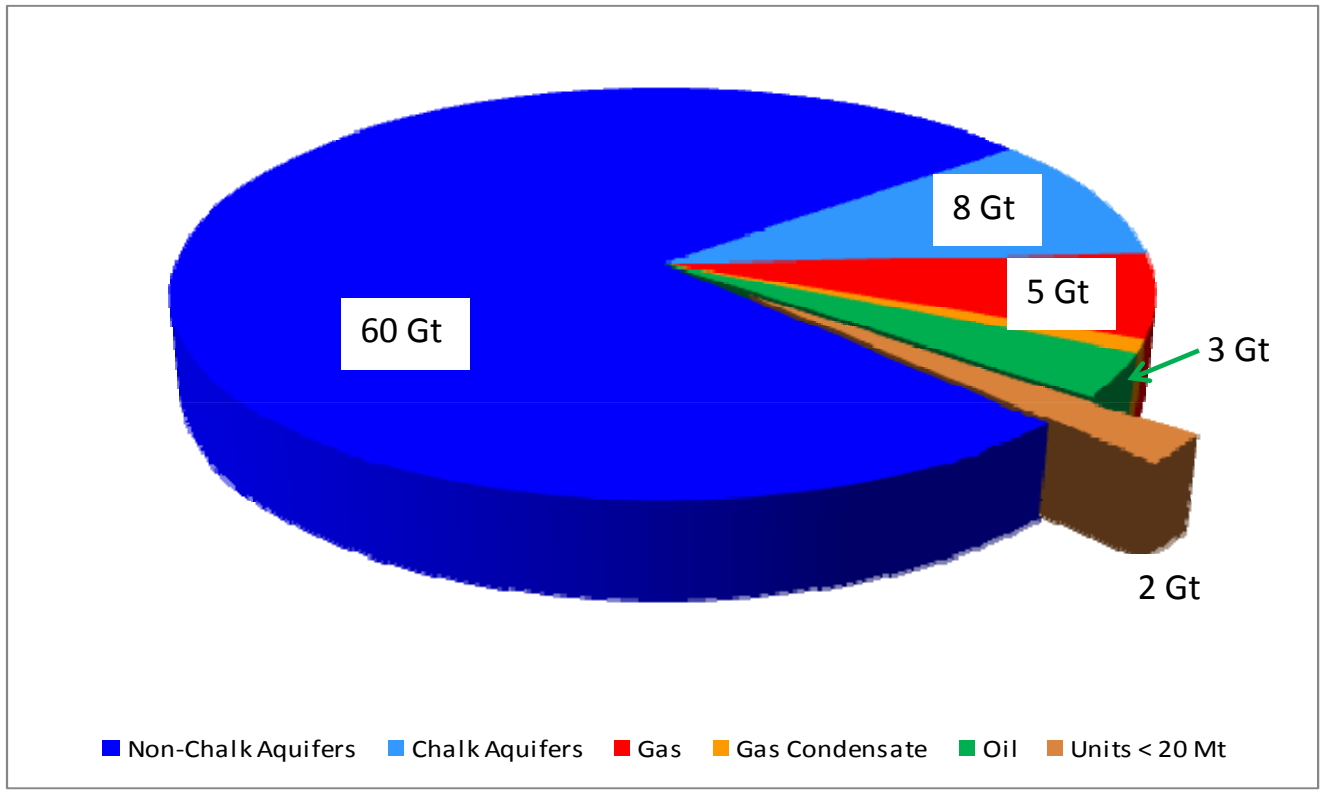
## Overall estimate of UK capacity and quality
## Informing CCS investment decisions

- Realistic, defensible & fully auditable assessment of potential CO2 storage capacity in the UK
- Unique & comprehensive GIS storage database
  - Capacity
  - Security of storage
  - Economics
  - Underlying data



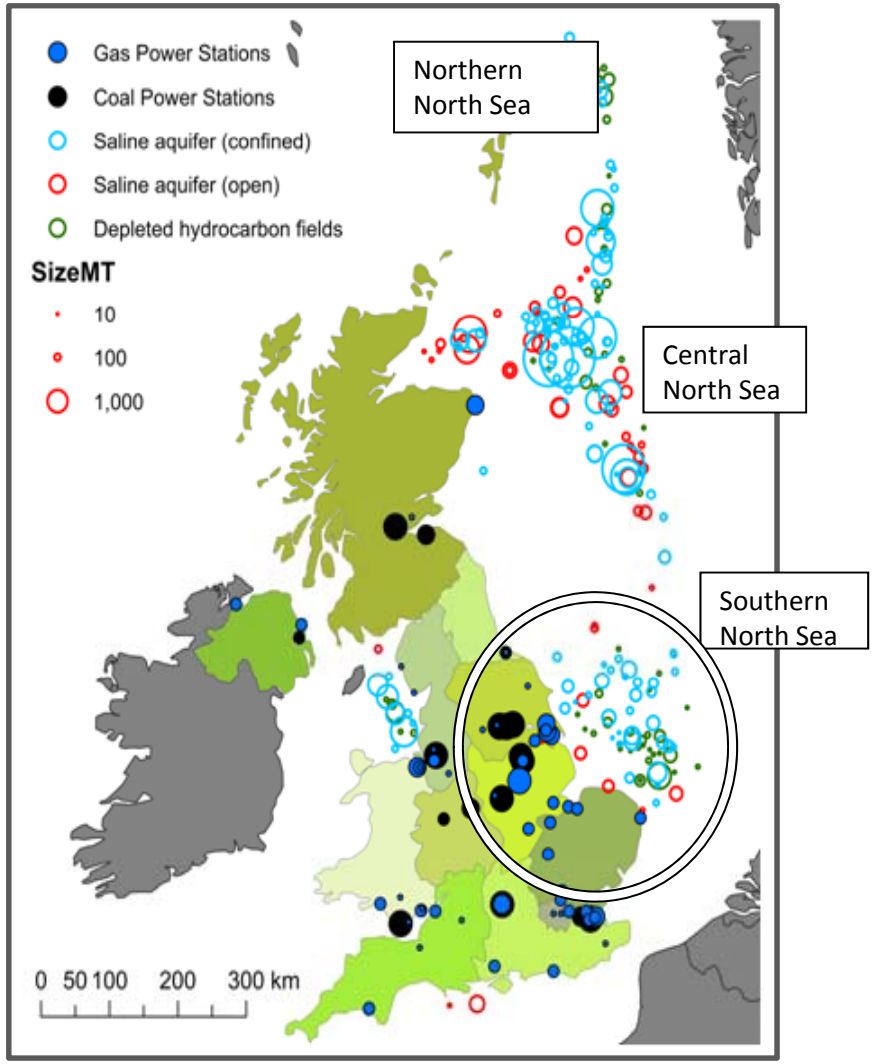
# Overall UK $CO_2$ Storage Capacity

- dominated by saline aquifer stores
- P50 capacity 78GT
- UK requires about 15GT for 100years




- Total 'technical' capacity
  - does not take economics and security of storage into account
- Large number of stores whose final assessed capacity is less than 20 Mt

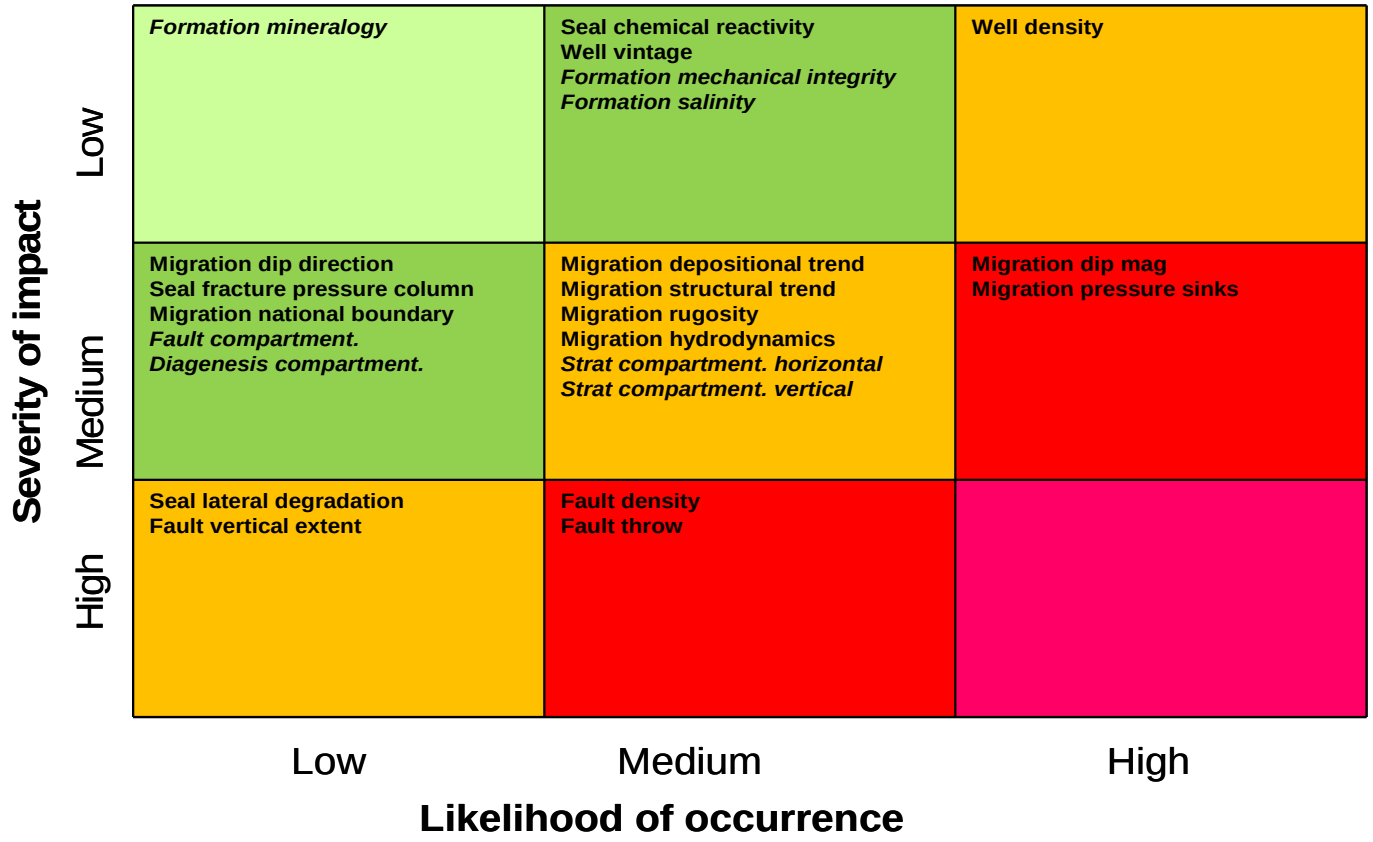
# Where is the storage?




- Viable storage found in all areas studied
- Storage is stacked and clustered – both oil & gas and aquifer
- Opportunities for 'basin scale' approaches

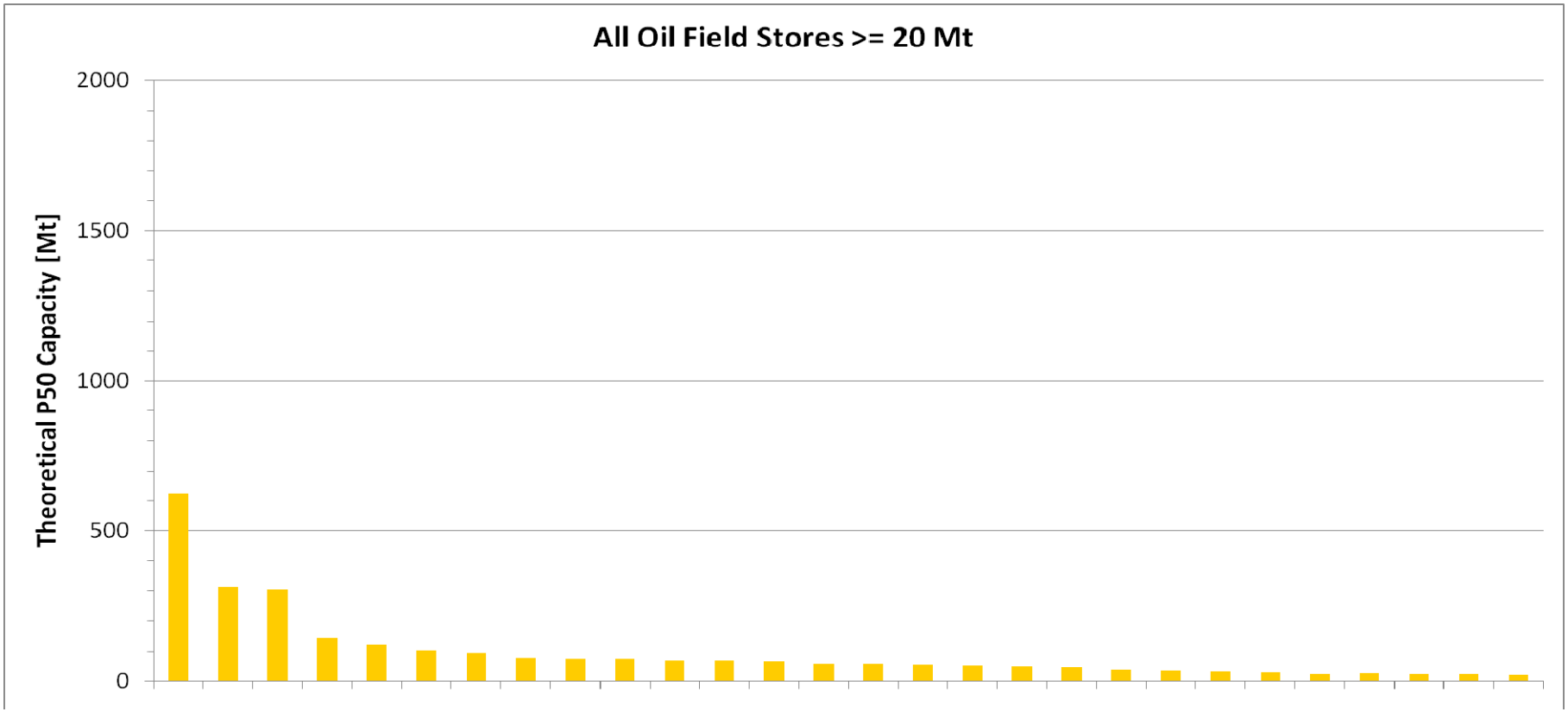
Key:
Black = coal-fired station
Royal blue = gas-fired station
Green = hydrocarbon unit
Light Blue = closed aquifer
Red = open aquifer

# Security of Storage




- Security of Storage assessments carried out for all saline aquifer units
  - Consistent methodology
  - 23 risk factors considered

# How much storage do we have?



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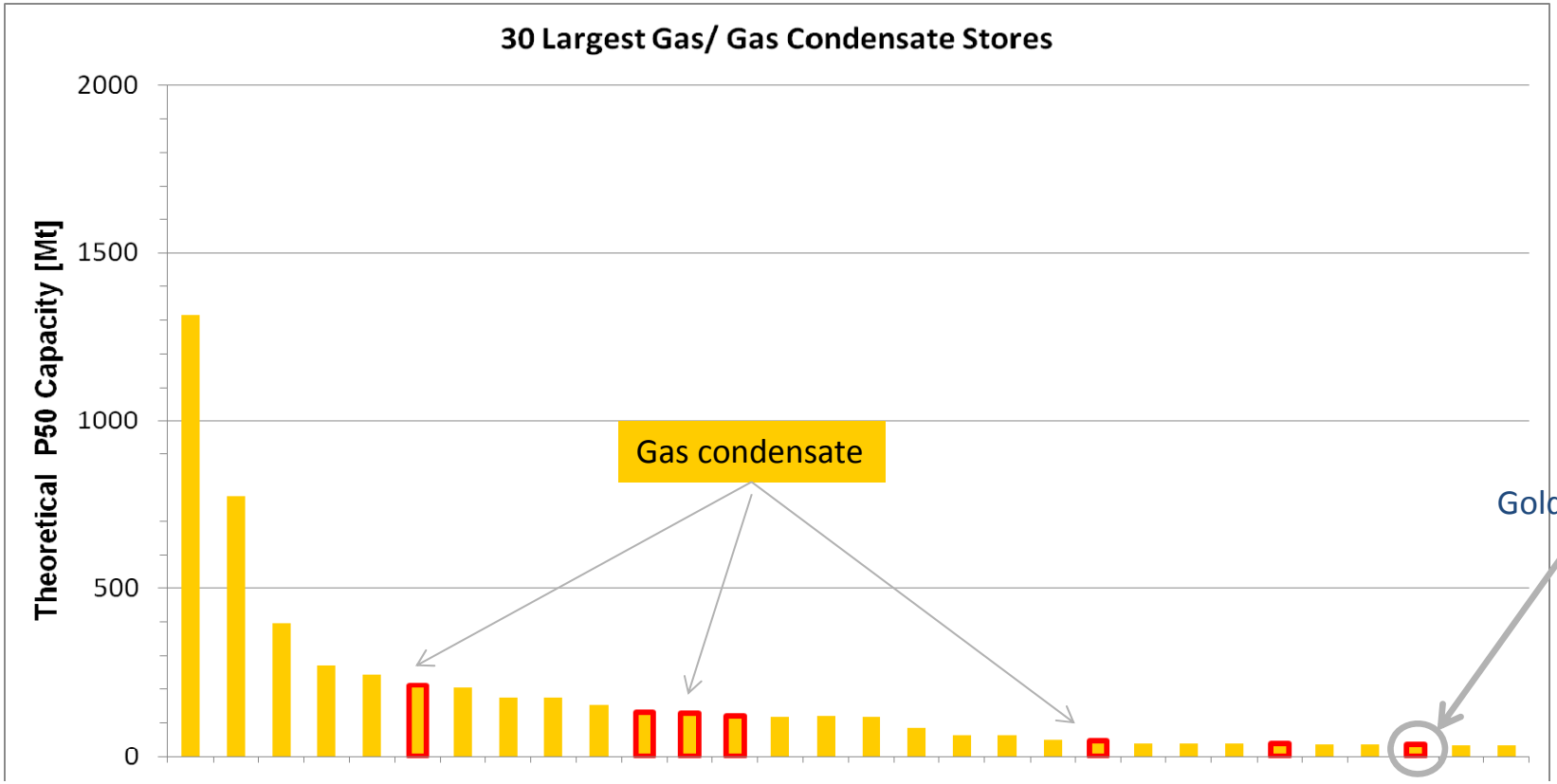

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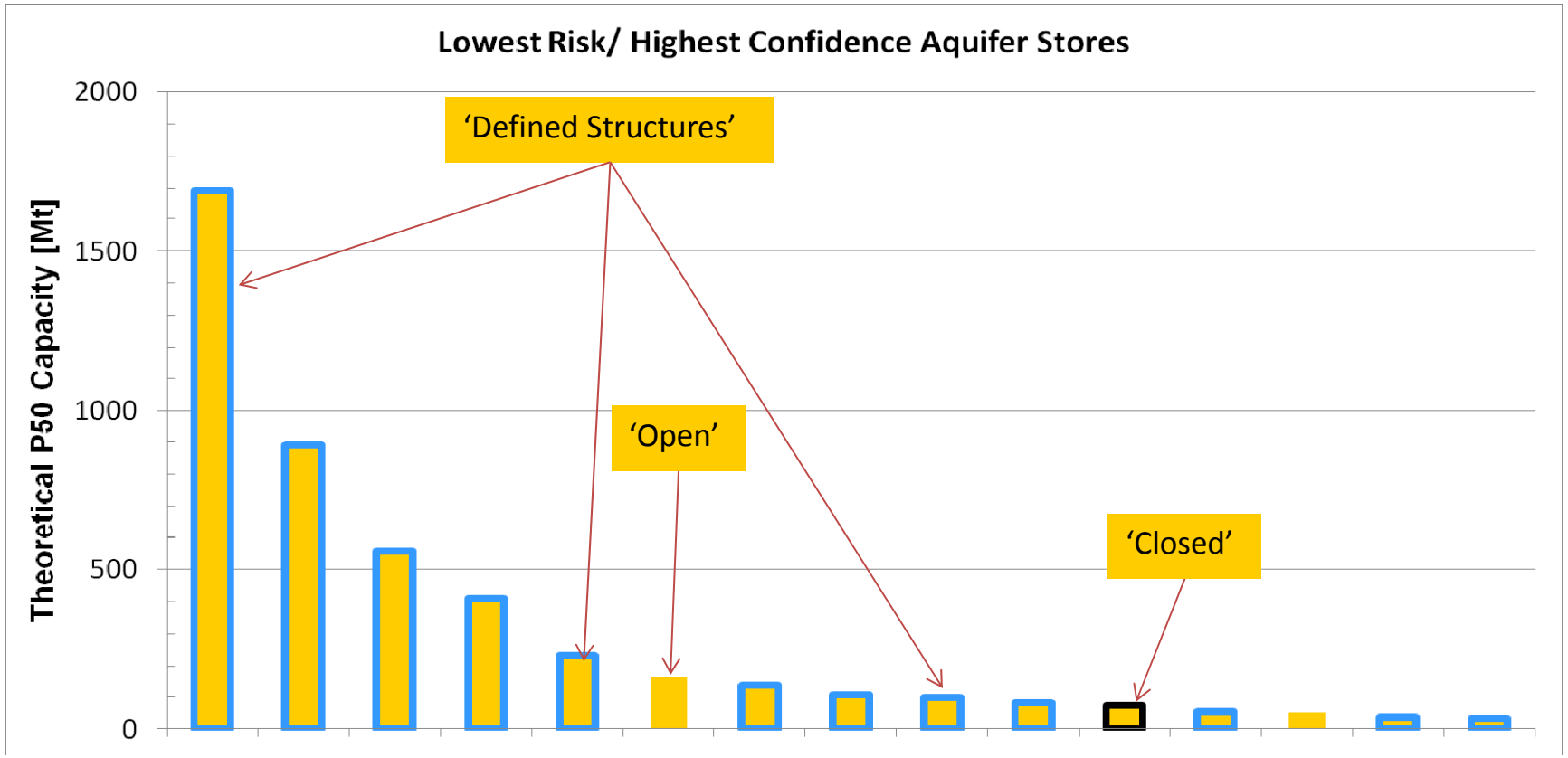
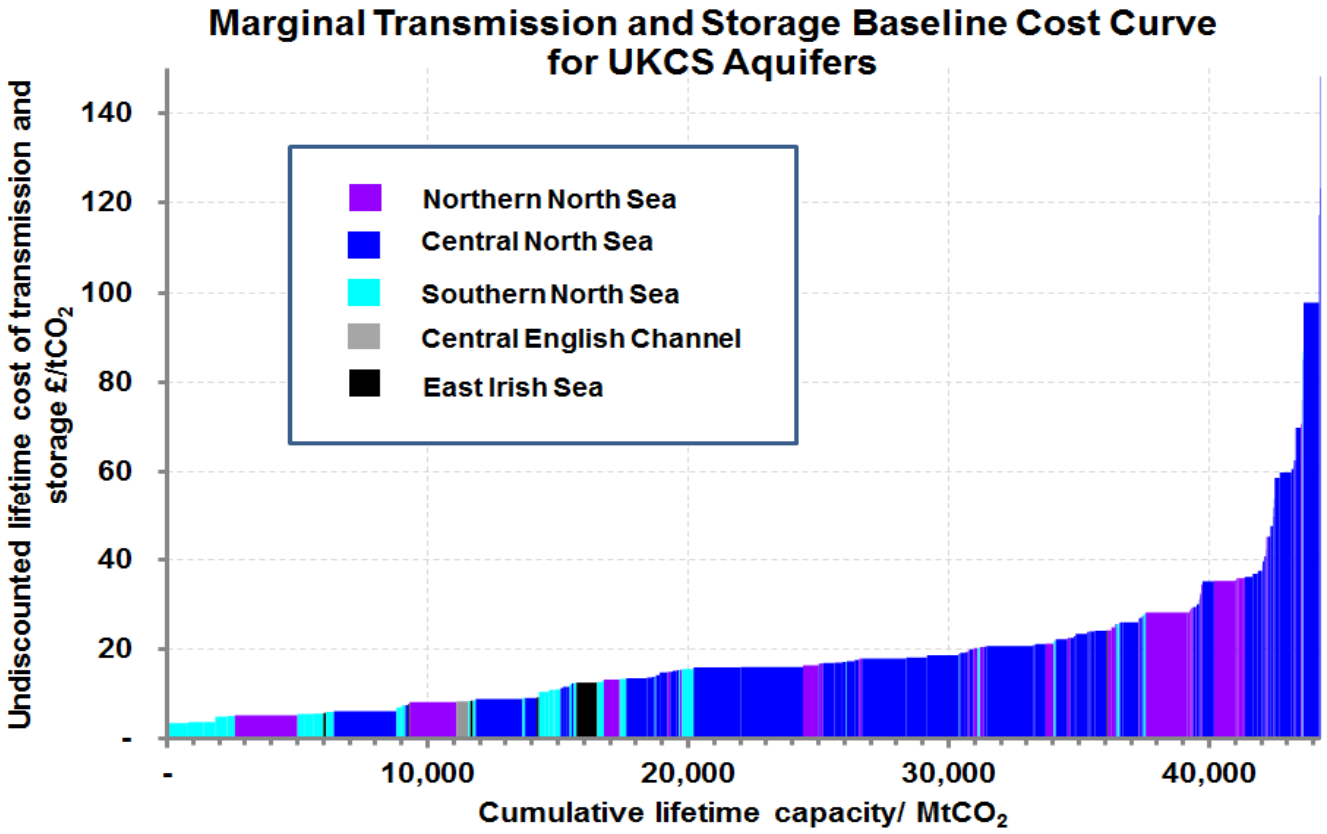


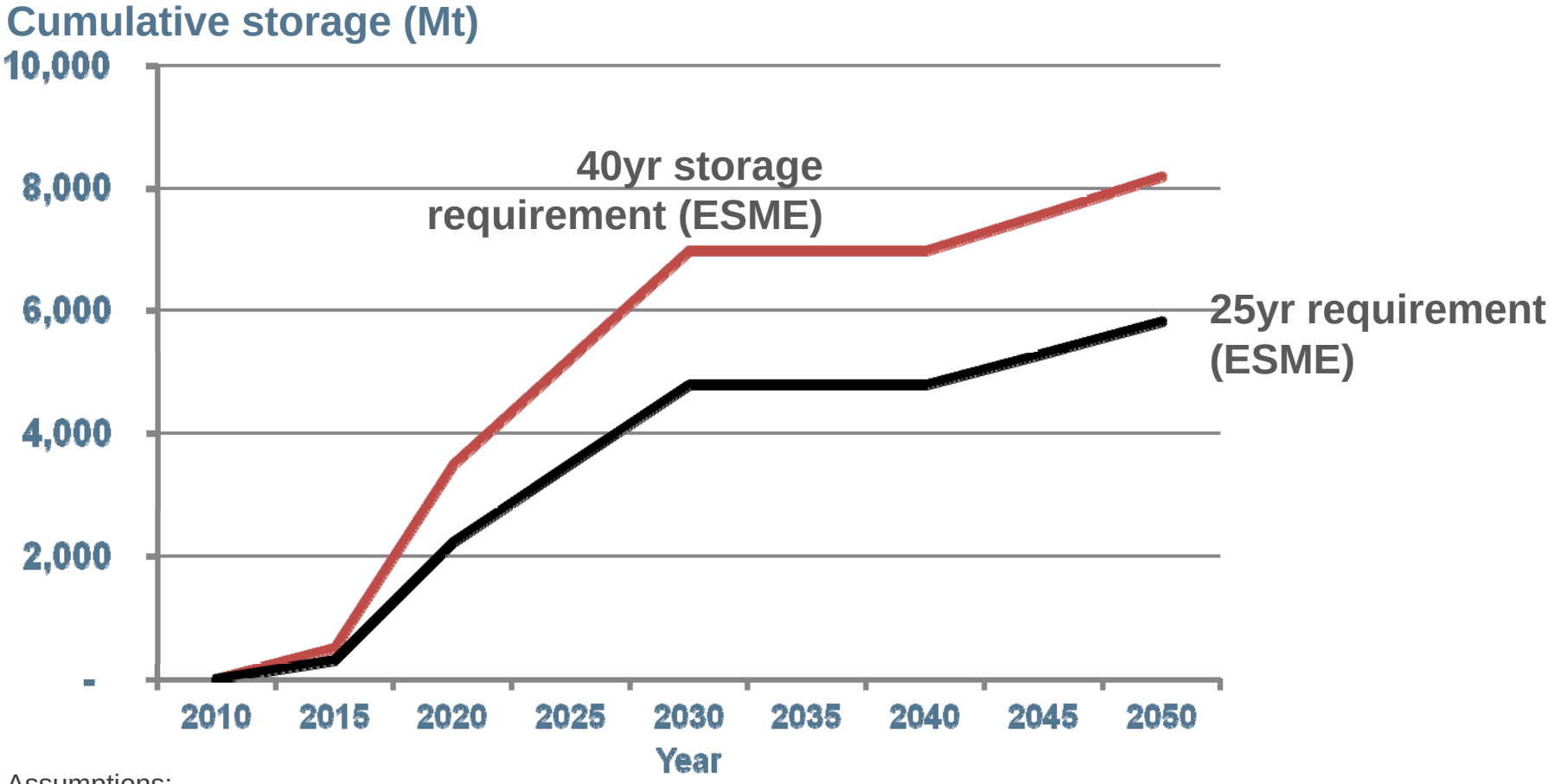
# Economics - Aquifers




- Notes:
  - Cost model takes into account key capital and operating costs
  - Costs are undiscounted: higher (initial) risk sites will require larger returns on capital
  - Transport costs are offshore only, and are based on (shoreline) ‘point to point’ for each unit

# Storage capacity

## must be committed in advance of need




Assumptions:

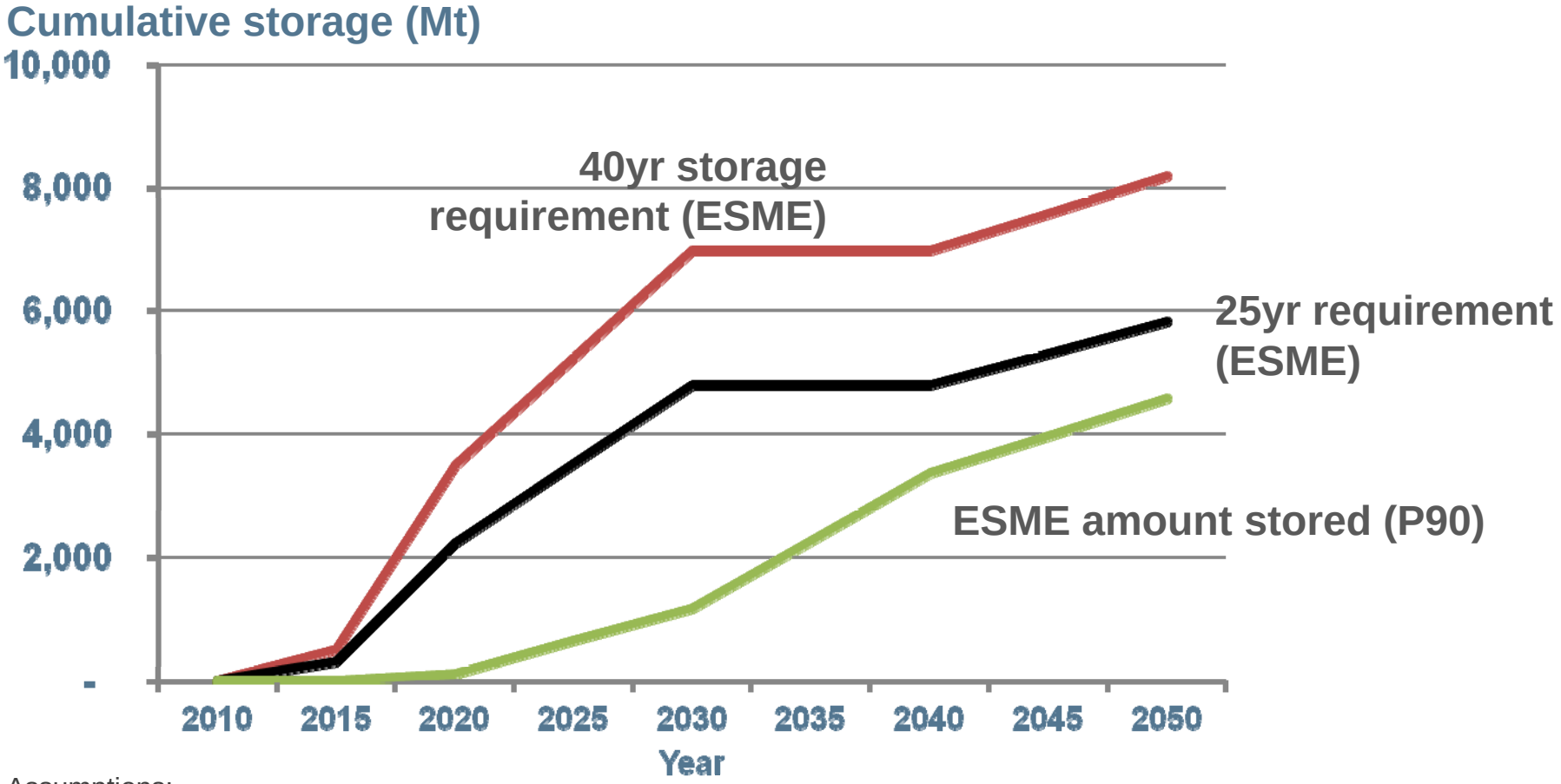
– ESME decadal pathway analysis to 2050

– Storage Requirement = actual to date + 25/40 years for new assets

Total UK Storage Requirement (100 years) ~ 15,000 Mt (P90)

# Storage capacity

## must be committed in advance of need




Assumptions:

– ESME decadal pathway analysis to 2050

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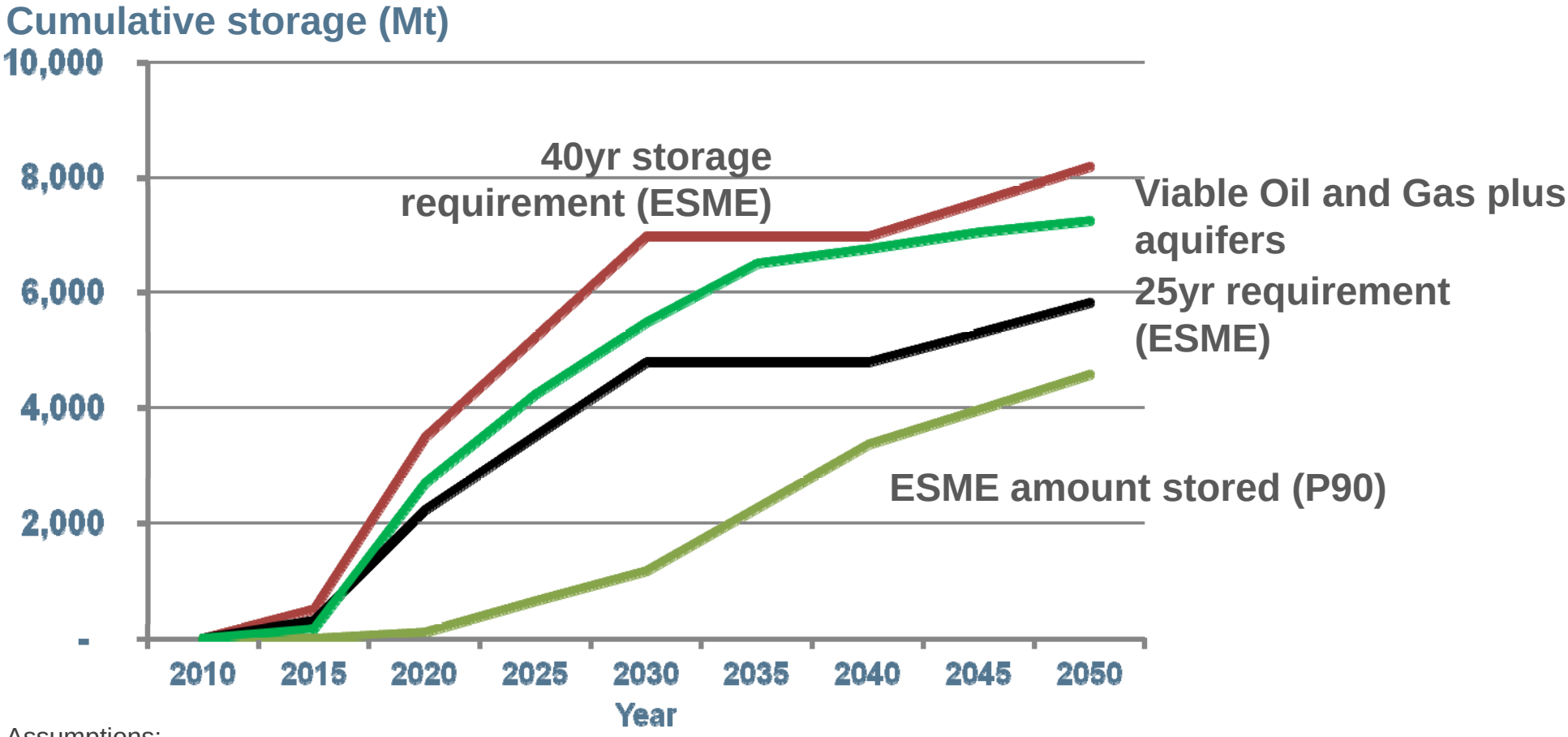
Total UK Storage Requirement (100 years) ~ 15,000 Mt (P90)

# 2050 pathway requires saline aquifers

## "viable" oil and gas alone unlikely to meet availability needs for capacity or timing



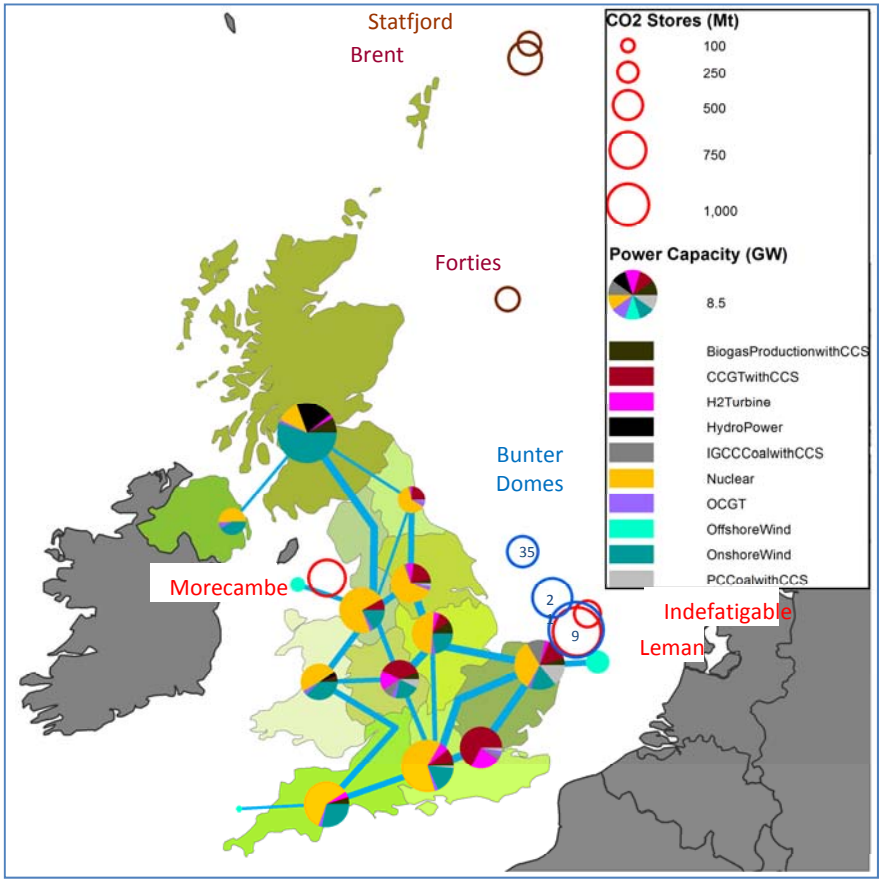

Assumptions:

- Based on UKSAP capacity for viable depleted oil & gas reservoirs with 5 year delay
- Availability based on DECC data for Close of Production (smoothed)
- Additional 1,500 Mt appraised aquifer storage available by 2020 rising to 2,700 Mt by 2050

# CCS

## A key lever - particularly combined with bioenergy
## Long development time requires early start on storage
## ETI investing over £60m in enabling CCS

- Potentially very wide use
  - Power
  - Hydrogen and 'Synthetic Natural Gas' (SNG) production
  - Heavy industry
- Demonstration projects need to de-risk full value-chain operation and prepare strategic aquifer storage
- Strategic management of UK storage required to allow cost effective development and maximisation of resource potential



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