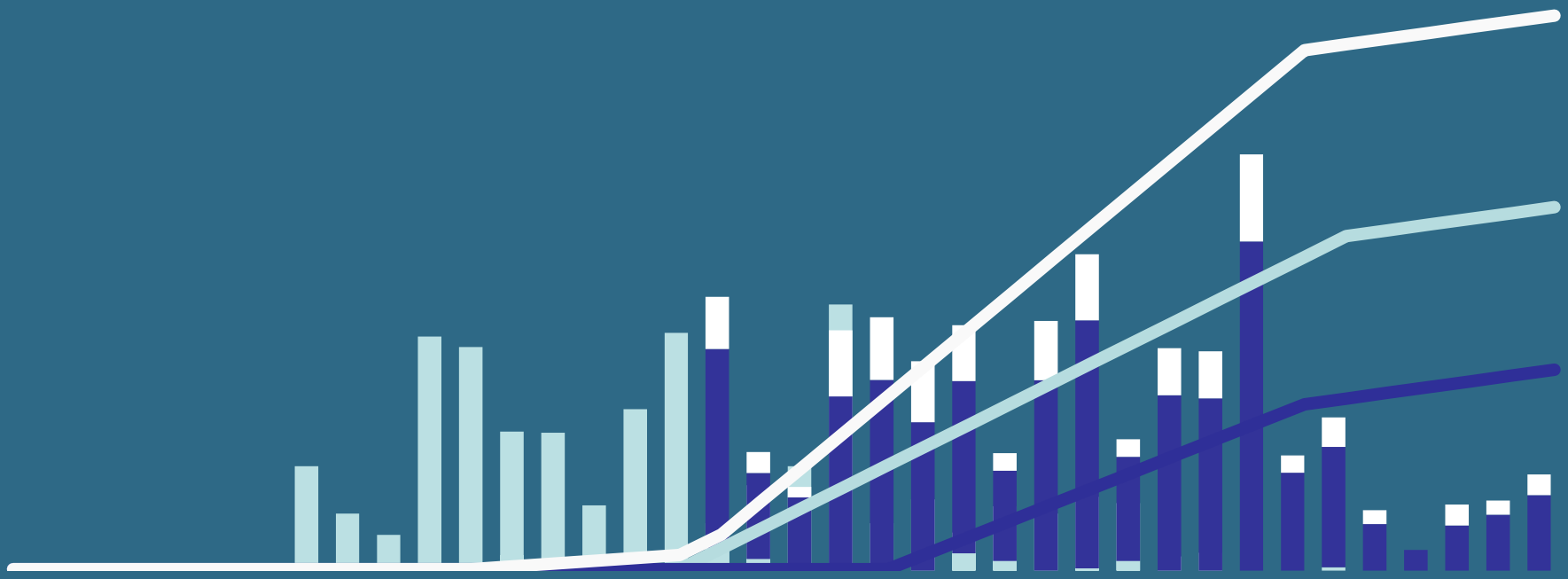
The Scale and Development Timeline of the European CO_2 Storage Industry

BELLONA EUROPA



- **Urgency**

Annual investments in the range of €500 million need to begin by 2020 in order to provide the injection and storage capacity needed for the 2030s

- **CO_2 storage industry will be large**

The CO_2 storage industry has the potential to be comparable to oil and gas activities. The need for wells, seismic, injection testing and professionals will rival or surpass that of oil and gas operations in many Member States.

- **Injectivity is the critical parameter**

Lower injectivity has outsized effects on the number of storage sites to be deployed under all capture scenarios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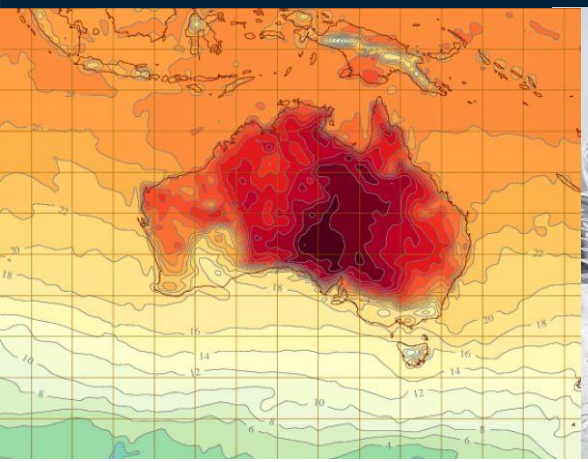
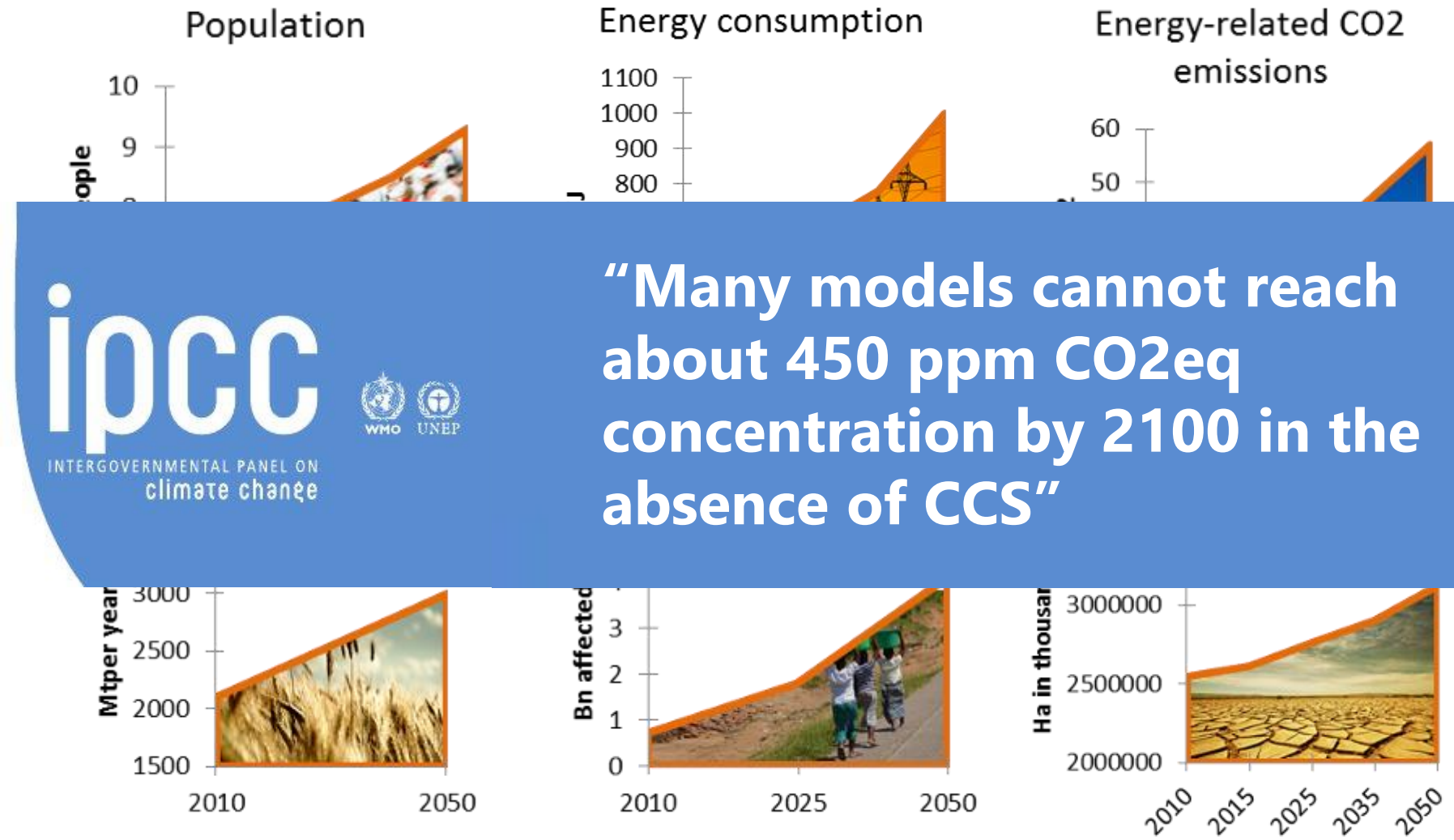


Increasing and persistent drought

Damaging weather events

Coastal and inland flooding

<u>Economic Growth and Poverty Reduction</u> = Rising global demand for energy and goods



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INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

"Many models cannot reach about 450 ppm CO2eq concentration by 2100 in the absence of CCS"

How many storage sites will be needed ?

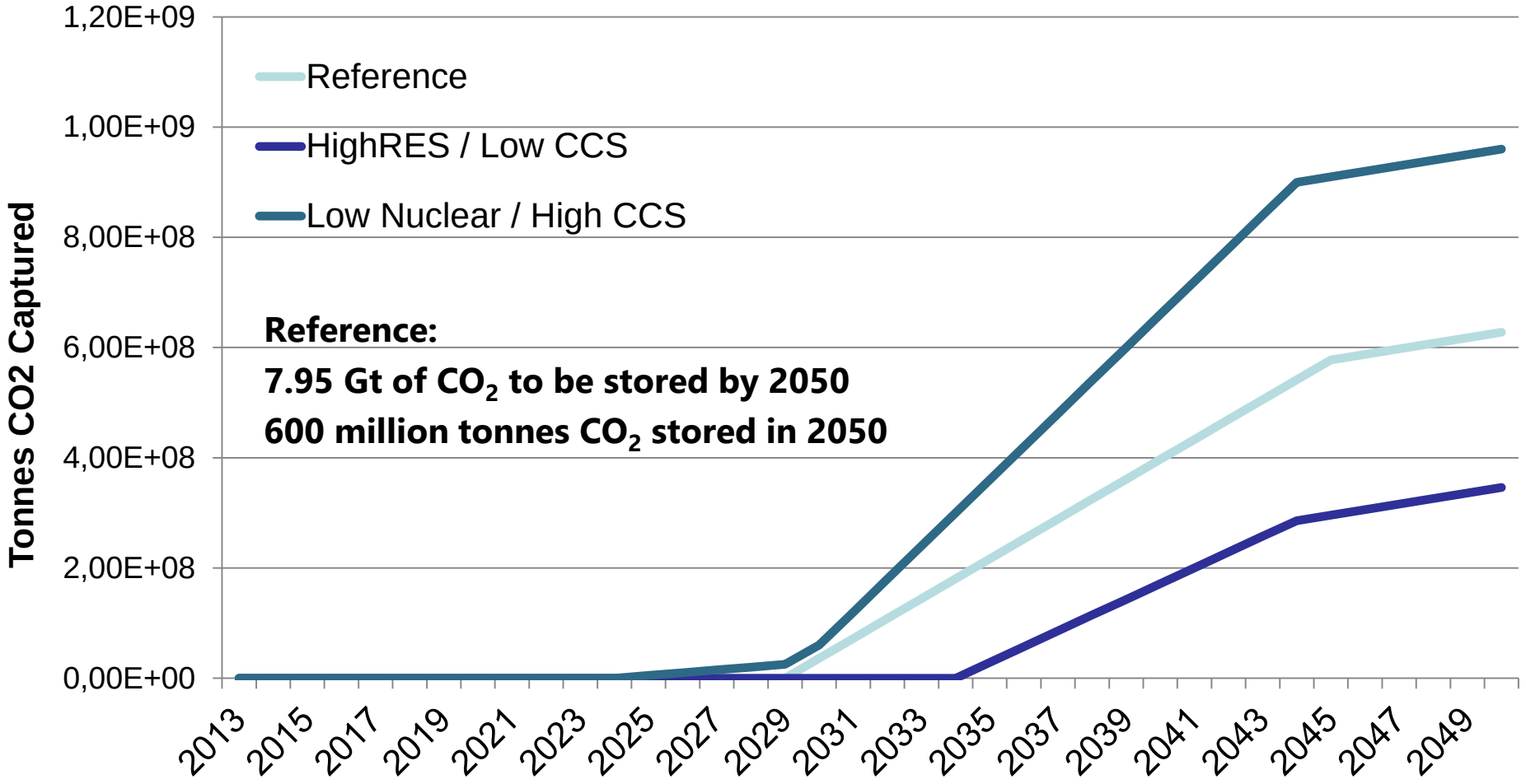
When will these storage sites be needed?

When must we start?

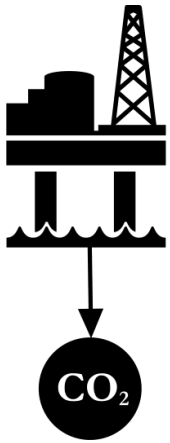
Are our assumptions reasonable?

Is storage at scale feasible?

Capture Rate based on EU Energy Raodmap 2050



		Time (years)			Cost ($ million)			Success rate
		10p	Mean	90p	10p	Mean	90p	
Phase 0 Screening	*Studies and R&D*	0.5	**0.75**	1	0.5	**0.75**	1	
Phase 1 Desk Based Assessment	*Studies and R&D*	0.5	**0.75**	1	1.25	**2.5**	5	
Licensing Exploration Permit	*Administrative engineering, license application and award*	0.5	**1**	2	0.2	**0.3**	0.7	
Phase 2 Site confirmation and characterization	*Studies and engineering*	0.5	**1**	1.5	3	**5**	8	
	2D seismic acquisition	0.42	**0.6**	1		**9**		0.75
	3D seismic acquisition	0.42	**0.6**	1		**7.2**		0.85
	3D retreatment	0.05	**0.08**	0.1		**0.1**		0.75
	Mob/demob	0.01	**0.02**	0.03	2	**3**		
	First well		**0.1**			**20.14**		0.75
	2nd well if any		**0.09**			**17.58**		0.75
	Water production test	0.05	**0.08**	0.11	1.76	**2.64**	3.52	
Licensing injection test permit	*Administrative engineering, license application and award*	0	**1**	1.5	0.2	**0.3**	0.7	
Phase 2 injection test	*Injection test duration + data analysis*	0.5	**1.25**	2		**41.88**		



Characterisation Cost of Offshore Storage (100 Mt)

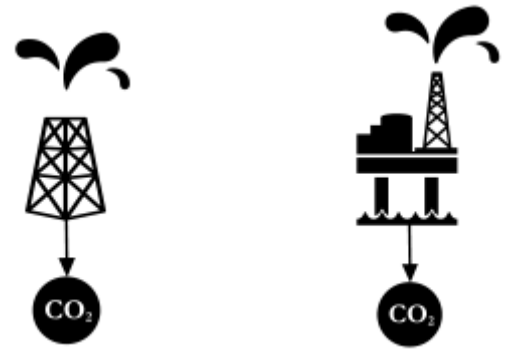
Mean Cost Figures

- Formation at 2000 metes depth
- Water depth 100 metes
- No local CO_2 source for injection test

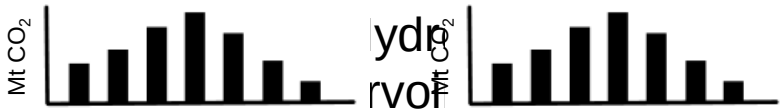
Costs include Contingency & Risk

Are storage characterisation costs linier ?

	Mean Development Cost ($ million)	Mean Development Time (years)
Deep saline formation, offshore	**93**	**9.5**



Onshore & Offshore / Hydr



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4 Storage Properties

A distribution of anticipated Storage Capacity, Injection Rate, Storage Life, and Injectivity per Well, are given for each Storage Variety

The contribution of each storage variety is chosen

20% Onshore & Offshore 40%

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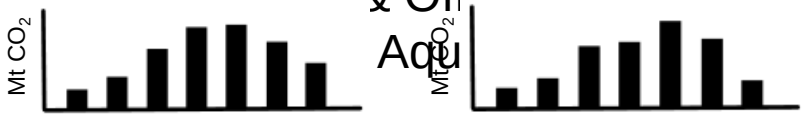
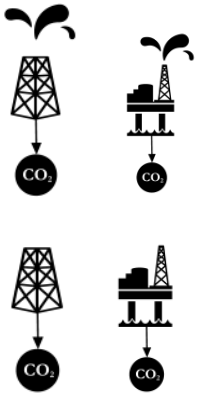


Storage Varieties



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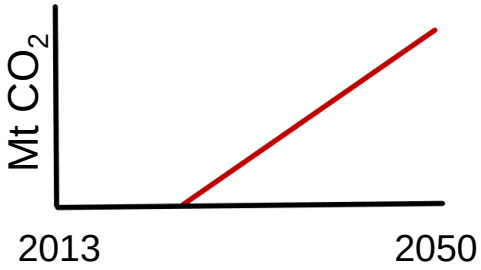
CO_2 Captured in Europe



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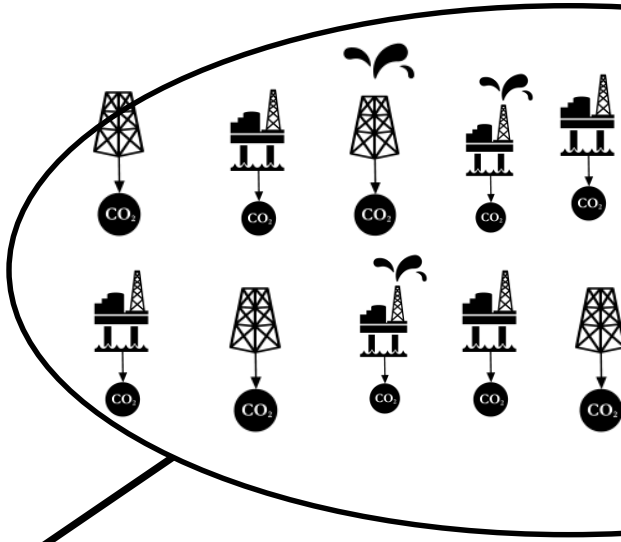
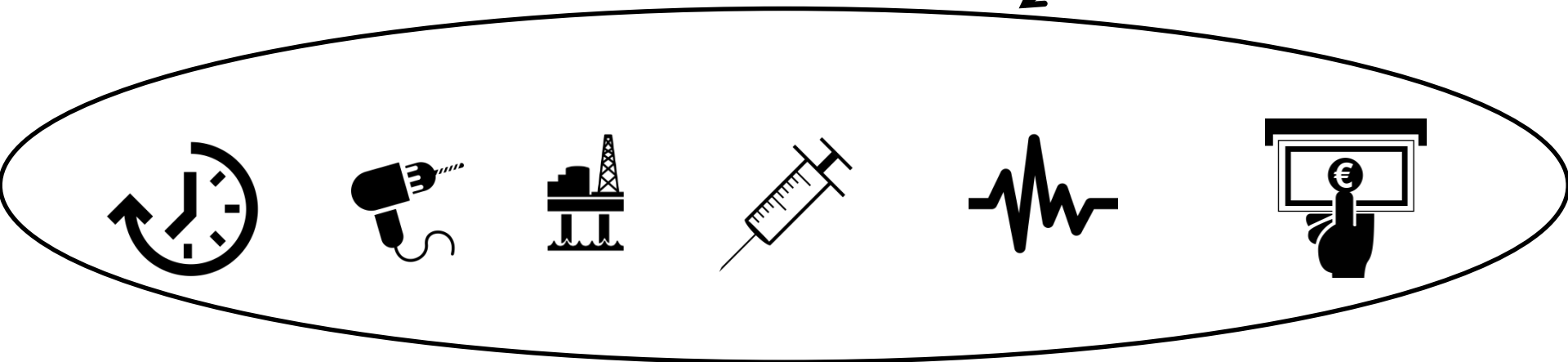
CO_2 Storage Deployment



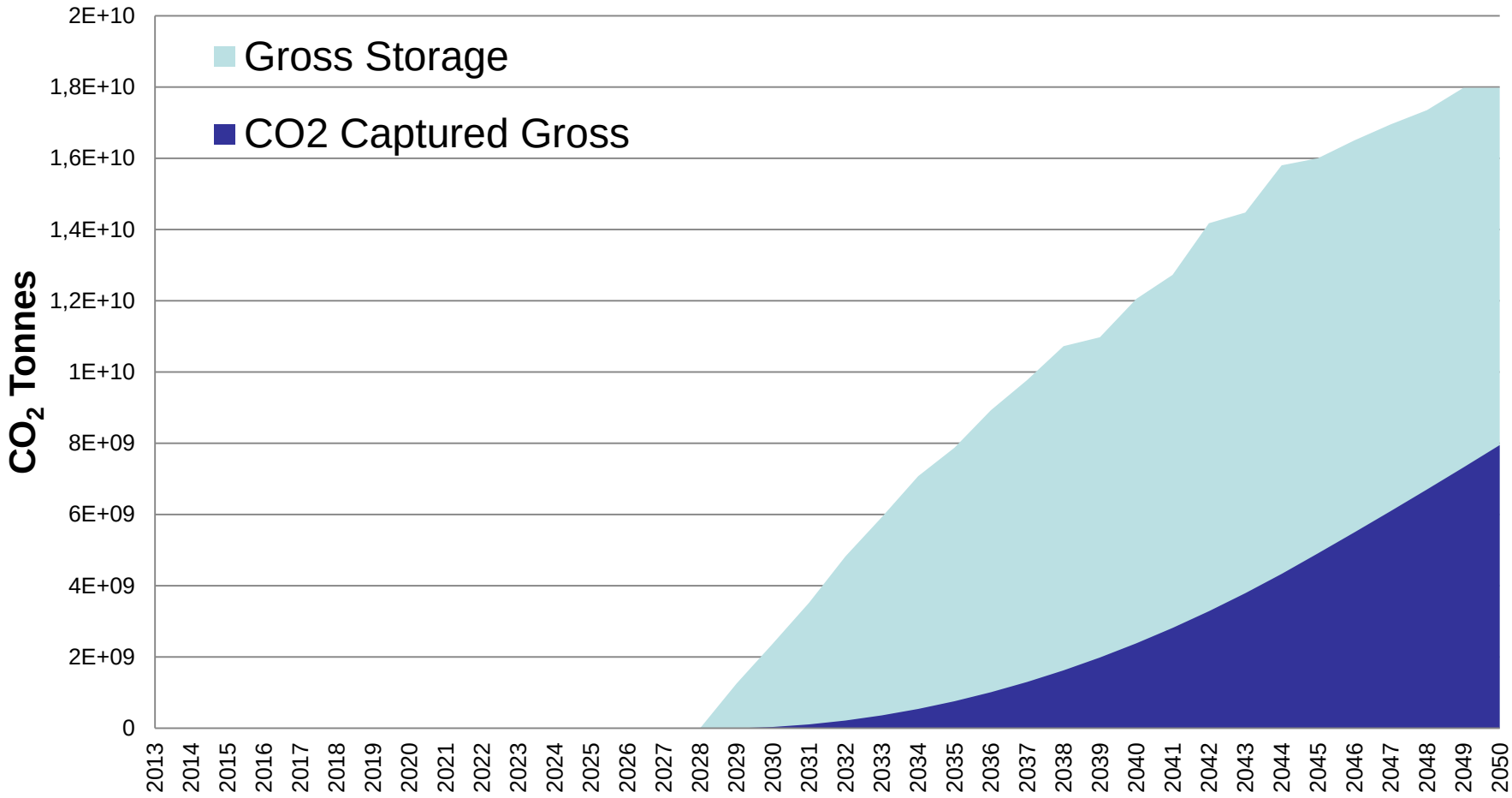


Reference Scenario:

Storage Site	Number 2050	Number 2040	Number 2030	Average fill time for storage type (years)
Onshore EOR	0	0	0	na
Offshore EOR	0	0	0	na
Onshore hydrocarbon	4	2	1	24
Offshore hydrocarbon	11	9	2	34
Onshore aquifer	31	20	6	37
Offshore aquifer	35	23	3	27
Sum	**81**	**54**	**12**	

	To 2050	To 2040	To 2030	Total
Storage Sites retired	3	0	0	3

CO_2 storage deployment vs. CO_2 Stored (tonnes). Reference scenario



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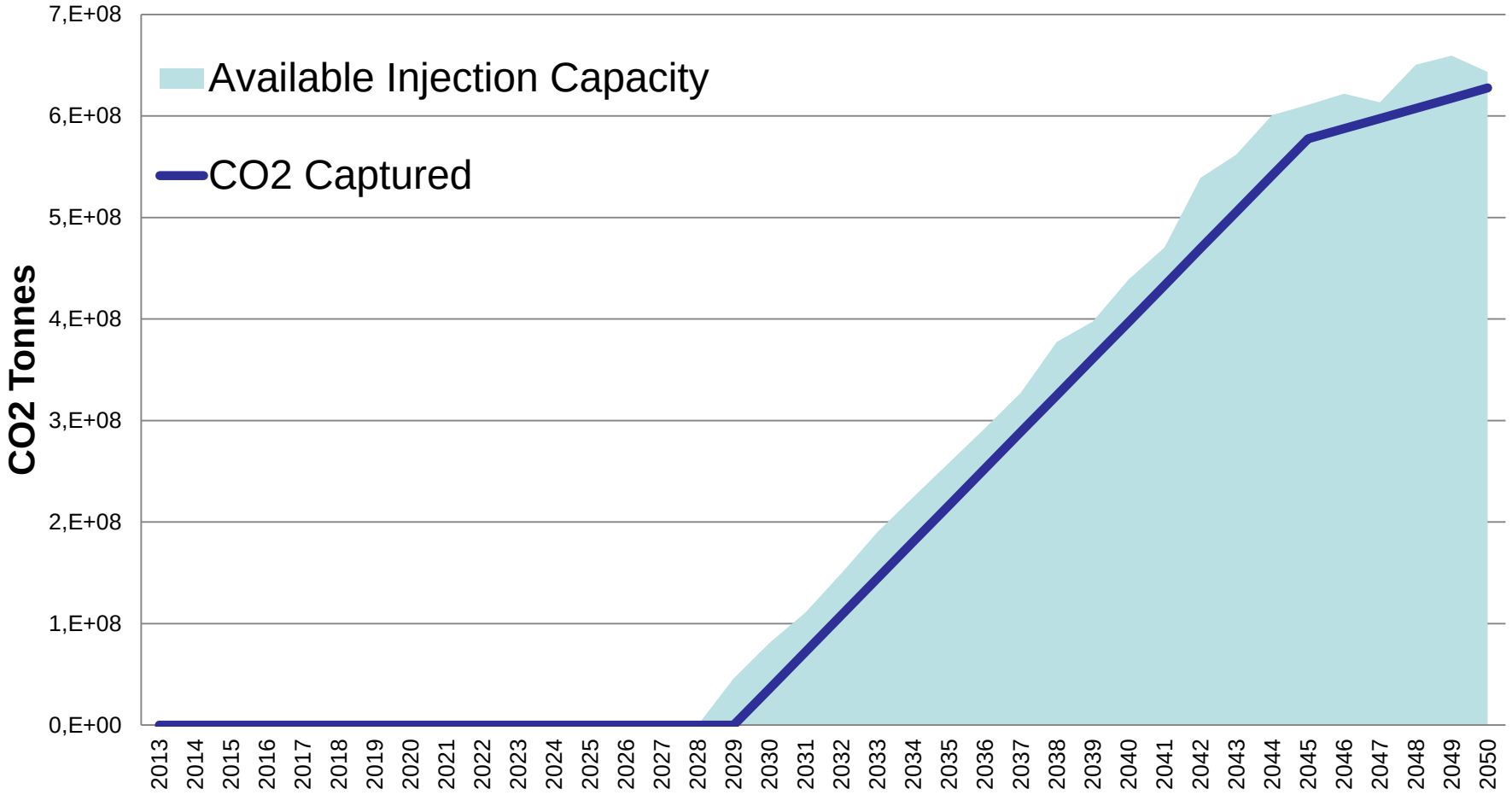
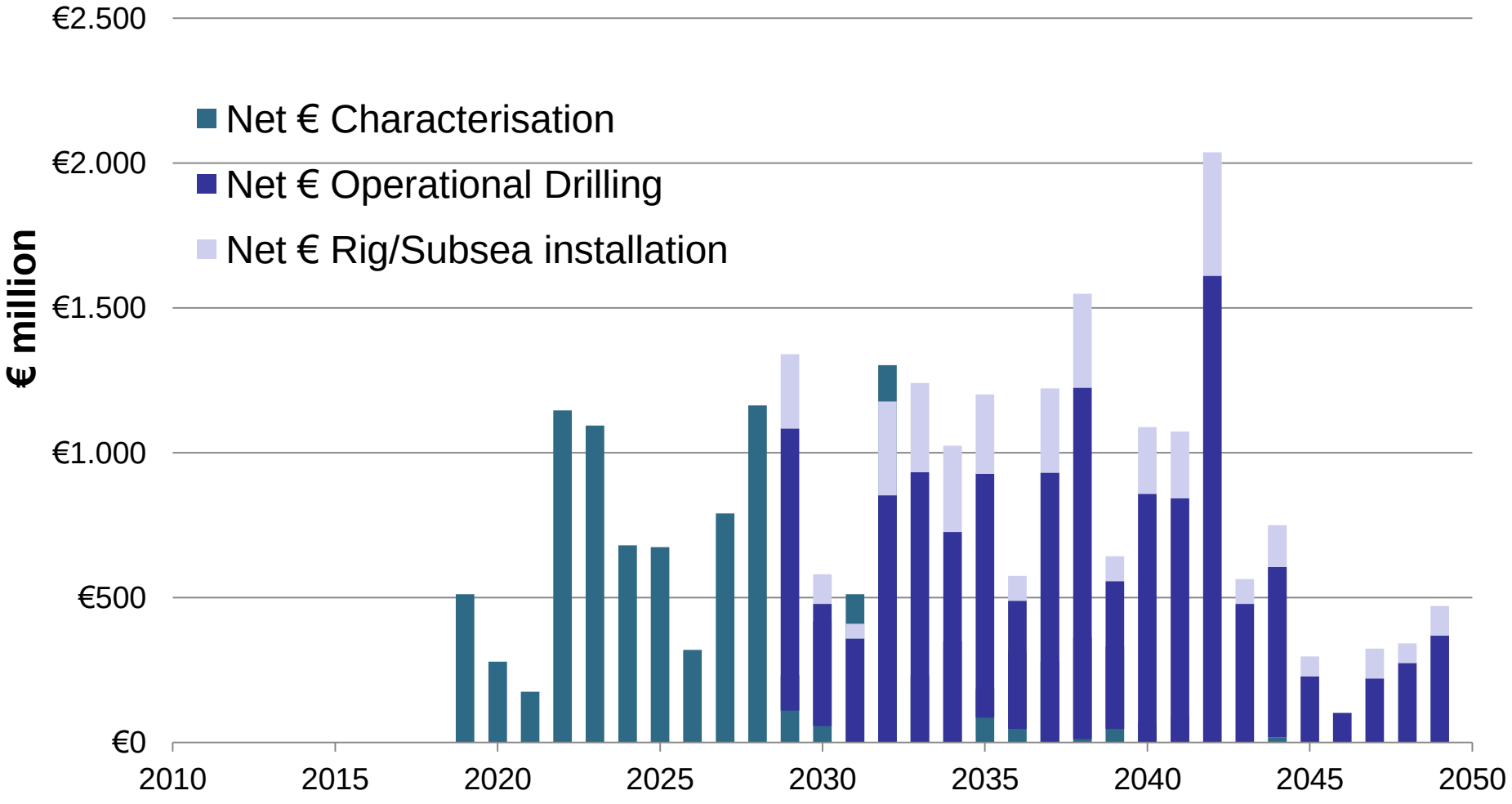
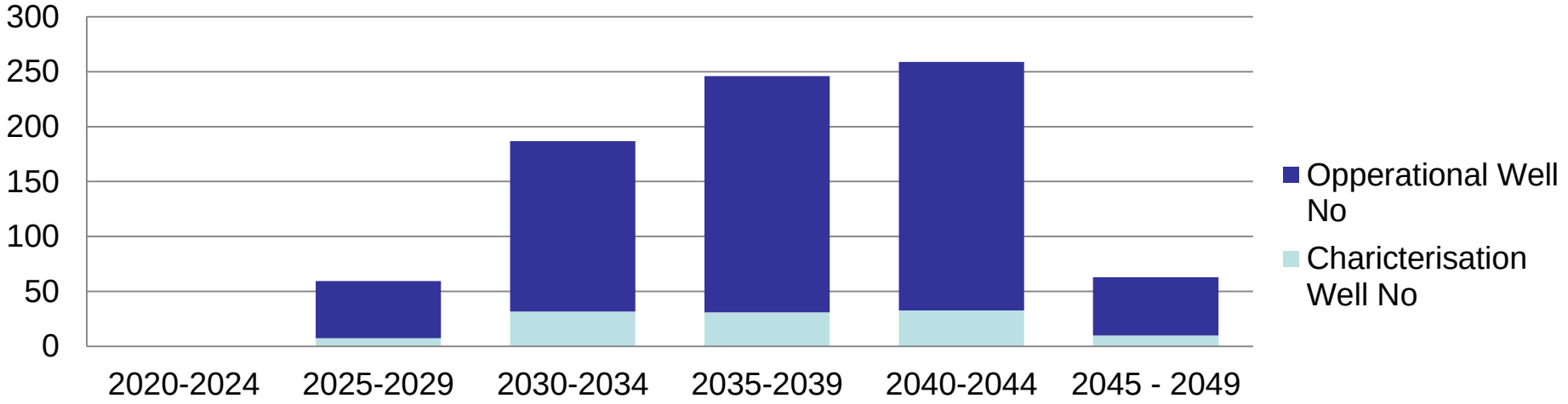
Injectivity available to CO_2 captured per annum. Reference Scenario



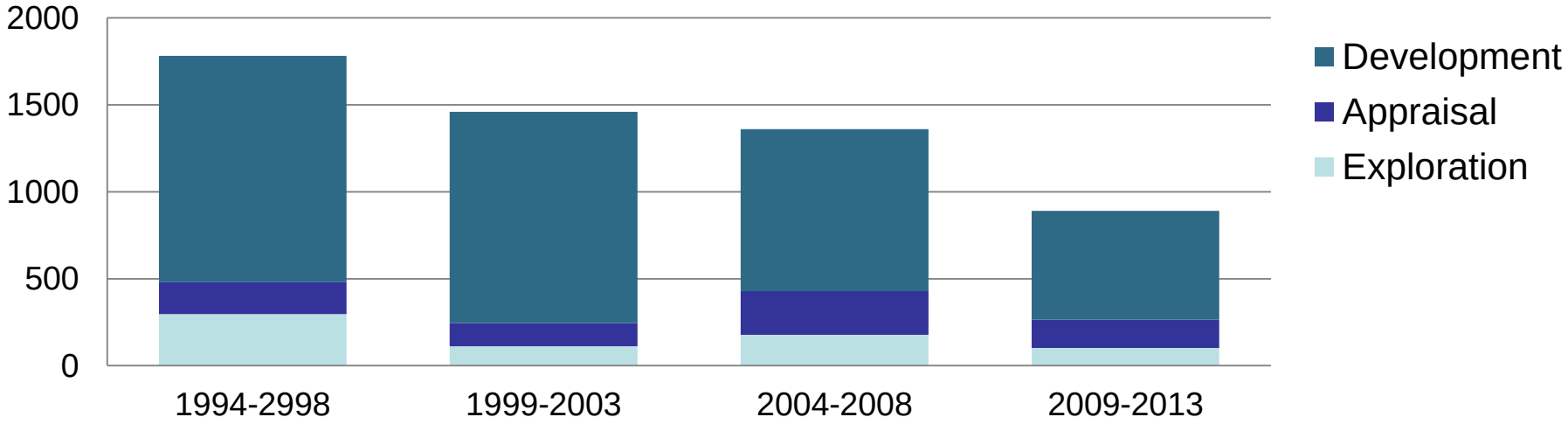
Annual investment to characterise storage sites (on year characterisation begins) and development (on year storage is delivered)



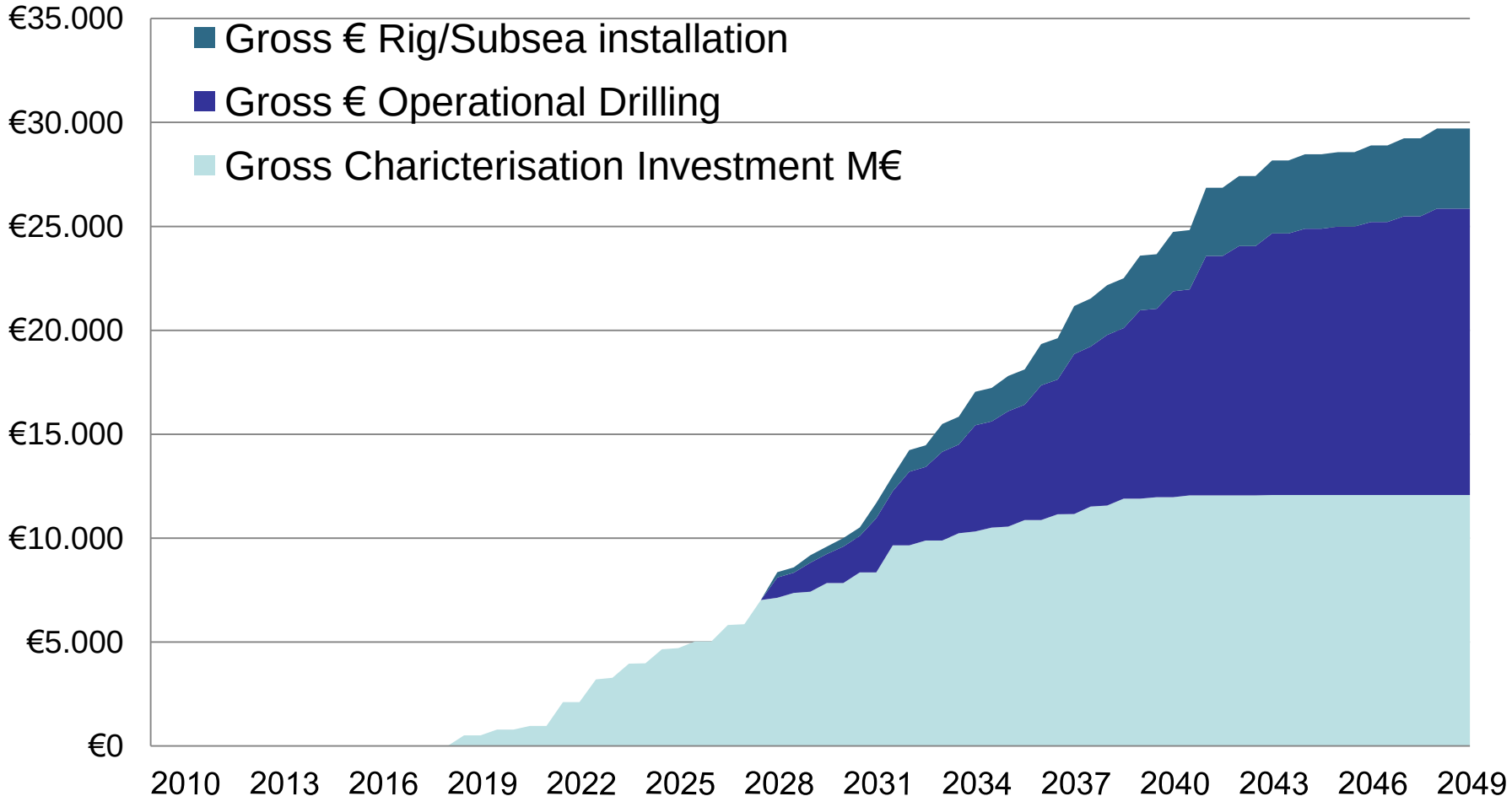
Wells drilled at offshore hydrocarbon and offshore aquifer. Reference Scenario



UK sector wells drilled offshore



Gross investment (€ million) to characterise and develop storage sites.



Low Injection Scenario:

Storage Site	Number 2050	Number 2040	Number 2030	Average fill time for storage type (years)
Onshore EOR	0	0	0	na
Offshore EOR	0	0	0	na
Onshore hydrocarbon	15	12	1	38
Offshore hydrocarbon	30	25	4	77
Onshore aquifer	63	47	12	78
Offshore aquifer	86	52	6	78
Sum	**194**	**136**	**23**	
	To 2050	To 2040	To 2030	Total
Storage Sites retired	3	0	0	3

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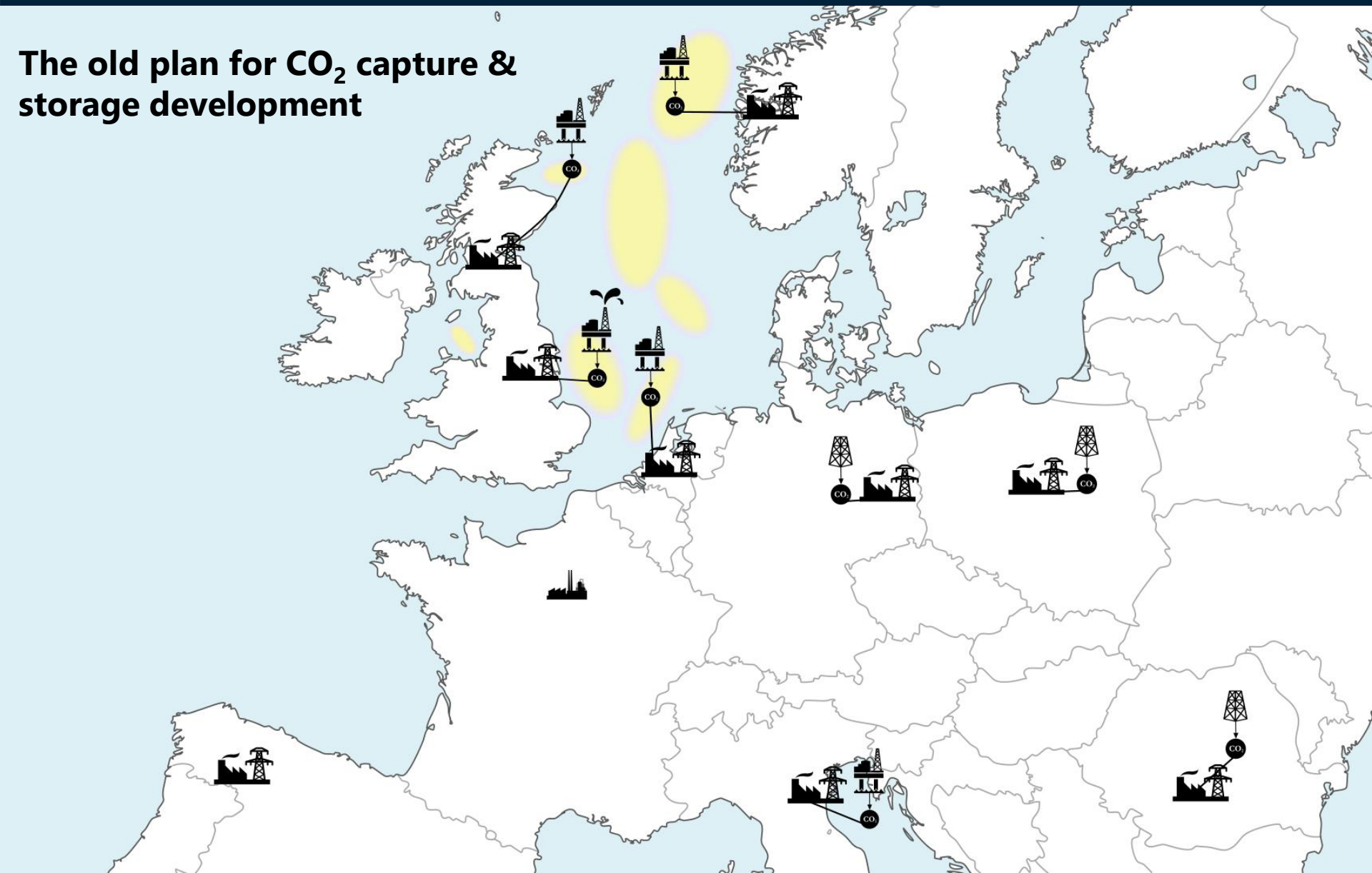
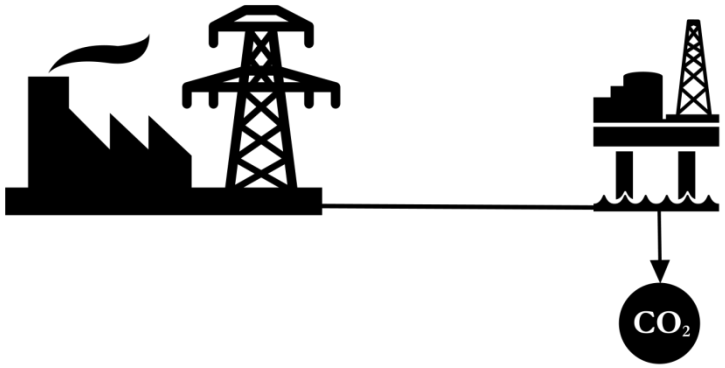
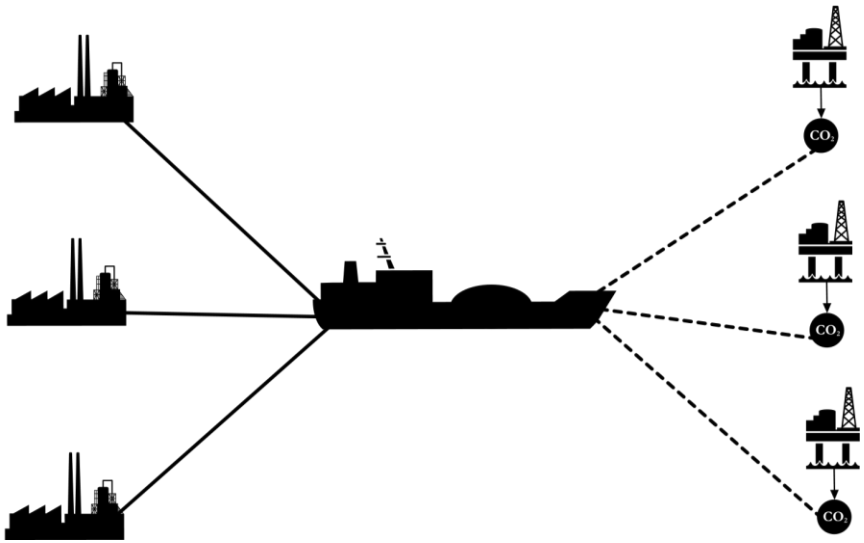
The old plan for CO_2 capture & storage development







- Continuing solely with point to point demonstration projects will not provide sufficient bankable storage capacity at the rate needed
- Strategic and Targeted development of CO_2 storage capacity is key to the future of CCS
- **Projects must be rated highly on storage and infrastructure provided**

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