Ireland’s Energy Transition

Role & Timeline of Carbon Capture & Removal Technologies

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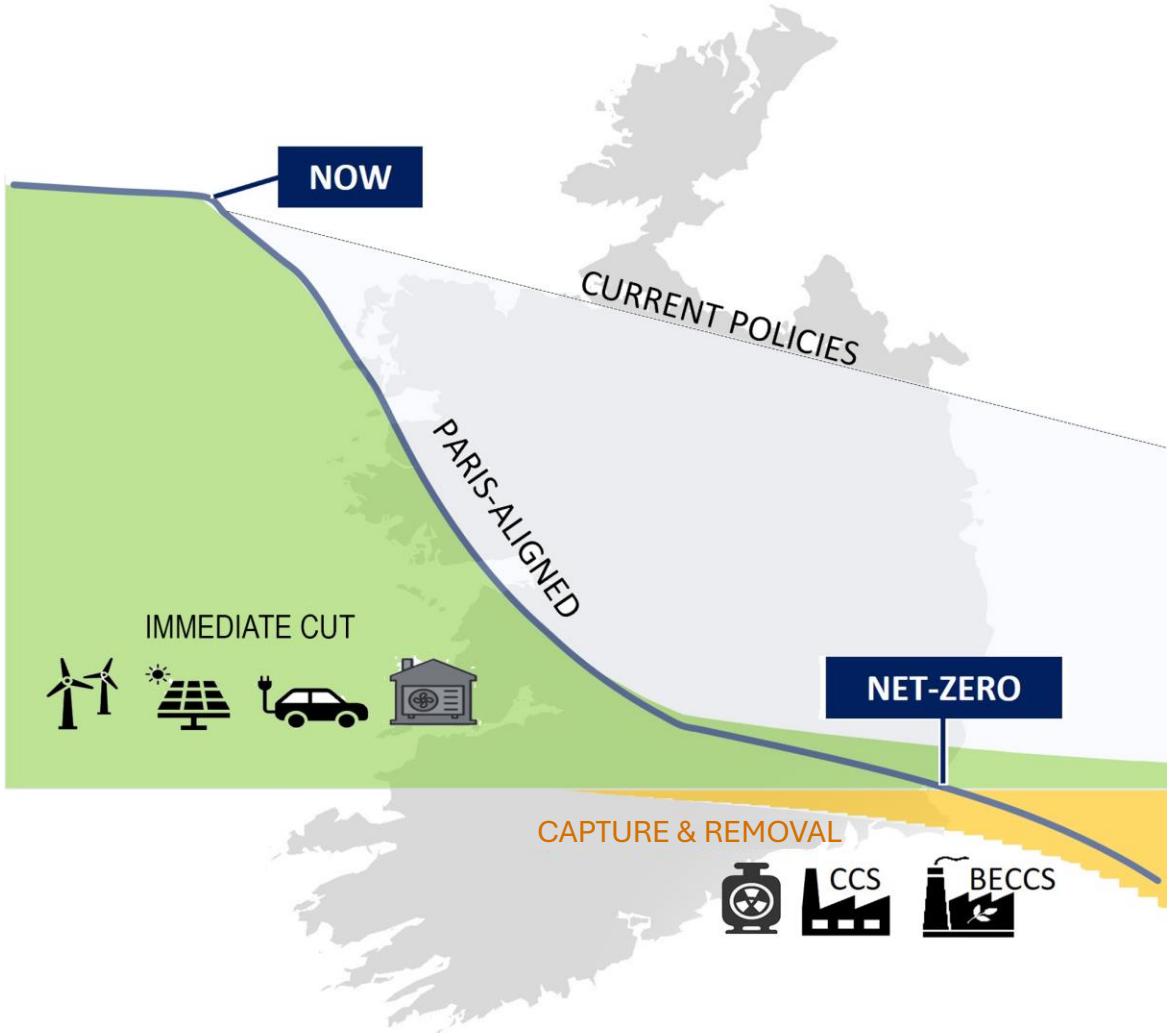
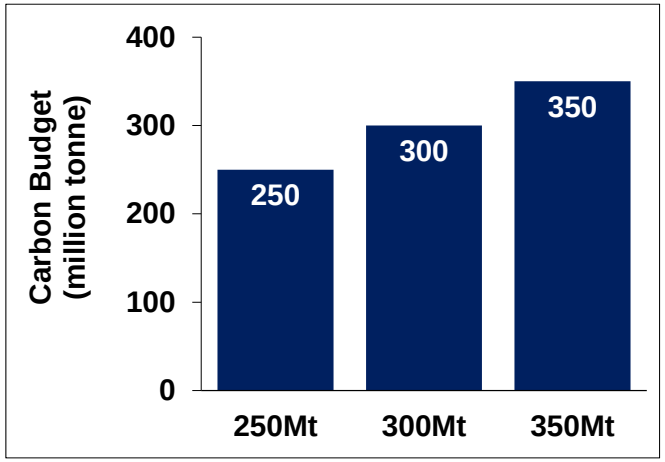


Introduction

Carbon Budget

- Global warming is driven by **cumulative** GHG emissions
- Carbon budget (CB) in this figure sets the maximum allowable CO_2 emissions from energy systems (legally binding in Ireland)
- Three CB scenarios are used with emissions limits of 250, 300, and 350 million tonnes (Mt) of CO_2 from 2021 to 2050 (align with the Paris Agreement's ambition to limit global warming to 1.5–2°C and Ireland's target of achieving net-zero by 2050)



Carbon Capture & Removal Technologies

Technologies	Type	Negative emissions?	Note
Carbon Capture & Storage (CCS)	Capture	No, reduces emissions from industry	Needed due to CB overshoot especially with delayed action. They can help return to safe temperatures and address the hard-to-abate emissions, like the last 10-15% from fossil fuels in aviation and shipping.
Bioenergy with Carbon Capture & Storage (BECCS)	Removal	Yes, net CO_2 removal	
Direct Air Capture (DAC)	Removal	Yes, pulls CO_2 from atmosphere	

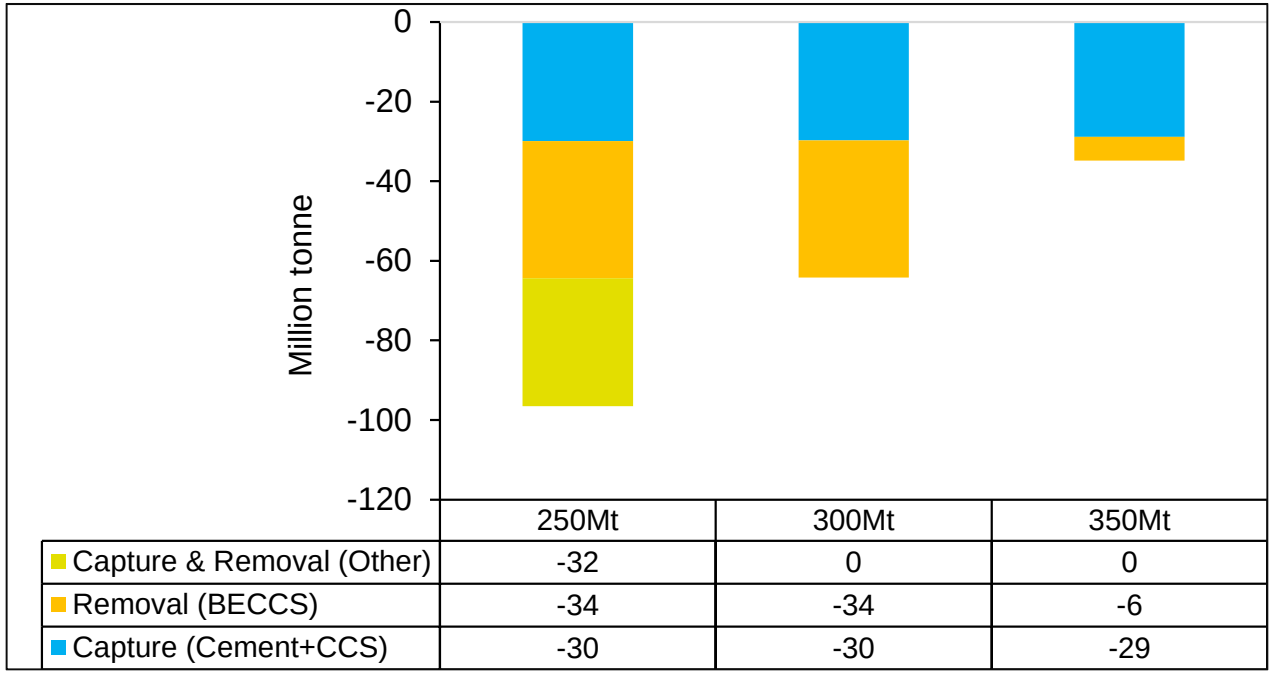
What is the Role and Timeline of Carbon Capture & Removal Technologies in Ireland's Energy Transition?

See more details on cost-effective mitigation pathways for Ireland's energy systems to 2050 and comprehensive results in different scenarios.

Carbon Capture & Removal Needs

Cumulative carbon capture & removal from 2021 to 2050:

- The most stringent scenario (250Mt) requires the highest removal—96 Mt in total
- BECCS is used mainly in the 250Mt and 300Mt cases, contributing up to 34 Mt
- Cement+CCS plays a key role in all scenarios
- Other capture and removal methods appear only in the 250Mt scenario, needing 32 Mt of cumulative removal



	250Mt	300Mt	350Mt
Capture & Removal (Other)	-32	0	0
Removal (BECCS)	-34	-34	-6
Capture (Cement+CCS)	-30	-30	-29

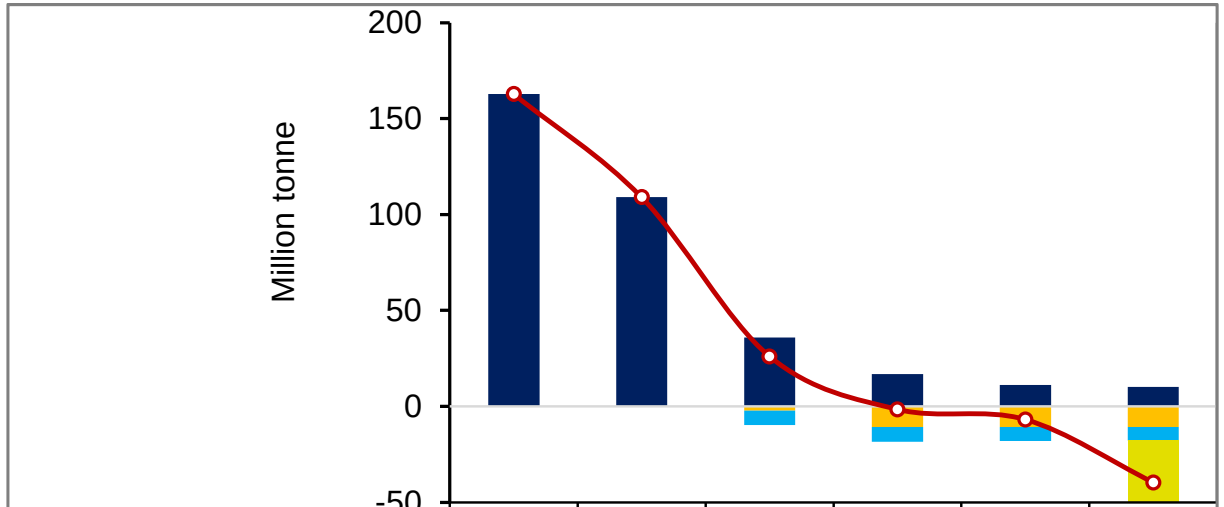
Although CCS in cement production and Other removal methods are not classified as negative emission technologies, this figure aims to illustrate the relative scale of reliance on them in different scenarios. CCS is likely to be the only measure capable of decarbonising cement production, but alternatives may emerge.

➢ **Stricter CBs need more capture & removal, while a generous budget rely less on them**

Emissions, Capture & Removal in 250Mt

5-year CB allocations set limits on emissions for each five years and show:

- Most emissions occur between 2021 and 2030 with 272 Mt emitted, exceeding the 250 Mt limit. Capture and removal later offset this excess from CB4
- Carbon capture begins in CB3
- BECCS starts in CB4, with increasing removals later
- Cement+CCS begins in CB3, capturing 7-8Mt per period
- Other capture & removal technologies are deployed only in the final period (2046–2050), with 32 Mt capacity



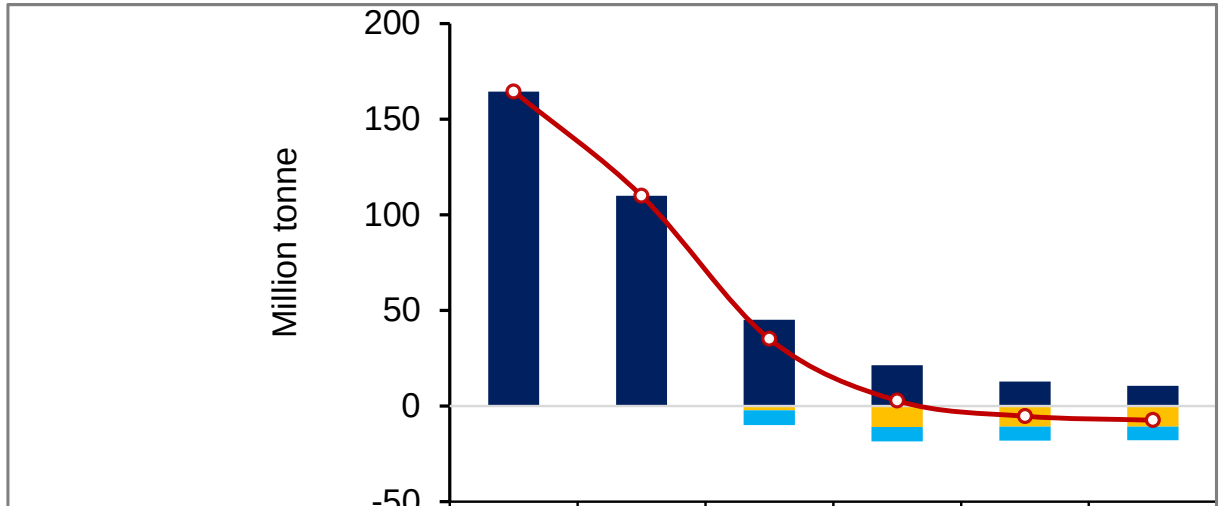
	CB1 (2021-25)	CB2 (2026-30)	CB3 (2031-35)	CB4 (2036-40)	CB5 (2041-45)	CB6 (2046-50)
Capture & Removal (Other)	0	0	0	0	0	-32
Capture (Cement+CCS)	0	0	-8	-8	-7	-7
Removal (BECCS)	0	0	-2	-11	-11	-11
Sectoral Emissions	163	109	36	17	11	10
Net Emissions	163	109	26	-2	-7	-40

➢ **BECCS and cement CCS after 2030; other removals begin post-2045**

Emissions, Capture & Removal in 300Mt

5-year CB allocations show:

- Emissions are front-loaded — 275 Mt (92%) occur by 2030
- Capture & Removal begin in CB3 via BECCS and cement CCS
- BECCS scales up after 2035, reaching 11 Mt per period
- Cement+CCS contributes consistently after 2030 (7–8 Mt per period)
- No other capture and removals are deployed



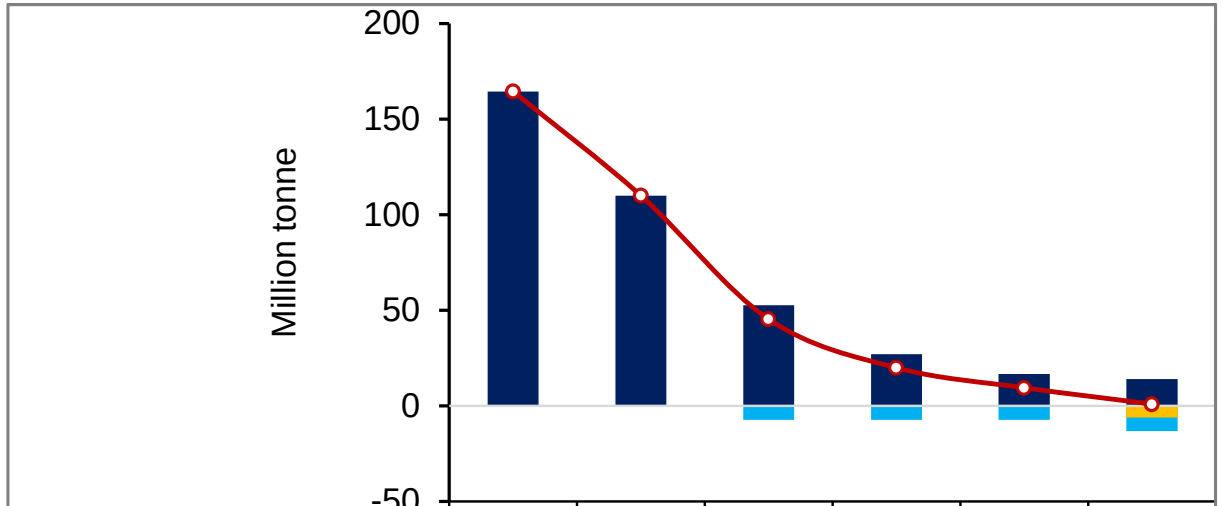
	CB1 (2021-25)	CB2 (2026-30)	CB3 (2031-35)	CB4 (2036-40)	CB5 (2041-45)	CB6 (2046-50)
Capture & Removal (Other)	0	0	0	0	0	0
Capture (Cement+CCS)	0	0	-8	-8	-7	-7
Removal (BECCS)	0	0	-2	-11	-11	-11
Sectoral Emissions	165	110	45	21	13	11
Net Emissions	165	110	35	3	-5	-7

➢ **Deep emissions cuts by 2030 are followed by removals that drive net-negative post-2040**

Emissions, Capture & Removal in 350Mt

5-year CB allocations show:

- Over 90% of emissions occur by 2035
- Cement sector CCS is the sole contributor to capturing until late 2040s
- BECCS appears only in CB6, indicating the delay of their applications in more generous CB scenario
- No other capture & removals are deployed



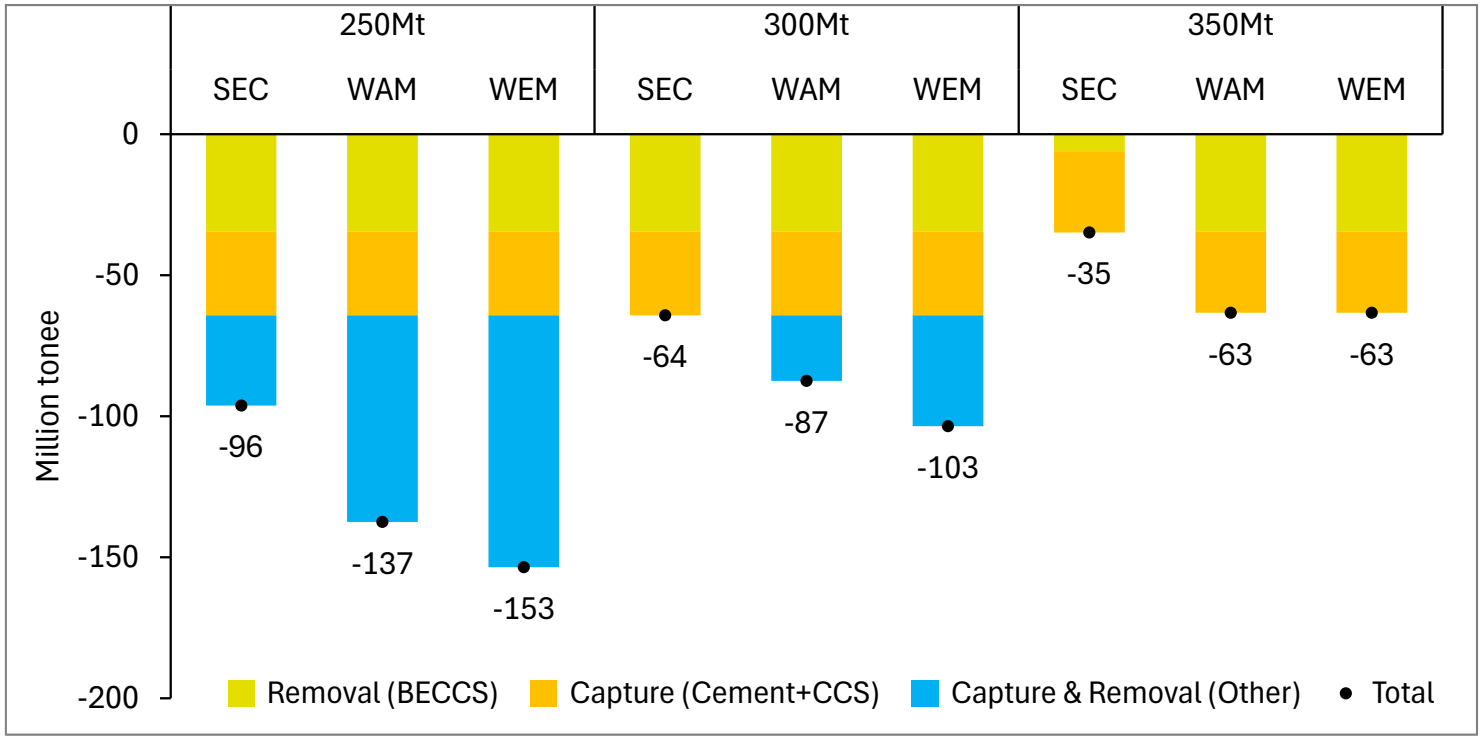
	CB1 (2021-25)	CB2 (2026-30)	CB3 (2031-35)	CB4 (2036-40)	CB5 (2041-45)	CB6 (2046-50)
Capture & Removal (Other)	0	0	0	0	0	0
Capture (Cement+CCS)	0	0	-7	-7	-7	-7
Removal (BECCS)	0	0	0	0	0	-6
Sectoral Emissions	165	110	53	27	17	14
Net Emissions	165	110	45	20	10	1

➢ **Deep emissions cuts by 2030 are followed by cement CCS after 2030**

Capture & Removal in WEM & WAM

Comparison of Sectoral Emission Ceilings (SEC) with EPA projection of future emissions With Existing Measures (WEM) and With Additional Measures (WAM) show:

- WEM & WAM consistently increase capture and removal needs across all scenarios
- WAM achieves targets with fewer removals than WEM
- BECCS and Cement+CCS are maximised under WEM & WAM in stricter budgets



➢ **Current policy trajectory (mitigation trends implied by existing and additional measures) risks making carbon budgets unachievable**

Key Takeaways

- Mitigation through renewables, electrification, demand cuts, efficiency and measures in agriculture and land use cannot be avoided or effectively be replaced through carbon capture/removal
- Capture & Removal is not part of least-cost solutions for Ireland's 2026–2030 emissions gap
- BECCS and CCS in cement may be needed, but current technologies are early-stage and face high costs, tech uncertainty, and infrastructure hurdles
- Bioenergy limits and land use conflicts constrain BECCS deployment
- Capture and removal should be a long-term tool for hard-to-abate sectors (cement and long-distance aviation), not a short-term solution
- Immediate emissions cuts are critical to avoid overreliance on costly and uncertain removals
- Current policy trajectory (WEM & WAM) risks making carbon budgets unachievable

Looking forward to hearing your thoughts—Keep in touch!

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