Rialtas na hÉireann
Government of Ireland

Summary of Analysis to Support Preparation of the Sectoral Emissions Ceilings

2022

Prepared by the Department of
The Environment, Climate and Communications
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Background

The Climate Action and Low Carbon Development (Amendment) Act 2021 provides that the Minister for the Environment, Climate and Communications must prepare, within the limits of the agreed carbon budget programme, the maximum amount of greenhouse gas emissions that are permitted in different sectors of the economy during a budget period ('sectoral emissions ceilings') and different ceilings may apply to different sectors.

The Act requires the Minister to submit sectoral emissions ceilings to Government for approval 'as soon as may be after a carbon budget takes effect'. The Government approved the Sectoral Emissions Ceilings on 28 July 2022.

Process to Prepare the Sectoral Emissions Ceilings

Following the approval of the Carbon Budgets, the Department of the Environment, Climate and Communications (DECC) engaged with relevant Government Departments and Agencies to prepare Sectoral Emissions Ceilings for Government review and approval. This engagement was informed and supported by the procurement of external technical support services, as well as modelling support from members of the Climate Action Modelling Group (CAMG).

Analysis undertaken to inform and support Climate Action Plan 2021 (published November 2021), served a starting point for establishing the Sectoral Emissions Ceilings. Through an iterative process that comprised extensive and frequent engagement with the relevant Departments and Agencies, as well as with members of the CAMG, measures and actions (including those identified in Climate Action Plan 2021) were assessed and refined to determine their emission abatement potential, while also considering various other factors and constraints such as cost, feasibility, and socioeconomic impact.

The potential measures, actions and ceilings were also assessed in terms of alignment with other sustainability goals, and effectiveness in reaching 'net zero' no later than 2050. A significant number of workshops, bilaterals, and inter-departmental meetings were held to refine the analysis, and to understand the associated delivery challenges.

The following Appendices provide detail of the analysis and research that informed the preparation of the Sectoral Emissions Ceilings.

Appendix 1: UCC Technical Analysis to Inform Development of the Sectoral Emission Ceilings

Overview

In April 2022, UCC was requested to undertake energy systems modelling analysis to inform the development of Sectoral Emissions Ceilings as part of the Government's carbon budgeting programme. This work took place under the CAPACITY project, part of the DECC-funded Climate Action Modelling Group (CAMG). UCC develops and applies several energy modelling analytical tools in order to assess the impacts of climate and energy policies and technology, market and demand dynamics.

One such modelling tool, the TIMES-Ireland Model (TIM), is an energy systems optimisation model which quantifies cost-optimal pathways for the energy system (encompassing the primary energy supply, power, transport, buildings and industry sectors) to meet future energy demands. Given projections and scenarios of future climate policies, technology and fuel costs, availabilities and efficiency and alternate energy demand futures, TIM projects energy technology investments, fuel flows and marginal energy and CO_2 abatement costs across all sectors.

The core TIMES-Ireland Model is peer-reviewed with the documentation and model inputs available open source,[1] and in 2021 UCC fed into the Climate Change Advisory Council deliberations on the national carbon budget with this model[2]. For the Sectoral Emissions Ceilings analysis in April 2022, UCC used this model to examine the following questions:

1. What energy system pathways are required for sectoral carbon budget allocations consistent with each energy system sector meeting a decarbonisation trajectory implied from the "upper ranges" in the Climate Action Plan 2021?
2. What additional efforts and investments would be required for the energy system to decarbonise should sectors be required to exceed the "upper ranges" in Climate Action Plan 2021, which would be required in the case that other sectors (Agriculture and LULUCF) did not achieve the upper target range?
3. What is the role of lower energy demands and/or potential technology breakthroughs to 2030?

Full results of the study are available on an interactive web-app: https://epmg.netlify.app/tim-carbon-budgets-2022/results/

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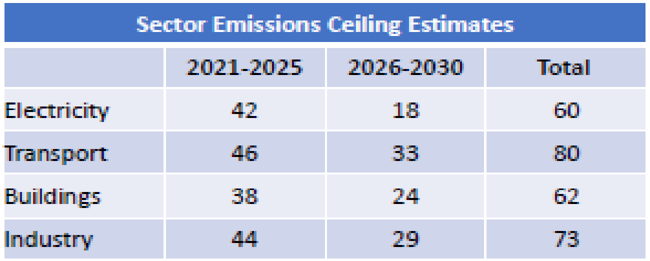
[1] Balyk, O., Glynn, J., Aryanpur, V., Gaur, A., McGuire, J., Smith, A., Yue, X., and Daly, H.: TIM: modelling pathways to meet Ireland's long-term energy system challenges with the TIMES-Ireland Model (v1.0), Geosci. Model Dev., 15, 4991–5019, https://doi.org/10.5194/gmd-15-4991-2022, 2022

[2] https://www.climatecouncil.ie/carbonbudgets/carbonbudgetscommittee/

Scenario Outline

Core assumptions related to sectoral carbon budgets are outlined below, which were derived by UCC from sectors meeting the upper ranges of proposed 2030 targets in Climate Action Plan 2021 (CAP21)



Sector Emissions Ceiling Estimates

	2021-2025	2026-2030	Total
Electricity	42	18	60
Transport	46	33	80
Buildings	38	24	62
Industry	44	29	73

Scenario names (for example, “*Reduced Sectoral CBs (HL)*”), refer to key scenario dimensions:

- Whether the carbon budgets is applied to individual energy sectors or the energy system as a whole without sectoral constraints (“*Sectoral CBs”/”Whole System CBs*”).
- Whether energy system carbon budgets are reduced (“*Reduced*”), to reflect a scenario where the agriculture sector met a reduction target of 22% rather than 30% by 2030 relative to 2018, which reduces the carbon budget available to the energy system by 12 $MtCO_2eq$.
- Whether alternative futures for energy demand and technology are assumed:
  - *“HL”* - Lower energy service demands relative to BAU: transport reduction and mode shifting; lower cement, heating, data centre demands, informed by Gaur et. al, (2020)[3]
  - “*TO*” more optimistic technology outlooks are assumed: Up to 25 GW variable renewable electricity by 2030, H2 import, bioenergy import x3 times 2018 by 2030, CCS (including BECCS available from 2027.

UCC is currently refining the study to take account of adopted sectoral carbon budgets, the ongoing energy price situation, and the short-term outlook for renewables deployment ahead of submitting the study for peer review.

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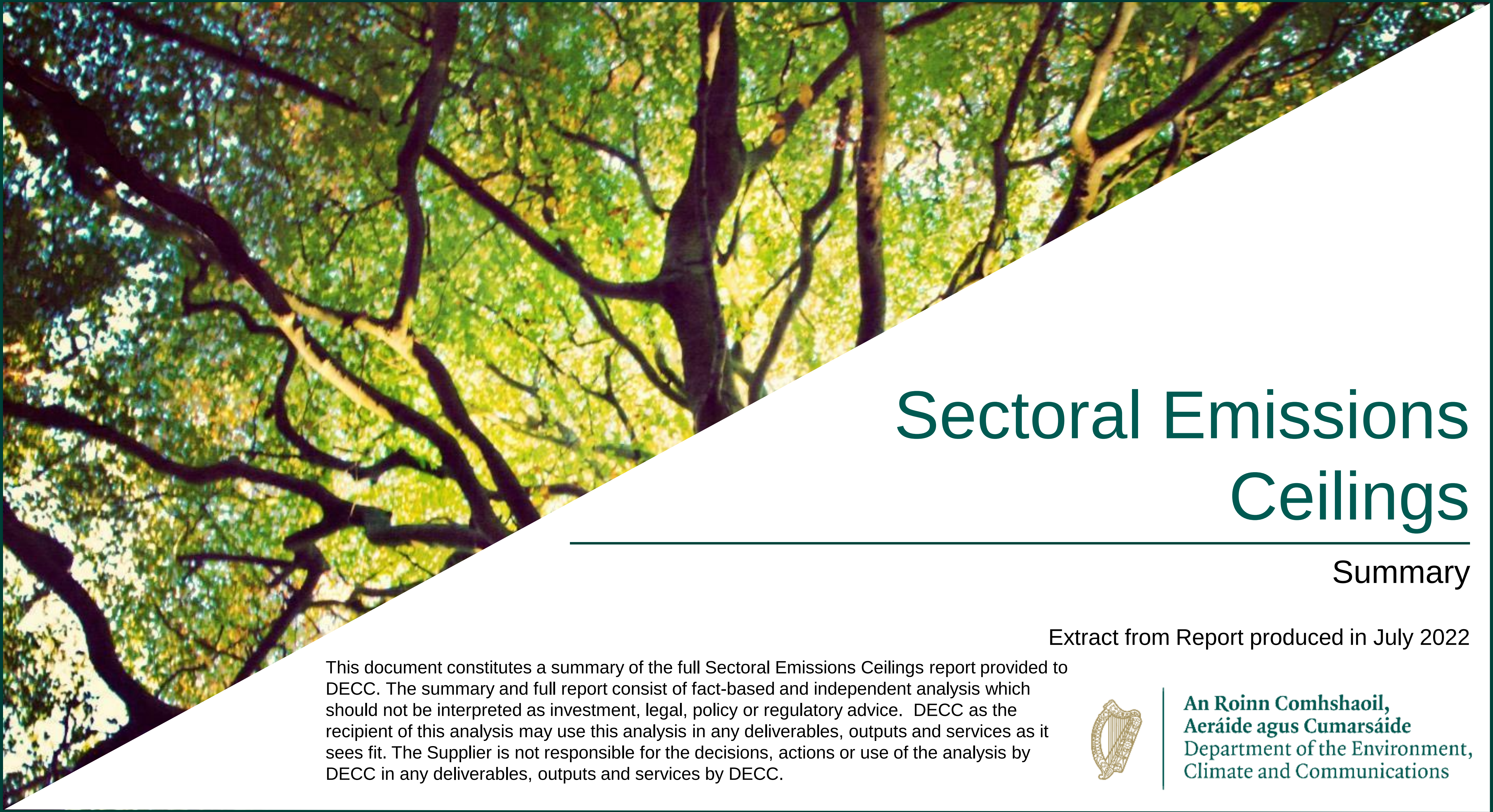
[3] Low energy demand scenario for feasible deep decarbonisation: Whole energy systems modelling for Ireland https://doi.org/10.1016/j.rset.2022.100024

Appendix 2: Technical Analysis by McKinsey and Company

A summary of the technical analysis provided by McKinsey and Company follows. This analysis supported and informed the process to develop the Sectoral Emissions Ceilings.



Sectoral Emissions Ceilings

Summary

Extract from Report produced in July 2022

This document constitutes a summary of the full Sectoral Emissions Ceilings report provided to DECC. The summary and full report consist of fact-based and independent analysis which should not be interpreted as investment, legal, policy or regulatory advice. DECC as the recipient of this analysis may use this analysis in any deliverables, outputs and services as it sees fit. The Supplier is not responsible for the decisions, actions or use of the analysis by DECC in any deliverables, outputs and services by DECC.

An Roinn Comhshaoil, Aeráide agus Cumarsáide
Department of the Environment, Climate and Communications

Key messages (1/2)

- **Carbon budgets:** Delivering The Climate Act and meeting the EU 'Fit for 55' ambition will require a step-change in pace of emissions reductions.
    - The first two budgets require **a 51% reduction in GHGs** by 2030.
    - Ireland has **delivered 0.5% of annual emissions reductions since 2010**, so the Climate Act targets require an acceleration.
    - The economy-wide carbon budgets are closely aligned with targets for emissions reductions by 2030 vs. the 2005 baseline set by the EU 'Fit **for 55**' package. Ireland is marginally ahead of its ESR obligation (~45% vs. 42%) but in line with its ETS obligation (~61% reduction)
- **Sectoral emission ceilings:** The proposed **scenario results in a ~45% reduction by 2030** and meets the carbon budgets laid out in the Climate Act using 'unallocated savings' of ~4MT per year. The proposed sectoral emissions ceilings are **closely aligned to those put forward by CAMG partners** including the UCC MaREI modelling team
- **Evaluation:** The proposed sectoral emissions ceilings were compared based on a **high-level assessment of their cost, feasibility, socioeconomic impact**, as well as alignment with **other sustainability goals** and ability to serve as a stepping-stone to **net zero by 2050**
    - **Cost:** Delivering this pathway will require a major **investment of ~€119bn by 2030**, focused on the **Electricity (€~36bn), Transport (€~42bn) and Buildings (€~31bn)** sectors. Alternative scenarios with reduced ambition in agriculture result in higher total economy costs (e.g. required building of CCS infrastructure)
    - **Feasibility:** Delivering these measures implies a major **step-up in key decarbonisation activities** across sectors, such as a 5x increase in installed solar capacity required by 2030 compared with today. However, **costs of key low-carbon technologies have reduced significantly** over the last 5 years (e.g. solar PV reduction of ~50%) and there is a **favourable environment** (e.g. ETS pricing increase)

Key messages (2/2)

- **Socio-economic:** The distributional impacts of the emission ceilings will be **determined by policy design.** Given similar contexts, Ireland may consider analysis of the UK's 6th carbon budget which suggests it will **have net positive impacts** on job creation, with net annual costs (<1% GDP in UK) that are significantly offset by co-benefits (e.g. environmental, health).
  - **There is potential for net employment increase,** likely to be driven by **renewables build-out and retrofits/heat pump activity** in buildings sector. **Agriculture is the only sector with likely net job losses** (potentially ~4-5k net decrease), driven by cattle diversification requirements
  - **The Irish economy** is well positioned to capture value from the net zero transition, especially across **low-carbon products** (e.g. alternative proteins) and supporting services (e.g. finance, design).
  - **Household spending could increase marginally as a result of the transition**, driven by increased cost of utilities (e.g. cost of retrofits, heat pumps). This is significantly offset by reduced private transportation costs
- **Delivery challenges:** Delivering the sectoral emission ceilings will require a **major step-up in key decarbonisation activities** across sectors in the near term.
  - **There is precedent of governments moving at similar pace.** Countries across Europe have scaled up technologies and ramped down emissions faster than what will be required of Ireland to 2030
  - **Intensive collaboration will be required** across departments within government and with stakeholders across the economy
- Going forward, Departments will need to **design the policies** required to achieve the sector emissions ceilings and the **delivery infrastructure** will have to be updated to enable implementation at pace

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Objective of this work is to inform sectoral emissions ceilings and support the development of the cross-government delivery approach

PRELIMINARY

Context: Climate Act and Climate Action Plan 2021

- Oireachtas has adopted the carbon budgets as recommended by the Climate Change Advisory Council. The **first two budgets require a 51% reduction in GHGs by 2030** (made-up of a ~4.8% p.a. emissions reduction from 2021-25 and a ~8.3% p.a. reduction from 2026-30)
- **The Climate Action Plan 2021 sets a potential pathway to a 51% reduction in GHGs by 2030[1]** as well as to net-zero by 2050. However, this pathway:
  - Requires implementation of both Core Measures and Further Measures
  - Relies on up to 4 Mt CO2e of unallocated savings
  - Uses ranged 2030 sector targets and did not prescribe cumulative emissions ceilings
  - Could encounter headwinds in calculation of emissions from Agriculture & LULUCF sectors
- **Next step under the Climate Act is for Minister to prepare and submit to government 'sectoral emissions ceilings'** (in consultation with other Ministers)

Objective of this work: Sectoral emissions ceilings & delivery approach

- Provide input to Minister in setting **sectoral emissions ceilings**:
  - Identify the sectoral emissions ceilings implied by the full delivery of Climate Action Plan 2021
  - Develop alternative sectoral emissions ceiling scenarios and assess based on cost, feasibility, socioeconomic impact
  - Engage with relevant stakeholders to syndicate and refine
- Advance **delivery approach**:
  - Identify **required measures** to meet ceilings (i.e., mix of demand mgmt., technology adoption and fuel switching) and share **examples of government action** taken to deliver in other contexts
  - Define **cross-government delivery approach**, including governance and delivery structures
  - **Ensure continued capability building** on modelling and delivery

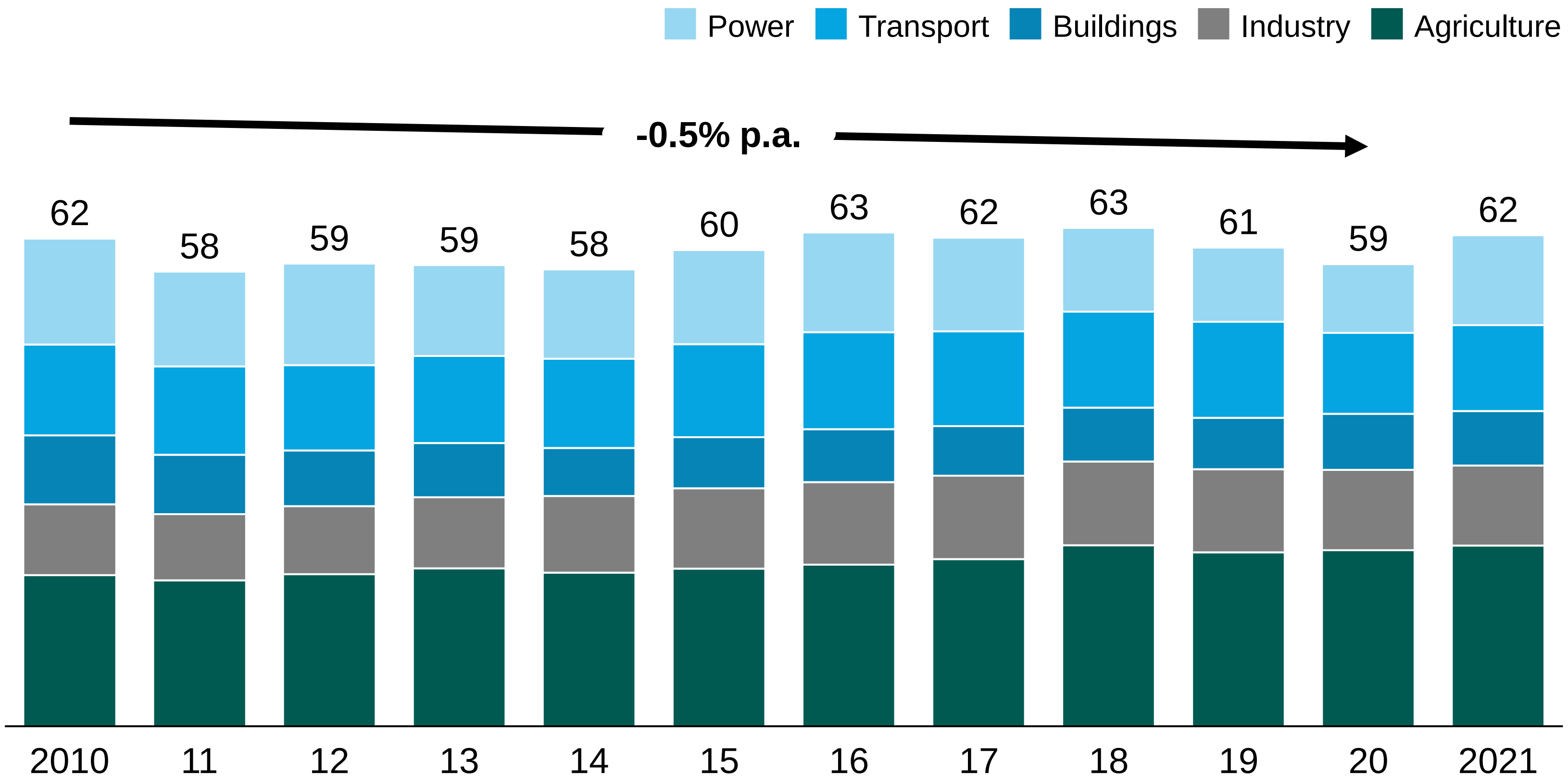
Next steps: Policy measures, actions, and implementation

- **Define precise policy measures and actions** to take in each sector to meet ceilings. Policies to be informed by:
  - Cost to **exchequer**
  - **Socio-economic implications of policy design choices**
- **Drive implementation in line with cross-government delivery approach**

Source: Climate Action and Low Carbon Development (Amendment) Act 2021; Climate Change Advisory Council; CAP21

Ireland starts with a challenging backdrop of limited GHG emissions reductions since 2010

Greenhouse gas emissions (excl. LULUCF) with Climate Action Plan 2021 Core and Further Measures[1], MtCO2eq



Note: Excludes LULUCF

1. GHG emissions based on AR5 2021 EPA methodology

Source: CAP21; Programme for Government 2020

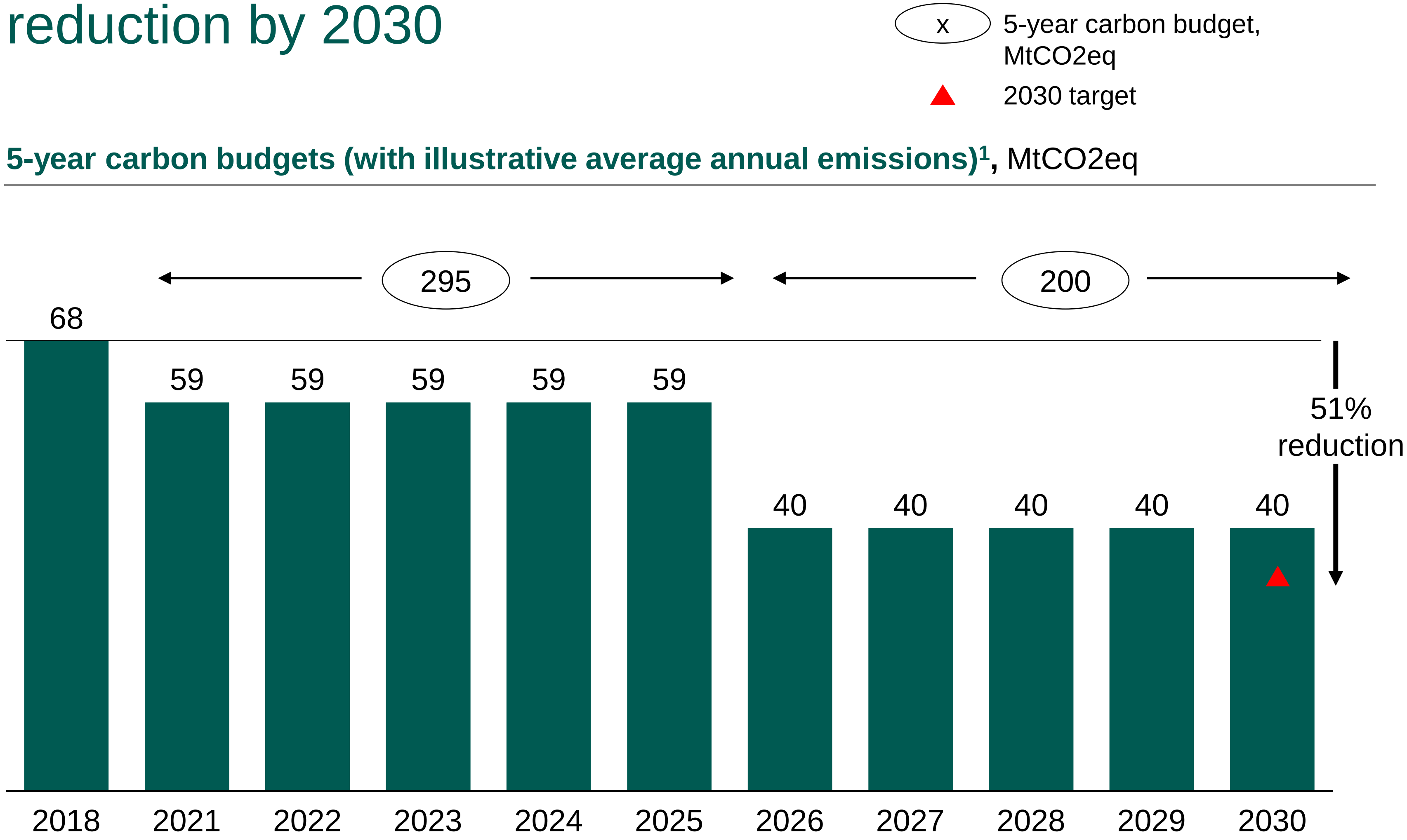
Commentary

Average emissions reduction of only 0.5% per annum from 2010-2020

Significant deviation from BAU emissions across sectors is required to meet 51% economy-wide target for 2030 and further net zero target in 2050

Since CAP21, Oireachtas adopted 5-year carbon budgets; first two budgets suggest a 51% emissions reduction by 2030

5-year carbon budgets (with illustrative average annual emissions)[1], MtCO2eq



The CCAC also recommended an indicative budget for 2031-2035 of 151Mt

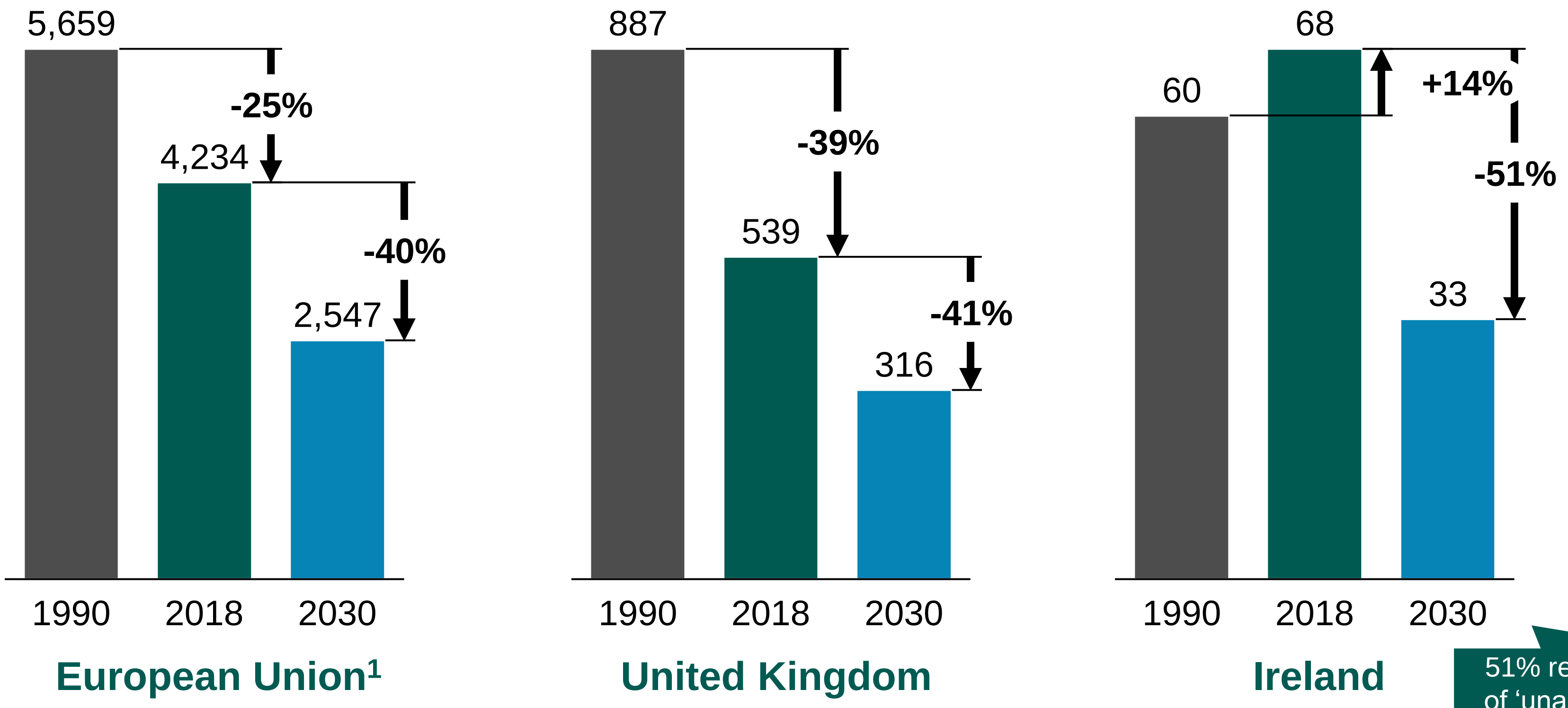
In addition, CCAC outlined potential to ‘borrow’ future LULUCF sequestration

1. Including LULUCF

Source: Climate Change Advisory Council: Technical Report on carbon budgets (25.10.2021)

A more aggressive reduction trajectory will allow Ireland to meet its 2030 ambitions, which are in line with EU Fit for 55 plans and the UK's 6th carbon budget

Proposed GHG Emissions Reduction Trajectories, MtCO2eq



51% reduction to 2030 assumes 4MT of 'unallocated savings' per year from 2021-2030

1. EU figures exclude LULUCF

Source: Climate Change Advisory Council: Technical Report on carbon budgets (25.10.2021); EPA "Ireland's provisional Greenhouse Gas Emissions", 2020; UK CCC The Sixth Carbon Budget, 2020; EEA "Annual European Union Greenhouse gas inventory 1990-2018 and inventory report 2020" 2020.

Ireland's 2030 ambitions are in line with those set out by the EU Fit for 55 and the UK CCC

However, Ireland has made significantly less progress since 1990 in comparison to the EU and UK

As a result a **more aggressive reduction trajectory** for the period 2021-2030 could help Ireland meet 2030 its ambitions

The proposed sectoral emission ceilings have been developed in consultation with a wide range of stakeholders

Government departments (incl. relevant agencies)

- Department of Finance
- Department of Public Expenditure and Reform
- Department of Agriculture, Food and the Marine
- Department of Enterprise, Trade and Employment
- Department of Housing, Local Government and Heritage
- Department of Transport
- Department of Environment, Climate and Communications
- Department of the Taoiseach
- Department of Public Expenditure and Reform

Analytical input

- SEAI
- Climate Action Modelling Group (CAMG)
    - University College Cork
    - Economic and Social Research Institute
    - EnvCon Decision Support
    - UCD Energy Institute

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‘CAP 21 Core and Further Measures’ were identified as the most suitable emission ceiling scenarios to comply with the carbon budgets

▨ Focus

Scenario	Implications
1. CAP 21 Core and Further Measures Top of emissions reduction range agreed in CAP 21	🟡 Meets carbon budgets 2021-2030 (using ~4Mt ‘unallocated savings’) 🟢 Pathway selected to optimize for economy-wide cost, feasibility, socio-economic impact, contribution to other sustainability goals and ability to serve as stepping stone to 2050 net zero goals
2. Consistent across sectors *51% reduction applied to all sectors*	🟢 Meets carbon budgets 2021-2030 🔴 Pathway does not optimize for economy-wide cost, feasibility, socio-economic impact, contribution to other sustainability goals or ability to serve 2050 net zero goals 🔴 Large reductions in hard-to-abate sectors have high risk given reliance on unproven technology and demand management.
3. CAP 21 Core Measures Bottom of emissions reduction range in CAP 21	🔴 Does not deliver either of first two carbon budgets or 51% emissions reduction by 2030 🔴 Does not support path to net zero by 2050
4. CAP 21 Core and Further Measures outside Agriculture Top of emissions reduction range in CAP 21 for all sectors outside of agriculture	🔴 Does not deliver either of first two carbon budgets or 51% emissions reduction by 2030 🔴 Does not support path to net zero by 2050
5. Delivery of Climate Act 2021 Core and Further Measures from CAP 21. Additional measures to meet carbon budgets	🟢 Meets carbon budgets 2021-2030 (without using ‘unallocated savings’ mechanism) 🟡 Requires increasing ambition vs. CAP 21 for: zero-emissions gas, district heating, agriculture (incl. diversification)

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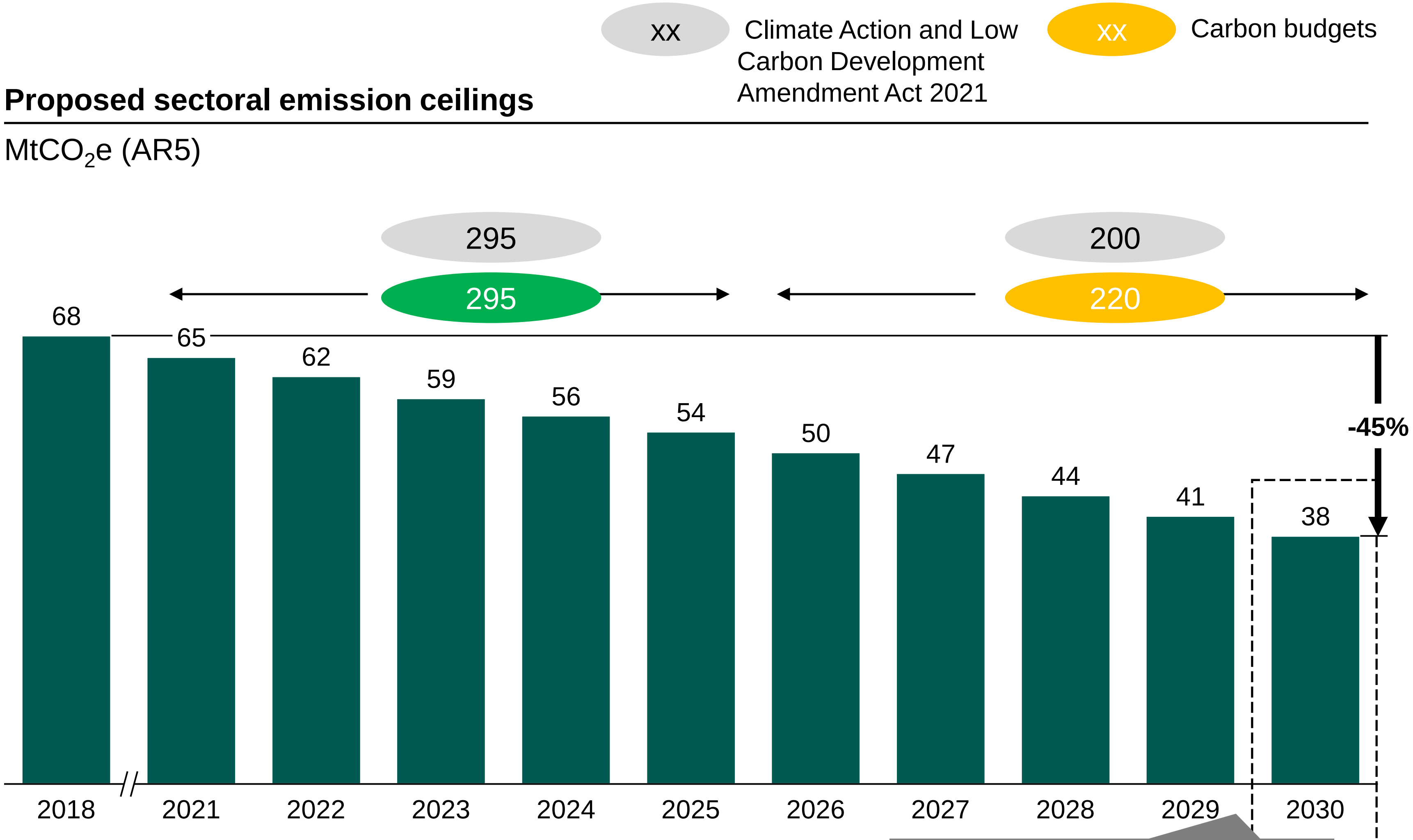
1. Assumes €55- €110/t abatement cost in line with Global CCS Institute assumptions

Source: CCS Global Institute; CCS Cost Model; K. Hanrahan, T. Donnellan & G.J. Lanigan. “Scenarios For Agricultural GHGs” 2019

The reduction pathway applying CAP21 Core and Further Measures results in ~45% reduction by 2030

Proposed sectoral emission ceilings

MtCO$_2$e (AR5)



LULUCF emission estimates under review. Emission ceilings may be reviewed following Land Use Review

Source: Internal analysis

Reduction pathway in Climate Action Plan 2021 results in -45% reduction by 2030

Meeting the target of -51% and the second carbon budget requires:

- Full implementation of Core and Further Measures from Climate Action Plan 2021
- Full impact of unallocated savings (up to 4Mt CO2e)

The proposed sectoral emission ceilings meet the carbon budget from the Climate Delivery Act by using 4MT CO2e of unallocated savings

	GHG emissions, $MtCO_2e$ (AR5)			% change 2030 vs. 18	% impact in CAP 2021	Carbon budgets, $MtCO_2e$	
	2018	2025	2030			2021-2025	2026-2030
Electricity	10	6	3	~75	60-80	40	20
Transport	12	10	6	~50	40-50	54	37
Buildings (residential)	7	5	4	~40	35-50	29	23
Building (commercial)[1]	2	1	1	~45	45	7	5
Industry	7	6	4	~35	30-40	30	24
Agriculture	23	20	16	~30	20-30	106	90
LULUCF[2]	5	3	2	~50	40-60	19	14
Other[3]	2	2	1			9	8
Sub-total	68	54	38	~45		**295**	**220**
Unallocated savings[4]			-4	~-6		0	-20[4]
Total	68	54	34	~51		**295**	**200**

Aligned with the Climate Action and Low Carbon Development Amendment Act

1. Includes public sector buildings; 2 Assumes 4.8 Mt baseline emissions in 2018 for LULUCF as per CAP21, pending revisions to be released by the EPA in 2022' 3 F-Gases, waste & Petroleum refining; 4 Unallocated savings of 4MT per year assumed from 2026-2030

CAP21 and further measures: The proposed emission ceiling scenarios require a step change in technology ramp up across sectors (1/2)

🟨 xx Demand management

	Measures	Measurement	KPI 2030
Electricity	E1 Phase in renewable energy	Share of renewable electricity %	75-80 –
		Indicative onshore wind capacity, GW[1]	Up to ~8
		Indicative offshore wind capacity, GW[1]	~5
		Indicative solar PV capacity, GW	~>2
	E2 Zero-emission gas generation	TWh generated	~0.5
Transport	T1 Electrify road transport: accelerated adoption of zero-emission passenger cars and commercial vehicles	Passenger EVs, #	950k passenger EVs with focus on BEVs
		Zero emissions vans and heavy goods vehicles, #	~95k vans and ~3.5k heavy goods vehicles
	T2 Increase biodiesel blend-rates	Bioethanol blend, Vol%	E10
		Biodiesel blend, Vol%	B20
	T3 Electrify mass transportation	Transport modes transitioned to low-carbon	1.5k EV buses and expanding electrified rail services
	🟨 T4 Sustainable transport journeys and demand management measures	Demand shifts	Flat demand, which means a 15.5% reduction in passenger vehicle kilometres vs do nothing
	🟨 T5 Additional emission reductions	For example, reduction of vkm travelled	To be defined
Residential Buildings	B1 Retrofit residential dwellings and deploy zero-emission heating in existing homes	Retrofitted homes[2], # dwellings	500,000 retrofitted homes (B2 BER /cost optimal equivalent or carbon equivalent)
		Existing homes with heat pumps heating, # dwellings	~400k heat pumps in residential dwellings
	B2 Continue to phase out fossil fuels in new homes	New homes with heat pumps, # dwellings	+280k new homes with heat pumps and zero new gas connections established in new homes beyond 2025
	B3 Increase targets for roll-out of district heating	District heating demand, TWh	2.5 TWh of district heat supplied e.g., ~200-220k homes connected to district heating network
	B4 Blend in zero-emission gas for fuel use in buildings	Consumption of zero-emission gas, TWh	0.7 TWh consumption of zero-emission gas[3]

1. RESS competitive auctions will determine the final generation mix; 2. Only additional installments, excluding existing building stock with applied technology; 3. Representative share of 5.7TWh of biomethane production. Revised downwards from 1-3TWh identified in CAP21 to avoid double counting across sectors

CAP21 and further measures: The proposed emission ceiling scenarios require a step change in technology ramp up across sectors (2/2)

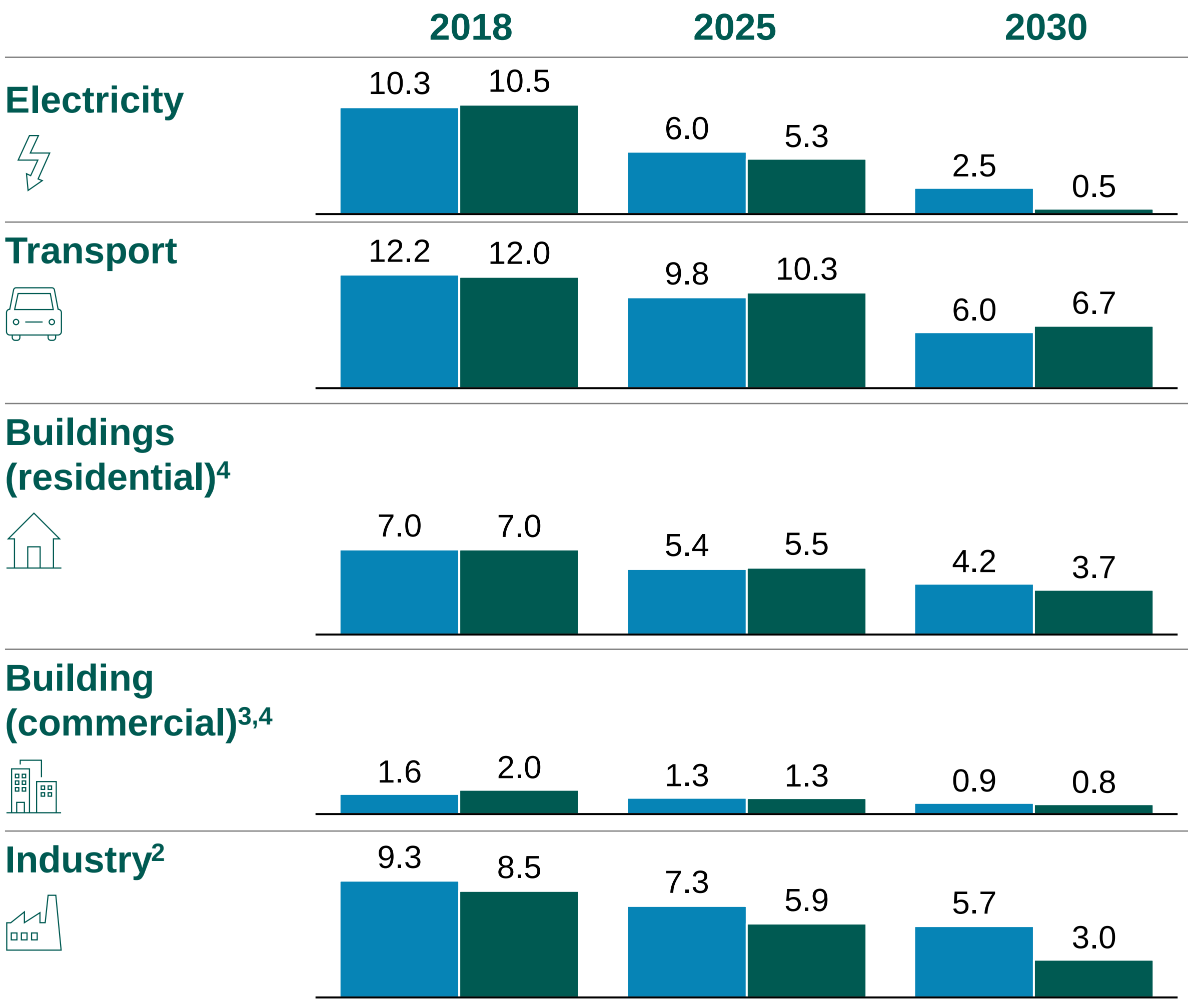
xx Demand management

		Measures	Measurement	KPI 2030
Commercial buildings	C1	Zero-emission heat in commercial buildings	Number of buildings with zero-emission heating	Number of buildings with heat pumps: ~55k
	C2	District heating in commercial buildings	District heating demand in TWh	Energy demand in TWh: ~0.2
Industry	I1	Accelerate uptake of carbon-neutral heating in industry	Share of carbon neutral heating in total fuel demand, %	~50-60% share of carbon neutral heating in total fuel demand (excluding measures I3, I4 and I6)
	I2	Phase-out high-GWP F-Gases	Emission reduction vs 2014, %	-80% emissions versus 2014 (in line with EU policy)
	I3	Decrease embodied carbon in construction materials	Emissions from non-metallic mineral products by 2030	Demand remains flat to 2030, 30% decrease vs ‘do nothing’ scenario
	I4	Enable electrification of high-temperature heat generation	Emission reduction of non-ferrous metals manufacturing vs 2018	100% of steam production from gas-electric hybrid heating
	I5	Decrease embodied carbon in construction materials	Consumption of zero-emission gas, TWh	~2.1 TWh consumption of zero-emission gas
Agriculture & LULUCF	A1	Increase adoption of GHG –efficient farming practices	Adoption rate	~1.5x Climate Action Plan 2019 ramp up
	Example submeasures	Reduction in nitrous oxide emissions		< 325kt nitrogen use, replacement of ~65% of ammonium nitrate through urea, reach ~90% uptake of low emission slurry spreading
		Improved animal breeding		Increase suckler beef weight/dairy herd recording to 70/90%
		Improved animal feeding		Reduce crude protein content of livestock food
		Early finishing age of cattle		Reduce average age of slaughter to 24 months
		Increasing organic farming		Increasing organically farmed area to ~350kha
	A2	Create new biomethane business opportunities	Biomethane production in TWh	~5.7 TWh total production of bio-methane, 4.7TWh from grass silage AD supplemented with 1TWh from food waste and pig slurry
	A3	Further technical measures	Advanced manure management	30% uptake of extended grazing techniques
			Electrification of tractors	3% of tractor vehicle stock are battery electric vehicles
	A4	Diversification implied by CAP21	Diversification from afforestation	72,000ha implied land use change
			Diversification from biomethane production	199,000ha implied land use change
	A5	Additional diversification	Additional diversification	To be determined

The proposed sectoral emissions ceilings are aligned closely to those developed by UCC’s MaREI model

🟦 Proposed Sectoral Ceilings 🟩 MaREI Low Energy Demand Halfway Scenario

GHG emissions Ceilings[1,5], MtCO2eq (AR5)



Differences in assumptions

	Proposed Ceilings	MaREI whole system CB (HL scenario)
Electricity	• Offshore wind: 0GW by 2025, 5GW by 2030 • Onshore wind: 8GW by 2030 • Solar: ~1GW by 2025, ~2GW by 2030	• Offshore wind: 2.1GW by 2025, 7.6GW by 2030 • Onshore wind: 6.1GW by 2025, 7GW by 2030 • Solar: 1.2GW by 2025, 3GW by 2030
Transport	• BEV share of car sales: 100% in 2030 • Decrease in passenger car kilometres by 15.5% relative to BAU by 2030	• BEV share of car and van sales >95% by 2028 • Decrease in passenger car kilometres by 21% relative to BAU by 2030
Buildings (residential)[4]	• District heating supplied: 2.5TWh by 2030 • Reduced coal and peat heating to continue through 2030	• District heating supplied: 21k new homes by 2030 • Zero coal or peat heating from 2026 onwards
Building (commercial)[3,4]	• District heating supplied: ~0.2TWh by 2030	• District heating supplied: 0TWh by 2030
Industry[2]	• Cement demand remains flat to 2030, 30% decrease vs ‘do nothing’ scenario • 12% of energy used in industry from bioenergy sources by 2030	• Industrial energy demand (including cement demand), 25% decrease vs ‘do nothing scenario’ to 2050 • 25% of energy used in industry from bioenergy sources by 2030

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1. GHG emissions and abatement impact based on AR5 2021 EPA methodology; 2. Including waste management; 3. Includes public sector buildings; 4. Excludes buildings cooking and other energy use; 5. UCC MaREI model excludes agriculture or LULUCF;

Source: CAP21; Programme for Government 2020; Balyk, O., Glynn, J., Aryanpur, V., Gaur, A., McGuire, J., Smith, A., Yue, X., and Daly, H.: TIM: Modelling pathways to meet Ireland’s long-term energy system challenges with the TIMES-Ireland Model (v1.0), Geosci. Model Dev. Discuss. [preprint], https://doi.org/10.5194/gmd-2021-359,

The proposed sectoral emission ceilings are aligned with the EU Fit for 55 targets

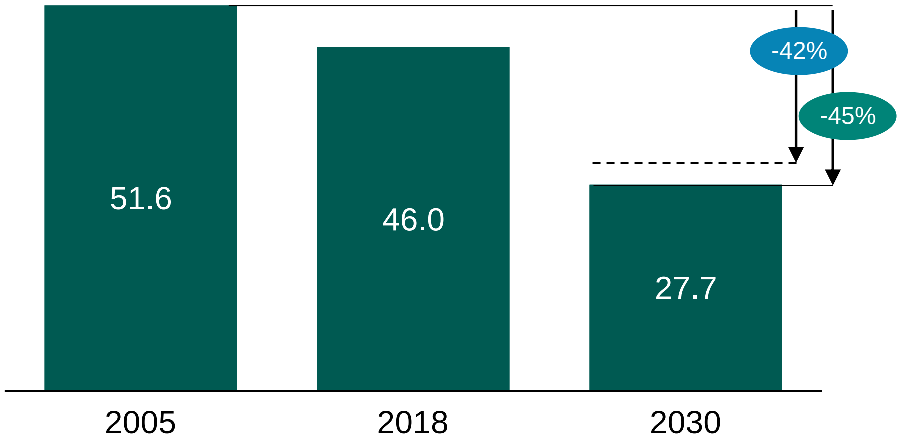
● Target proposed for Ireland by EU Fit for 55 Plan

● Target proposed for Ireland by emissions ceilings

Ireland's ESR and ETS emissions trajectory as proposed by emissions ceilings, $MtCO_2eq$

Commentary

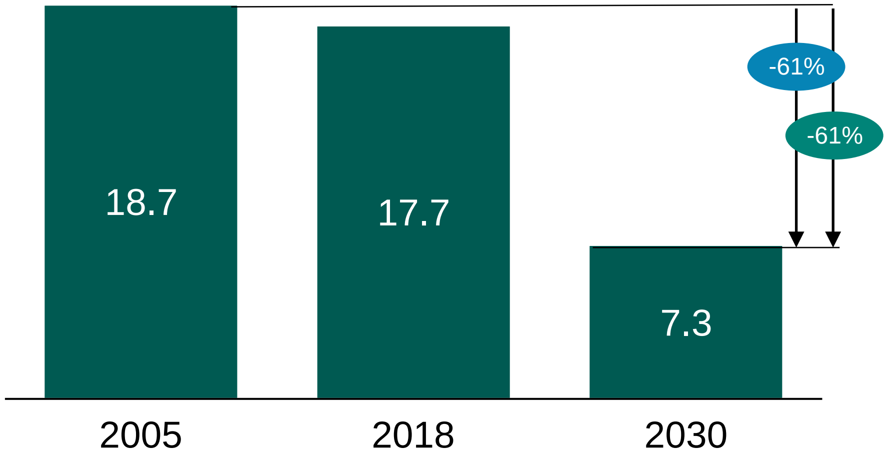
Effort Sharing Regulation (ESR)[1]



Proposed emissions ceilings outline a **reduction in ESR emissions of 45% by 2030**, compared to 2005, which is marginally greater than the target set for Ireland by EU Fit for 55 of a 42% reduction

<u>Financial cost of not meeting targets</u>: Note EUR50m fine already incurred for not meeting Renewable Energy Directive obligations in 2020

Emissions Trading System (ETS)[2]



Proposed emissions ceilings outline a reduction in **ETS emissions of 61% by 2030**, compared to 2005, which is aligned with target set for Ireland by EU Fit for 55

1. ESR includes all non-ETS emissions excluding LULUCF 2. ETS includes all emissions from large industry and electricity generation;

Source: CAP21; EPA, Ireland's Provisional Greenhouse Gas Emission Inventory Report 1990-2019, 2020; EU Fit for 55;

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Evaluation

Sectoral deep dives

Potential emission ceiling pathways were evaluated across five dimensions

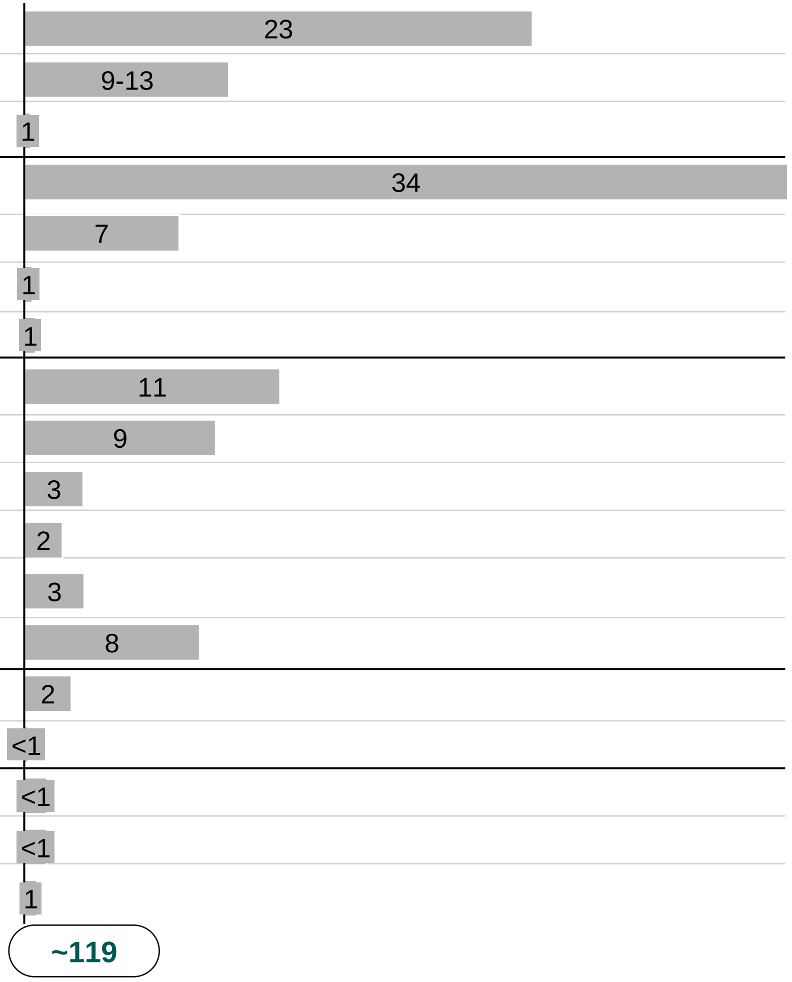
🟩 Deep dives in following sections

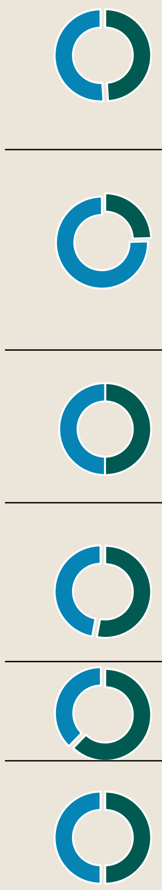
Dimension	Question considered	Approach
Total system cost	What is the **cost implication** of the measure taking TCO parity and carbon taxation into account? Who typically bears this cost?	The **least cost pathway** model was developed in collaboration with CAMG partners and optimizes total system cost
Feasibility	Can the measure be **implemented in the 2030 time horizon** taking supply and technical constraints into account? Does it ensure comparable challenge across sectors?	The feasibility of each measure was **scrutinized with relevant Departments** and experts over the course of 2021
Socioeconomic impact	Does the measure have positive impacts on the wider economy (e.g., **employment opportunities**, post-Covid economic recovery, export market, household expenditure)?	**Potential employment and GDP outcomes, as well as household distributional impacts** were estimated using a multiplier approach. Estimates built on previous ESRI and Central Bank analysis
Contribution to other sustainability goals	Has the measure ancillary sustainability benefits incl. **health** (e.g. improved air quality, lifestyle improvements) and **environment** (improved water quality, biodiversity)	The contribution of each measure to other sustainability goals was **assessed with relevant Departments** and experts over the course of 2021
Ability to serve as stepping stone to achieve 2050 target	**Most importantly, does the measure contribute to a net zero target in 2050?**	The **emissions trajectory to 2050 was modelled** to ensure the sequencing of levers and measures enabled net zero

~€119bn investments likely need to be mobilized in key technologies; incremental cost highest in industry

Figures may not sum due to rounding

🟦 Redirected 🟩 Incremental





Key technologies by sectors		Investment, EUR bn	Share of investment that is incremental, %
Electricity	Wind & solar	23	~50%
	TSO/DSO upgrades[2]	9-13	
	Backup capacity	1	
Transport	EV passenger cars	34	~25%
	EV trucks/vans	7	
	EV buses	1	
	EV charging infrastructure	1	
Buildings residential	Insulation in homes (retrofitted)	11	~50%
	Heat pumps in homes	9	
	District heating in homes	3	
Buildings commercial	Insulation in commercial buildings[1]	2	~53%
	DH and HP in commercial buildings	3	
	Other[3]	8	
Industry	Electrified heat supply in alumina	2	~63%
	Heat pumps and electric boilers	<1	
Agriculture	Electrification	<1	~50%
	Reforestation	<1	
	Anaerobic digesters	1	
	Total	~119	

1. Previously grouped under "Insulation for homes", including residential
2. Including interconnection
3. Includes e.g. residential and commercial electric cooking

The estimated allocation of cost to the Exchequer vs private funding typically varies by sector, though this will be determined by policy design

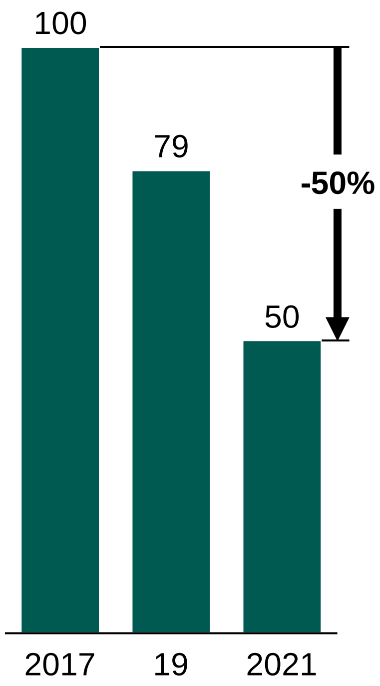
Sector	Total Investment 2021-30, €bn	Share of investment that is incremental, %	Potential Exchequer Role	Rationale – Existing Commitments
Electricity	~36	~50%	◔	Any generation cost increase impacts electricity users Public spending focused on Transmission and Distribution The NDP indicates the allocation of Non-Exchequer funds to Energy investments including renewables, interconnections, etc
Transport	~42	~10%	◔	Current support of purchase grants up to €5,000 for qualifying BEVs, as outlined in Budget 2021, is likely to be ramped down as TCO parity is reached
Buildings	~31	~75%	◑	The NDP allocated €8bn to DECC for residential retrofitting with €5bn of additional carbon tax revenues also being allocated to further support retrofitting to 2030
Industry	~9	~25%	○	The Industry sector will see the cost burden lie largely with corporations with limited Exchequer role required
Agriculture	~2	~50%	◑	As per PfG, €1.5bn of additional current funding will be made available to match funds provided under the Common Agriculture Policy for schemes designed to incentivise sustainable farming Opportunity to ensure this support is aligned with ambitions of CAP21
	~119			

Source: National Retrofit Plan 2021; CAP21; National Development Plan 2021-2030; Budget 2021; Programme for Government; Our Shared Future 2020

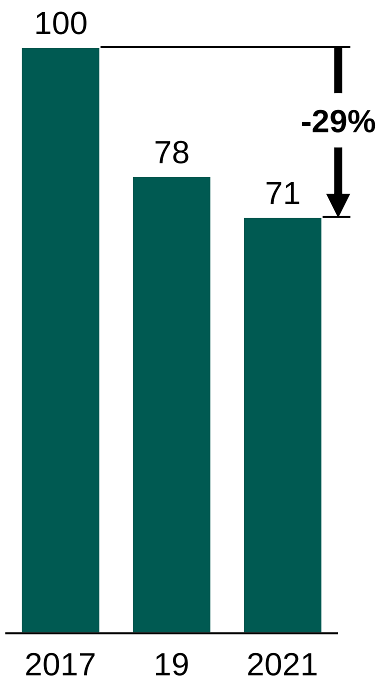
The cost of key technologies has decreased substantially, alongside a favourable ETS environment

Technology costs, decarbonization policies, and carbon markets have changed drastically in five years

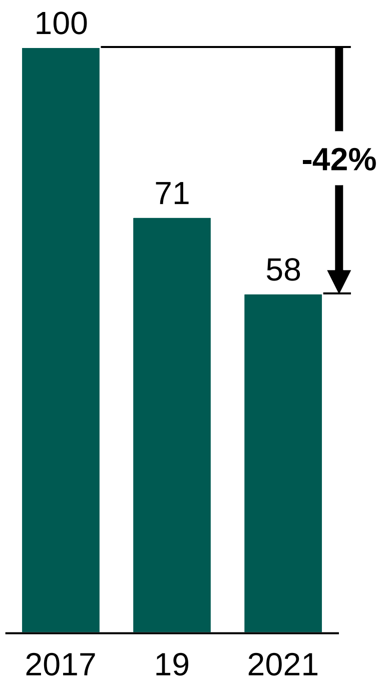
Solar PV technology cost, Indexed 2017 = 100



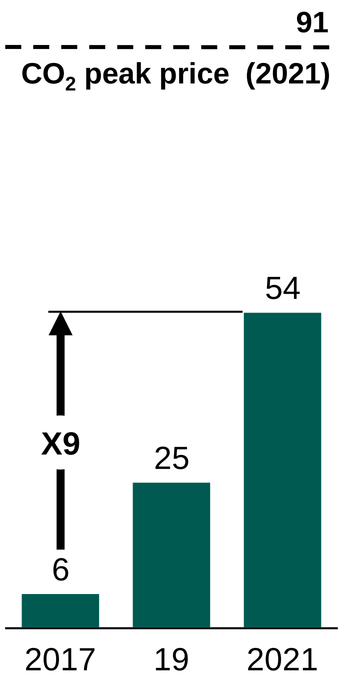
Offshore wind technology cost, Indexed 2017 = 100



Battery technology cost, Indexed 2017 = 100



EU ETS carbon price[1], €/tCO$_2$



Key takeaways

In the past five years, **technological improvements, economies of scale, and supply-chain optimization** have **lowered the cost of solar PV (in $/kW) by 50% - greater than other renewables technologies**

This tailwind, combined with **increasing ETS prices** and **lower costs for enabling technologies** (e.g. battery storage), is encouraging for the feasibility of renewables development in Ireland

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1. Yearly average

Source: Global Energy Perspective 2022; IRENA, Bloomberg NEF

The investment incurred is partially offset by a number of co-benefits

Co-benefits

A number of environmental and biodiversity benefits result from measures to decarbonise. These include:

- **Restoration of peatlands**: increases likelihood of upland peat habitats withstanding hotter, drier conditions
- **Increased woodland and hedgerow planting**: habitat creation, flood alleviation, air quality, and recreational benefits
- **Changes to farming practices**: air quality improvements from reduction in ammonia and reduced eutrophication/water pollution with more efficicent N2O application
- **Increasing adaptation to climate change**: changes in land use (e.g. forest cover) enabling greater adaptation to impacts of climate change

Health benefits

Clear evidence for health benefits of the Net Zero transition. These benefits are generally higher on demand-side measures of abatement. They include:

- Shift toward **active travel**
- **Healthier diets** away from meat consumption (50% reduction in red meat consumption could result in monetised benefit of ~0.5% GDP)
- **Air quality**: 40k deaths per year in UK from poor air quality. Air quality improvements in a low-carbon scenario could result in annual benefits of ~0.1% GDP by 2030
- **More liveable homes**: health cost to the NHS due to poor housing is estimated to be £1.4-2bn per year
- **Mental health improvements** for example, improved physical health and expanding woodlands have positive impacts on mental health

Job creation

A low-carbon transition will impact job opportunities across the UK. Outcomes will depend on the balance of UK proivision and imports. For some sectors, it is clear the balance of new jobs must be in the UK:

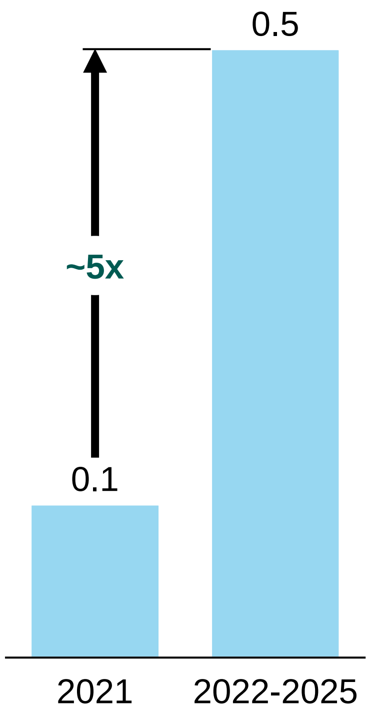
- **Buildings**: additional 200k FTEs required from late 2020s through to 2050 to support the energy efficiency and low-carbon heat programmes. More roles potentially in heat pump and other supply chains
- **Low-carbon energy**: ~260k new roles required over the next 30 years, including jobs in buildings retrofit. Jobs spread across the UK
- **Transport:** ~£10bn increase in annual investment required in transport sector. Up to 80k jobs in manufacturing of EVs and batteries, however dependent on UK policy
- **Manufacturing:** potential opportunities for exports if the UK becomes a market-leader in production of low-carbon technologies (e.g. CCUS). Up to 80k jobs could be supported here by 2050

Source: UK Sixth Carbon Budget, UK Climate Change Committee; LSE

Delivering these sector emissions ceilings requires a major step-up in key decarbonisation activities across sectors in the near term

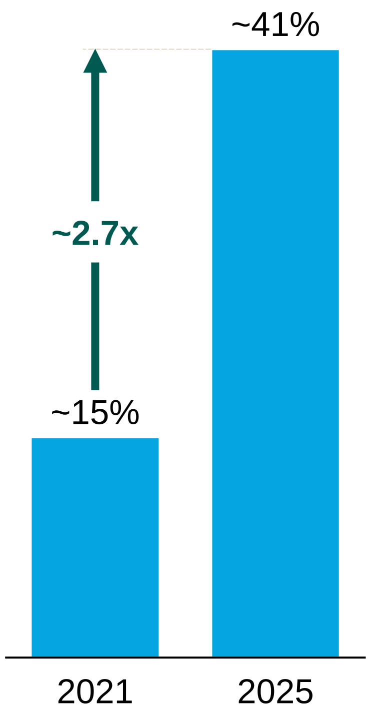
Electricity

Solar power – annual installation, GW p.a.



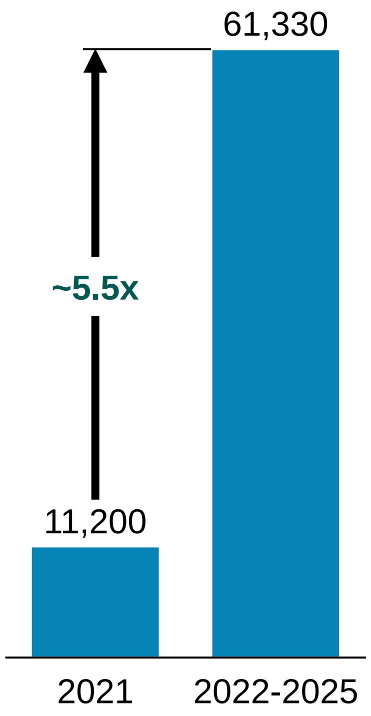
Transport

EV passenger cars– annual new car registrations, % EV of total car registrations



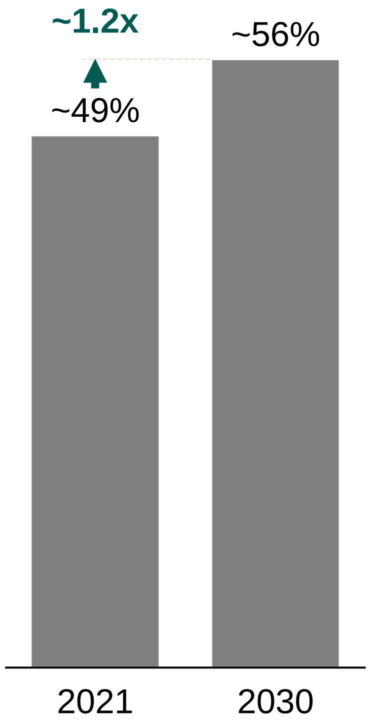
Buildings

Annual heat pumps installed in existing residential buildings
# of households p.a.



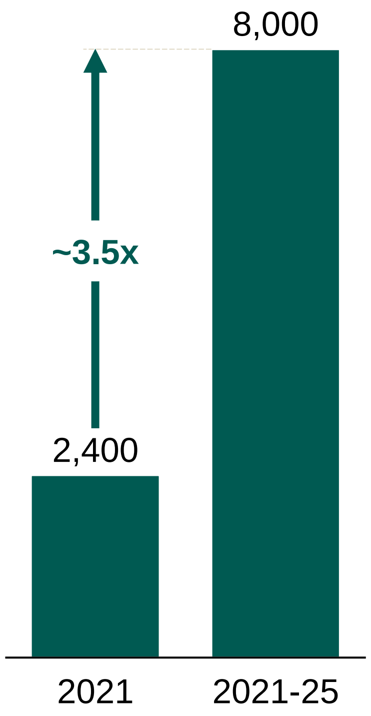
Industry

Share of low carbon heating
% of heat supply



Agriculture & LULUCF

Afforestation rate
ha p.a.



Biomethane production
TWh p.a.

Source: Climate Action Plan, 2019; Programme for Government 2020

Collaboration across departments could be required to deliver climate actions

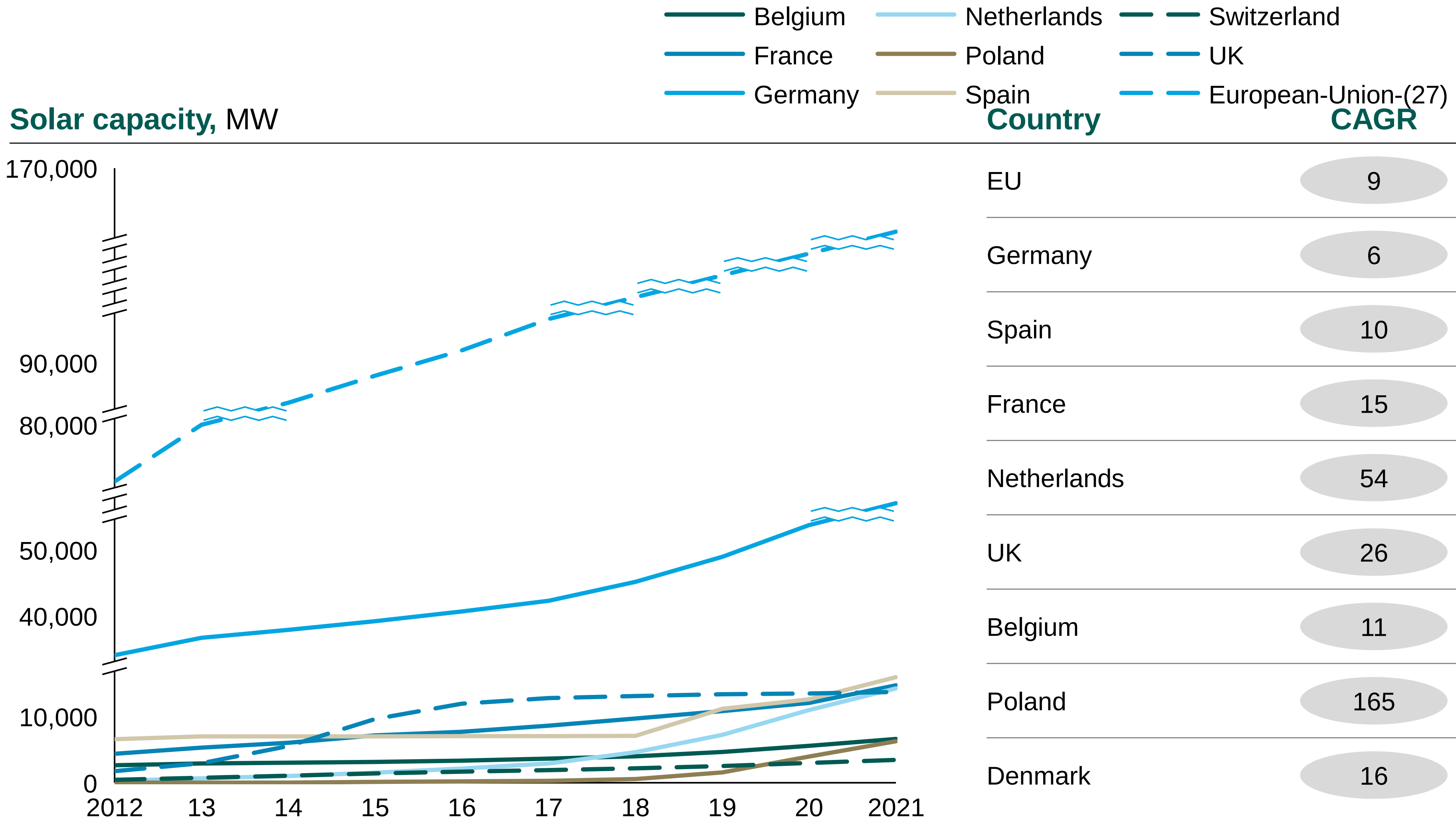
	Action	Collaborators
Electricity	Incentivize the rapid roll out of new renewable technologies. Support the development of **supporting infrastructure** (e.g., ports for offshore wind) required for construction.	DECC, DETE, EPA, SEAI, DFIN, DPER,
Transport	**Develop an integrated countrywide mobility strategy** to drive modal shift to extensively reduce passenger car use	Dept. of Transport, DFIN, DPER, DECC, SEAI, NTA, TII, Local Authorities, CIE, Private sector
Built Environment	**Identify an approach to rapidly roll-out district heating** – most likely to be led by a local authority (e.g., Dublin City Council (as in Nordics)) or by an existing utility (e.g., Ervia, Veolia (as in Berlin, Warsaw, Radet))	DHLGH, DECC, DFIN, DPER, SEAI, Local Authorities, Utility providers
Agriculture	**Develop an integrated agriculture and land use strategy** which seeks to deliver multiple long-term objectives incl. success for agri-food industry, farmers and communities; food and energy security; climate mitigation, and environmental protection and biodiversity	DAFM, DECC, DETE, DEASP, DRCD, EPA, Teagasc, BIM, Bord Bia
Cross-cutting enablers	**Greening the financial system** – cross economy approach to redirecting capital flows to green technologies and companies	DFIN, DPER, NTMA
	Detail approach to building generation capacity and use of zero-emission gas	DECC, DAFM, DETE, DPER, DFIN, DHLGH, SEAI
	Deliver fundamental demand shifts across sectors (e.g., building materials)	DFIN, DPER, Dept. of Transport, DETE, DAFM, DECC, SEAI, NTA

1. New car registrations based on driven vkm assumptions; 17,000km/EV and 17,000km/ICE declining linearly to 15,300km/ICE (-10%) in 2030

Countries across Europe have successfully expanded their capacity at a rate higher than CAP21 requires

~2 GW solar target in CAP21 requires ~250MW annual capacity increase 2021-30

Solar capacity, MW



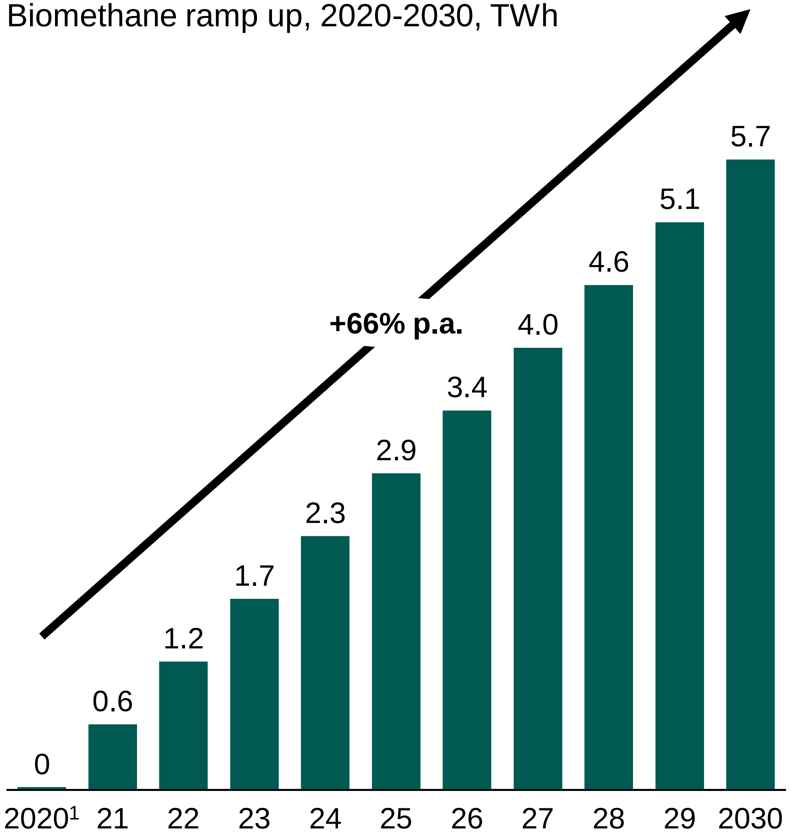
Country	CAGR	**Average annual capacity increase,** 2012-21
EU	9	9,900
Germany	6	2700
Spain	10	1000
France	15	1200
Netherlands	54	1500
UK	26	1300
Belgium	11	450
Poland	165	700
Denmark	16	130

Source: IRENA

To meet maximum biomethane potential, ramp up will be lower than the highest production European countries

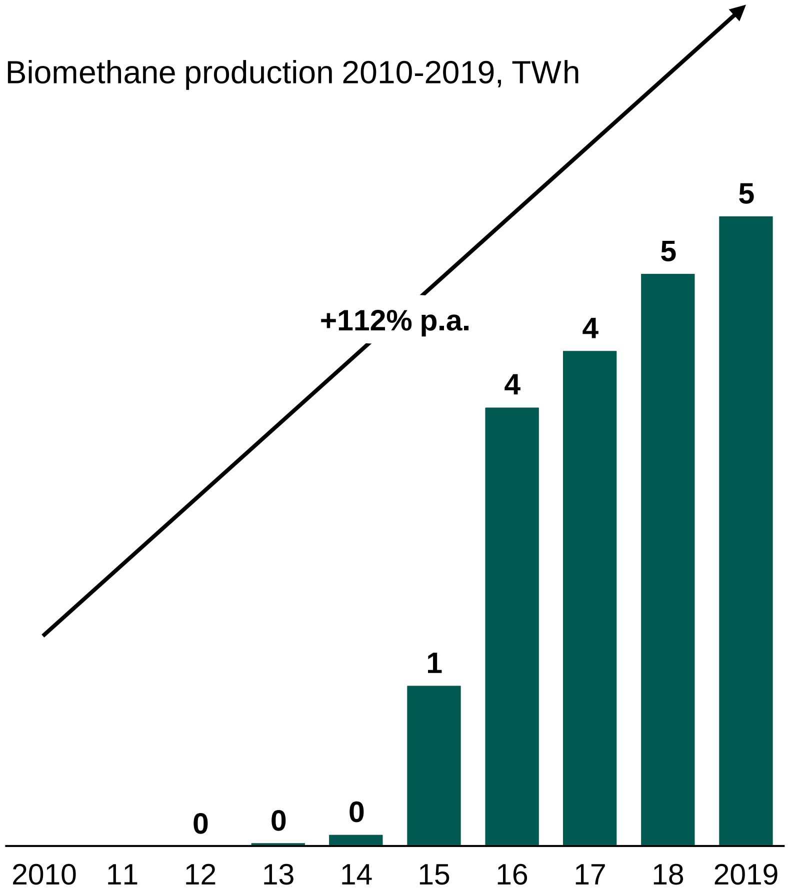
Ireland could be required to grow production by ~66% p.a. to reach highest potential by 2030 ,

Biomethane ramp up, 2020-2030, TWh



…which is within what has been achieved in the UK

Biomethane production 2010-2019, TWh



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1. First biomethane injection plant in Cush, Co. Kildare came online in 2020

Source: EBA 2020, CAP 21

Key takeaways

To reach highest potential biomethane production in 2030 as outlined by SEAI, ~66% p.a increase required

This is lower than the ramp up in production across the highest producing biomethane countries in Europe. UK achieved ~110% p.a growth between 2014-19

The socio-economic implications of potential sectoral emissions pathways will likely need to be strengthened in coming months

🟢 Complete
🟡 In progress
🔴 Incomplete

	Benchmarking	Multiplier-based impact assessments	Rigorous socio-economic and macroeconomic modelling
Detail	• Benchmarks from macro and socio-economic **assessment of similar climate action ambitions** proposed by other countries • Assessment of **existing analysis of climate action in Ireland** by the Central Bank, ESRI and others	• Use a **multiplier-based approach to identify the potential labour market implications,** incl. jobs by sector and reskilling/ support needed • **Quantitative assessment** of the major drivers of Ireland's competitiveness for existing businesses, including total energy costs • Identification of the **socioeconomic implications on example households** (e.g., impact on consumer bills) both in general, and for specific social groups	• **GDP:** Additional consideration of potential **effect on GDP**, as well as the detailed co-benefits of climate action (e.g. health, environmental and biodiversity benefits) • Quantitative assessment of the impact of the proposed **pathways on jobs**, energy bills and other **impacts on consumers** and the **competitiveness** of particular industries
Status	🟢 *Comparison vs UK 6th Carbon Budget and EU Fit for 55 complete*	🟡 *Preliminary multiplier based assessment complete*	🔴 *To be completed following finalization of ceilings*

Assessment builds on analysis already completed by the Central Bank and ESRI

Example analysis reviewed

PRELIMINARY

Reviewed potential macroeconomic impacts of ‘do-nothing’ scenario

Climate change could generate macro-economic shocks to the Irish economy if not properly mitigated:

- **Demand shocks:** Investment delays from uncertainty about climate risks, uninsured damage to property could cause permanent decrease in wealth, change in food prices and disruption to trade flows.
- **Supply shocks:** Loss of hours worked due to natural disasters, food and other input shortages, disruption to transport and production chains, damage to capital stock due to extreme weather, destruction of capital and infrastructure, diversion of resources from productive investment to adaptation capital.
- **Inflation:** Increased inflation volatility, particularly for food, housing and energy.

Source: McInerney, The Macroeconomic Implications of Climate Change for Central Banks, Jan 2022

Reviewed potential macroeconomic impacts of transition initiatives

- **Carbon tax negatively impacts economic activity**, production sectors and households. The increase in the carbon tax reduces GDP by 0.84% by 2025 and 1.36% by 2030 as compared to no increase in the carbon tax (scenario CT compared to BaU)
- **Economic activity is boosted by the introduction of electric vehicles and heat pumps** and largely eliminates the negative impacts of a carbon tax. The decline in real GDP becomes 0.1% and 0.2% in 2025 and in 2030, respectively. This occurs because adoptions of EV and HP can reduce households’ and firms’ reliance on fossil fuels, lowering their costs and adopting EVs and HP will boost economic activity through increased EV car sales, HP sales and construction demand

Source: Yakuta and De Bruin, The Impacts of Electric Vehicles Uptake and Heat Pump Installation on the Irish Economy, Dec 2021

Reviewed job creation forecasts of transition initiatives

- Government-based sectors such as **health, education and public administration face positive labour demand** impacts owing to an increase in government consumption from carbon tax.
- Carbon-intensive sectors like **mining and transportation stand to face negative labour demand** impacts
- The overall county-level results are positive for most counties, with **Sligo, Roscommon, Galway and Tipperary faring the best.**
- **Dublin and Westmeath face the most negative labour demand impacts**, due to their comparatively larger shares of employees in the most-impacted sectors. These impacts are relatively small.

Source: De Bruin, Lawless, Monaghan and Yakut, Transitioning to a low-carbon Irish economy: an analysis of regional labour impacts, 2019

Analysis of the UK's 6th Carbon Budget suggests economic benefits in the long run to the UK economy

The UK's 6th Carbon Budget sets similar ambitions to CAP 21…

		Ireland CAP 2021 targets (2030)	UK 6th Carbon Budget targets (2033)
Greenhouse gas emissions	Greenhouse gas emissions reduction over 2018, %	-47%	-41%
	Greenhouse gas emissions per person (tCO_2/capita)	5.9	4.5
Transport	Car-km per passenger car driver[2]	11,494	12,400
	Share of BEVs in new car sales	100%	97%
Electricity	Offshore wind (kW_e/capita)	1.0	0.6
	Carbon intensity of electricity (gCO_2/kWh_e)	40	45
Buildings	Heat pump installations (per year/thousand people)	13	15
LULUCF	Wood land area	12%	14%

Source: CSO, Teagasc, Climate Action Plan 2021, CCC: UK's 6th Carbon Budget report

…and the UK pathway is shown to be beneficial in the long term

Approach	UK's 6th Carbon Budget estimate
1 **Employment impacts**	The UK's transition to a net-zero-economy will lead to an **increase in GDP of 2-3% by 2050.** This economic boost will see employment rising ~1%, an **additional 300,000 jobs per year over the period 2030-2050**
2 **Investment/ competitiveness attractiveness**	Estimates of annualised resource **costs have fallen to less than 1% of GDP** for the entirety of the period 2020 to 2050. Much of the investment spending can be recouped through lower operating costs Modelling indicates a potential **boost to GDP of around 2% by 2035.**
3 **Household impacts**	By 2030, all income quintiles are forecast to see a relative **increase in real disposable income of between 1.2%-1.5%** By 2050, real disposable income is forecast to **be 2.5%-3.0% higher for the three lowest income quintiles**, but only around 2.0% higher for the highest two income quintiles

Illustrative comparison - note that socioeconomic outcomes of CAP 21 could vary significantly dependent on a number of factors (e.g. policy decisions)

Multiplier-based impact assessments of proposed sector emissions ceilings for Ireland

① Employment impacts

There could be a net increase in employment by 2030 in Ireland

- Applying a multiplier effect to transition activity shows a potential net increase of ~30k jobs by 2030, driven by increased renewables capacity, grid expansion and retrofits/heat pumps activity
- Agriculture is the only sector with net decrease in jobs, driven by herd diversification

② Investment/ competitiveness attractiveness

Effective delivery of emissions reductions measures could de-risk the economy and create economic value

- Careful management of CAP 21 delivery could minimise costs and maximise opportunities
- Irish business well positioned to seize opportunities in a low carbon transition in the near (e.g. alternative proteins, low carbon products, enabling services) and long term (e.g. green hydrogen end products)

③ Household impacts

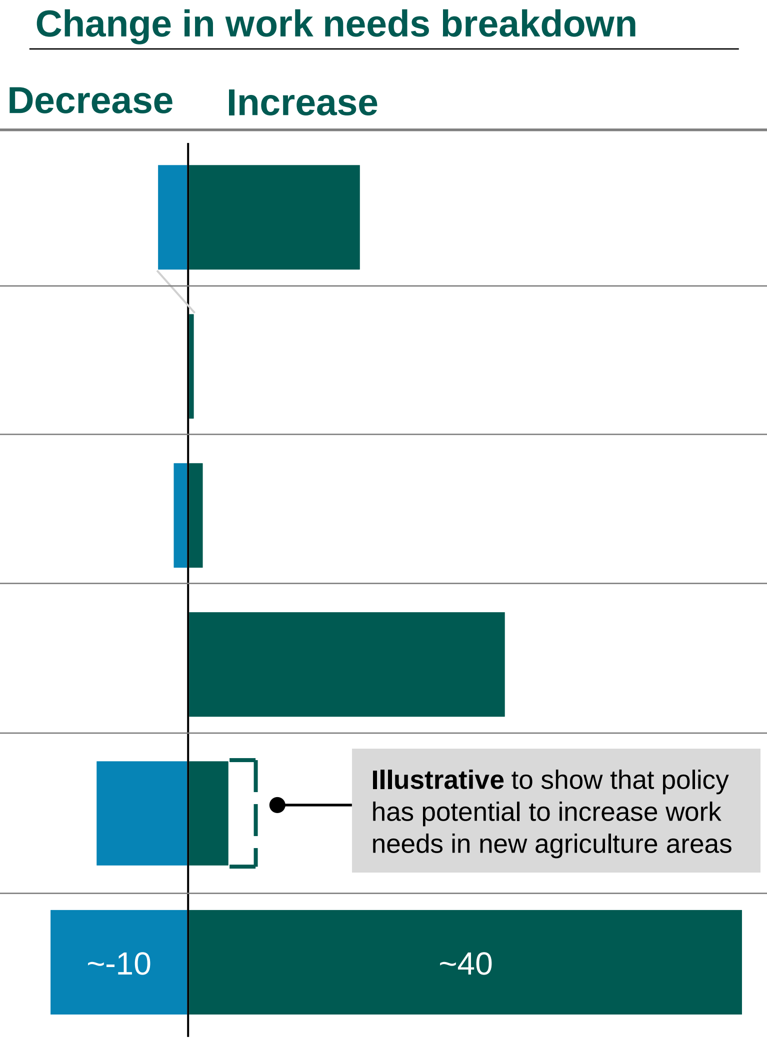
There is potential for a small increase in household spending by 2030, driven by increased utilities costs

- Overall potential for minimal increase of (potentially <1%) in household spending – liable to change (especially across income brackets) depending on policy decisions
- Household impacts driven by increase in utilities (e.g. heating, retrofits), which is significantly offset by less spending on private transport (e.g. more public transport, cheaper TCO of EVs)
- Likely to be cost saving by 2050

Employment impacts: Implementation of Climate Action Plan 2021 measures could create net work needs for ~30k direct FTEs in 2030

Multiplier effect applied to change in activity in low-carbon transition

🟩 Increase in job needs 🟦 Decrease in job needs



Illustrative to show that policy has potential to increase work needs in new agriculture areas

	Net change in work needs[1]	Rationale
Power	▲	Job needs driven by growth of renewables capacity and expansion of the grid to support electrification
Transport	▲	Limited job needs driven by installation and maintenance of electric vehicle charging infrastructure; no vehicle assembly assumed to occur in Ireland given historical precedent
Industry	▶	Decline in job needs observed in meat processing but this is offset by a small increase in industrial jobs associated with industrial decarbonisation initiatives
Buildings	▲	Major growth in jobs needs, driven by comprehensive roll out program for both low-carbon heating (e.g., heat pumps) and retrofits
Agriculture	▼	Fewer jobs needed in current farming activity; however, there will likely be increased job needs in alternative land uses, such as forestry and bioenergy crops. There has already been a decline in farming employment between 2000-2019
Total	▲	

Employment impacts: A skills shift could help support the transition to low-carbon world

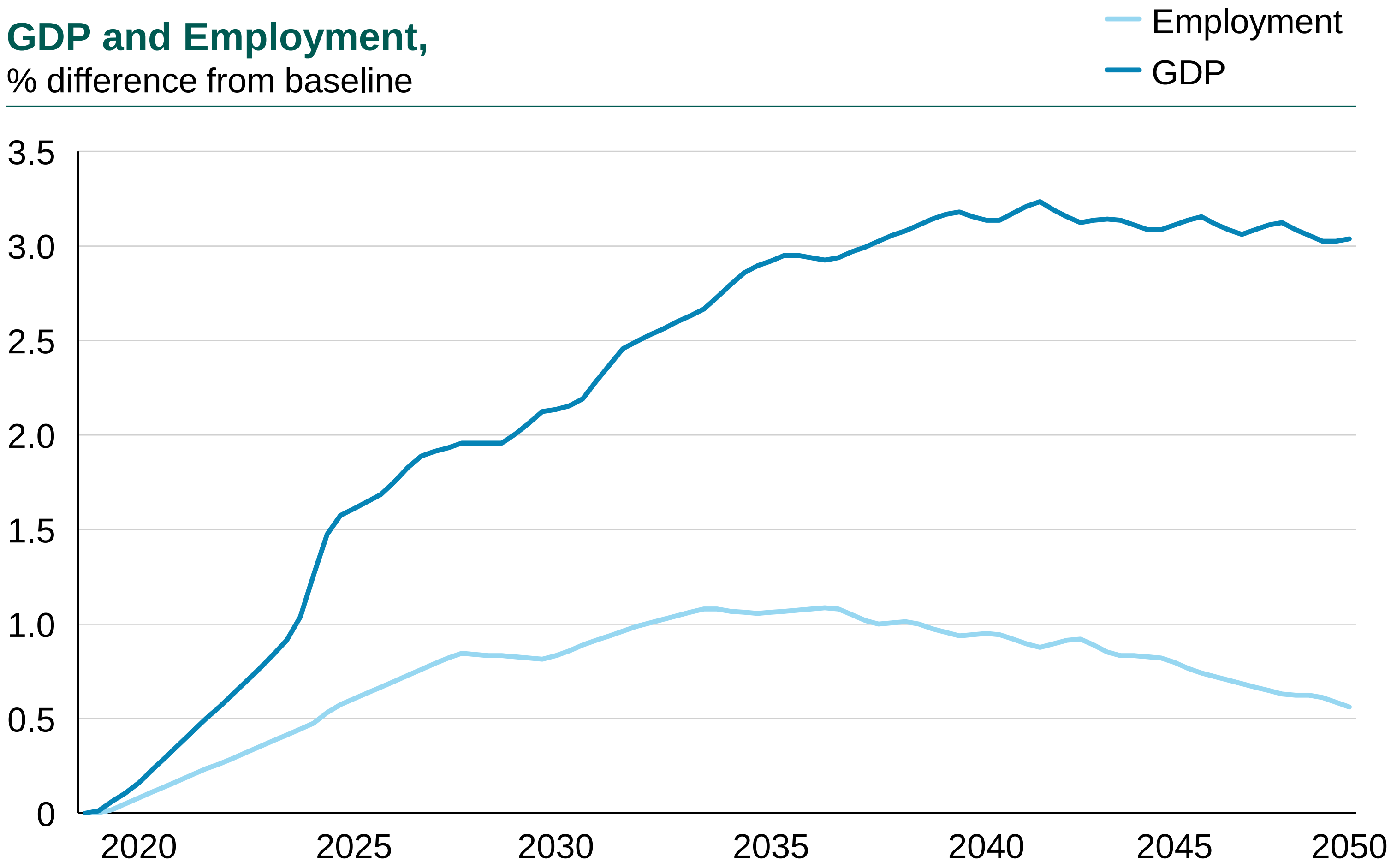
NOT EXHAUSTIVE

◕ High ◑ Medium ◔ Low

Sector	Occupation	Scale of skill shift	Potential upskilling requirements
Transport	Passenger and commercial vehicle mechanics	◕	New expertise in electric powertrains, rather than conventional ICE powertrains
Buildings	Plumbers	◕	New expertise in range of new heating technologies i.e. district heating, heat pumps, electric boilers
	Construction	◑	New expertise in low-carbon design and implementation (e.g., using new materials like CLT)
Agriculture	Extensification	◔	New expertise on how to reduce farming inputs (e.g., fertilizer) and alternative techniques that can be used
Power	Grid operators (TSO/DSO)	◑	New expertise in new technologies that are increasing their share of energy generation (e.g., renewables) and balancing technologies (e.g., batteries)
Other	Professional services	◔	New expertise on ESG topics in range of professional services (e.g., knowledge of new regulations for lawyers and knowledge of green finance for financial professionals)

Employment impacts: Analysis of the UK's 6th Carbon Budget estimate it will create ~300,000 jobs p.a

GDP and Employment,
% difference from baseline



Source: Cambridge Econometrics "Economic Impact of the Sixth Carbon Budget" 2020

The UK's 6th carbon budget runs **from 2033-37**

The UK's transition to a net-zero-economy will lead to an **increase in GDP of 2-3% by 2050**

This economic boost will see employment rising ~1%, an **additional 300,000 jobs per year over the period 2030-2050**

Investment / competitiveness attractiveness: Transitioning could help Irish business to maintain competitiveness

Businesses may adapt to changing stakeholder expectations:

Talent

84%

of employees are more loyal to a company that contributes to social / environmental issues

B2C customers

+30%

of consumers are looking to move towards sustainable companies and products after COVID 19

B2B customers

+81%

of companies stated that their commitment to sustainable has increased over 5Y

Businesses may need to respond to changing market environments

New / more sustainable products are displacing 'old'

~9%

growth of alternative protein consumption in Ireland 2013-18 – in several EU countries beef consumption is flat or declining

Increasing investor expectations

$50+ trillion

of assets are managed by ESG investors, growing at ~15% p.a. Increased expectation forr companies to fulfil sustainability criteria

Stringent targets are the new normal

23%

of Fortune 500 companies have a science-based target, up from <5% 5y ago

If businesses choose not to act early while options exist, a more sudden decarbonization journey is likely to cost more, e.g., impact of stranded assets

Investment / competitiveness attractiveness: Careful management of Climate Action Plan 2021 delivery may help minimize costs and maximise the benefits

Careful management of Climate Action Plan 2021 delivery could help ensure:

Irish business remains competitive in current markets

Increased energy costs, e.g., driven by build out of RES

Increased production costs driven by carbon prices

Irish business is well positioned to seize new opportunities

Supplying demand for new products (e.g., alt proteins)

Supplying demand for low-carbon versions of existing products (e.g., lower-carbon cement)

Supplying services that enable the transition (e.g., finance, design)

Investment / competitiveness attractiveness: Ireland is well placed to export emerging agriculture products in the near-term as well as energy, buildings end products longer term

▲ Estimated start date ● Highly relevant ○ Moderately relevant

		Possible export timeline			Competitive strengths			
	Export opportunities	**2021-25**	**2025-30**	**2030-35**	**Existing adjacent industry**	**Natural resources**	**Relevant skills**	**Target customers**
Agriculture	Alternative proteins end product and ingredients	▲			●	●	●	Global
	Low-carbon dairy end product	▲			●	●	●	Europe
	Carbon credits	▲			●	●		Global
	Bioeconomy products		▲		○	●		Europe
Energy	Green hydrogen end product			▲	○	●		Europe
	Green electricity end product			▲	○	●		Europe
Buildings	Heat pumps end product		▲		●			UK
Industry	Lower-carbon cement know how		▲		●		●	Global
Transport	Sustainable aviation fuels end product and know how[1]			▲	●	●	●	UK
Professional services and IT	Green finance products and services	▲			●	n/a	●	Europe
	Low-carbon data management	▲			●		●	Global

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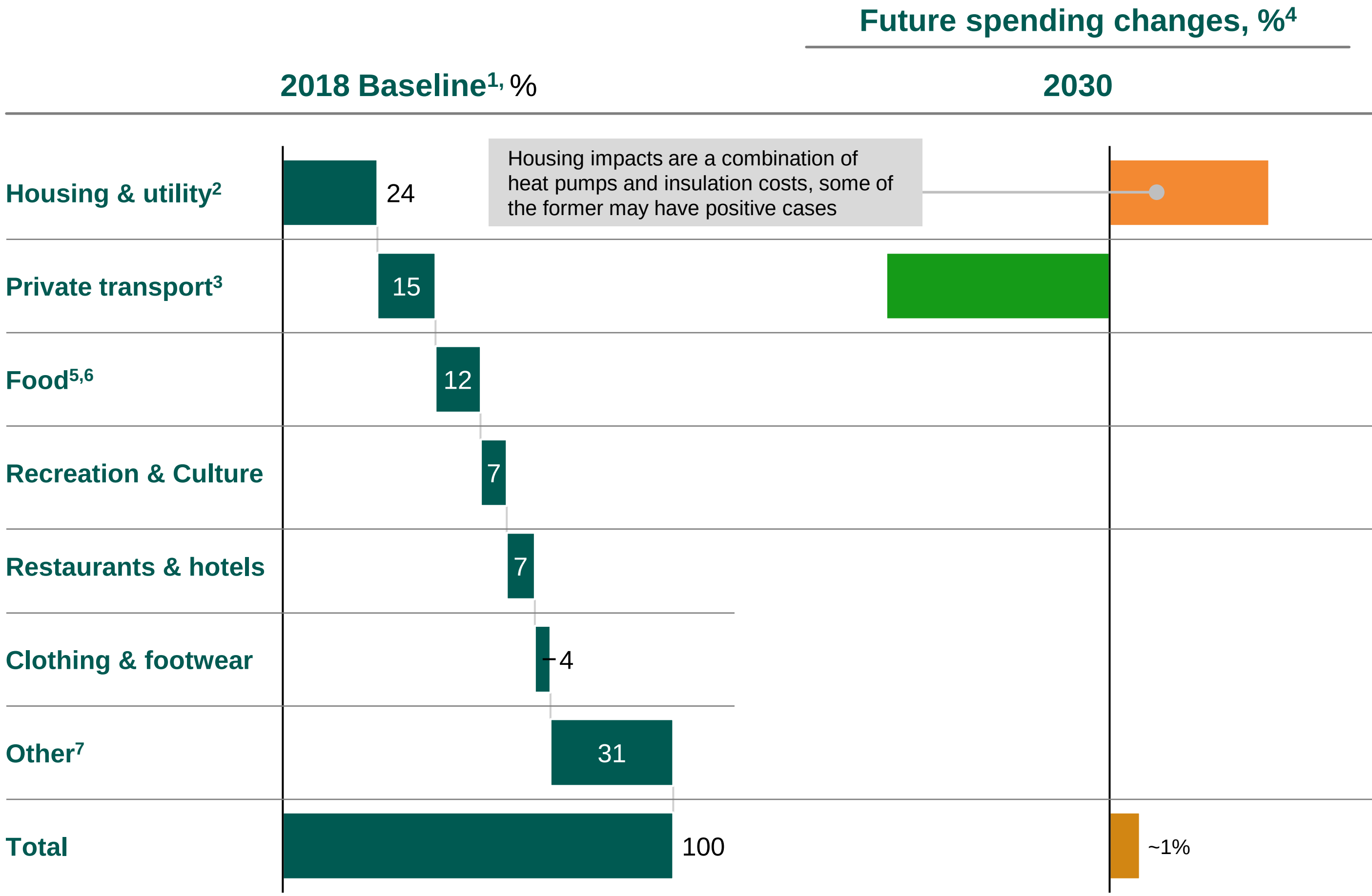
1. Contingent on there being sufficient available land for bioenergy crops, which may require further land uses changes given the competing needs for bioenergy crops

Household impacts: Delivery of Climate Action Plan 2021 could increase the average Irish household's bills by ~1%

ILLUSTRATIVE

Average household annual spending in Ireland for average household



Housing impacts are a combination of heat pumps and insulation costs, some of the former may have positive cases

	Narrative
Housing & utility[2]	**On average the combination of heating improvements do not pay back for at least 10 years.** Potential savings in longer term due to reduced OpEx (e.g. heating). Note baseline includes other housing costs, e.g., rent, which is driving down the scale of impact on the bill category
Private transport[3]	**EVs pay back quickly.** Similar but slightly smaller savings could also be observed for electrified public transport users
Food[5,6]	**No material changes** from costs in meat or plant-based foods in short term
Recreation & Culture	**No material changes** until aviation decarbonizes significantly; small cost increases may be observed in domestic tourism if businesses pass costs on building decarbonisation through to end customers
Restaurants & hotels Clothing & footwear Other[7]	The secondary impacts of decarbonization are minimal
Total	**Overall, a small increase in 2030**; this is likely to flip towards a saving by 2050

1. Based on Eurostat
2. Based on 2017 data, excluding ~5% spending in water
3. Only for passenger cars (i.e. no bus / rail) and exclude the price for green steel production
4. Assuming only the true costs are passed on to consumer, i.e. there is no additional mark up from the decarbonization costs. Note: % changes, not absolute
5. Only ~35% of food spending goes to the farmers and assuming 60% of food spending is for animal based products
6. Excludes the impact of electrification of tractors
7. Other includes health, communications, education, alcoholic beverages, tobacco, narcotics, furnishings, household equipment, routine household maintenance and miscellaneous goods and services

Source: Eurostat (2019)

Household impacts: Impact on household bills could be unevenly distributed: specific circumstances can materially affect the net impact

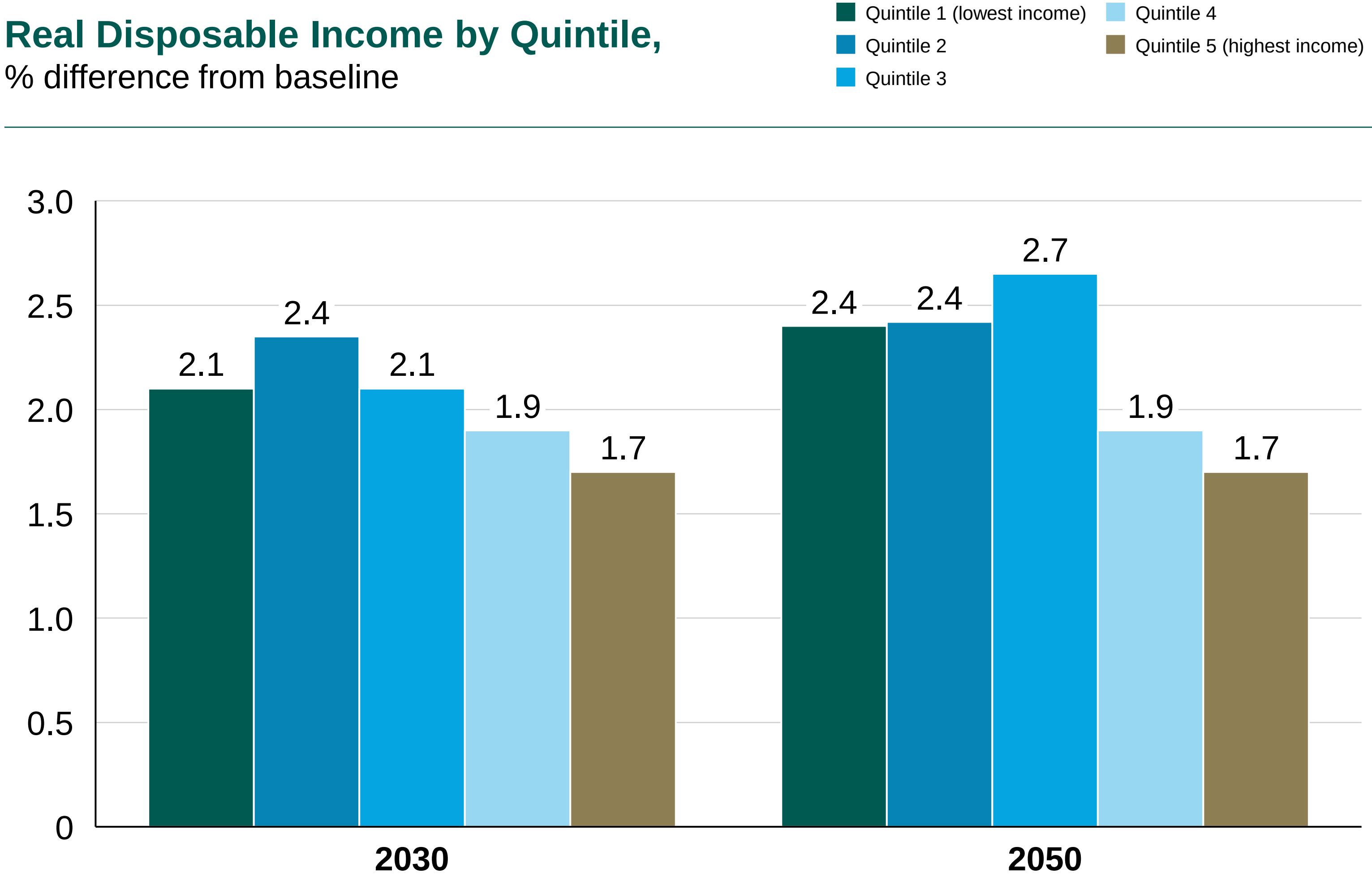
◕ High ◑ Medium ◔ Low

NON-EXHAUSTIVE

Mitigation area	Characteristic associated with higher cost impact	Magnitude of cost impact	Rationale
Buildings	Home ownership	◕	Home owners will likely face investment cost of retrofitting whilst renters may benefit from operating cost savings without investment (which is paid by landlord)
	Old housing stock & low insulation	◕	Those living in old housing stock with low insulation will likely face higher costs of retrofitting.
	Detached property	◑	Those living in detached houses typically have larger houses and less shared surface area (e.g., walls) so the cost per retrofit is typically higher than for smaller, connected properties
	Later retrofitters	◔	Those who retrofit later may incur higher costs associated with using the gas grid as the cost of managing the gas grids might be distributed over fewer billpayers.
Transport	2nd hand car buyer	◕	In the short-term, those that buy 2nd hand cars will likely have less choice on a BEV because there is a less developed resale market. This may mean they keep an ICE and bear additional cost of fuel from carbon price.
	No access to parking	◔	Those with access to private parking benefit from easier and often cheaper at-home vehicle charging.

Household impacts: Analysis of the UK's 6th Carbon Budget estimates it would increase disposable income across all income quintiles

Real Disposable Income by Quintile,
% difference from baseline



Source: Cambridge Econometrics "Economic Impact of the Sixth Carbon Budget" 2020

The UK's 6th carbon budget runs **from 2033-37**

The UK's transition to a net-zero-economy is forecast to lead to an **increase in GDP of 2-3% by 2050**

By 2030, all income quintiles are forecast to see a relative **increase in real disposable income of between 1.2%-1.5%**

By 2050, real disposable income is forecast to **be 2.5%-3.0% higher for the three lowest income quintiles**, but only around 2.0% higher for the highest two income quintiles, suggesting that the package of measures is slightly progressive

There are a number of socioeconomic challenges to delivering proposed sectoral emissions ceilings and associated activities

Sector	Challenge	Description
Electricity	CapEx	• Re-skilling of workforce required (e.g new offshore wind industry to be created) • Sensitivity to onshore wind installation in rural locations
Transport	EV cost	• Transition to EVs changes structure of servicing/maintenance industry of vehicles, requiring re-skilling of workforce • EV costs only reach TCO parity in mid-2020s, with implications for driving uptake before. Further incentives required after TCO parity achieved given higher up-front cost of purchasing
Buildings	Retrofitting	• Significant tail of residential homes that are more expensive to retrofit • Challenge to design policy determining who should pay and designing sufficient support
Industry	CapEx	• Least attractive abatement cost – will require significant investment from small number of enterprises (e.g. alumina furnaces)
	Competitiveness	• Challenge to ensure competitiveness of industry players whilst potentially increasing cost base – especially in exporting industries (e.g. cement)
Agriculture	Jobs	• Diversification requires change to agricultural economy • Lower herd size requires re-skilling of ageing workforce (e.g. avg age ~58)
LULUCF	Jobs	• Re-skilling requirements to deliver measures (e.g. wetlands rehabilitation) and incentives required to change practices (e.g. cover crop utilisation, better managing of organic grasslands)
Cross-cutting	Fiscal capacity	• Significant capital requirements to finance plans with sufficient support
	Distributional impacts	• Whilst economy-wide cost could be marginal or net-positive (e.g. UK CCC projections), the poorest households are likely to be impacted most by increased costs (e.g. highest need for retrofitting/insulation; most affected by heating cost increases, limited ability to absorb higher purchase cost of EV)

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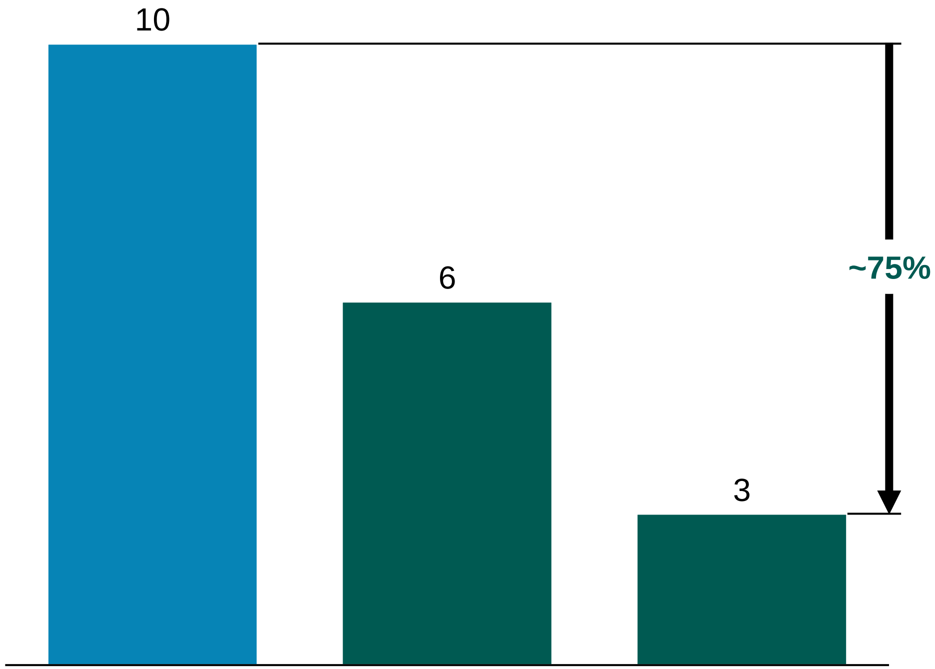
The proposed sectoral emissions ceilings deliver ~40% emissions reductions by 2025 and ~75% by 2030

	GHG emissions[1], MtCO2eq (AR5)			% change vs. 2018		% impact outlined in CAP 2021	Sectoral emissions ceilings, MtCO2eq	
	2018	2025	2030	To 2025	To 2030		2021-2025	2026-2030
Electricity	10	6	3	~40	~75	60-80	40	20



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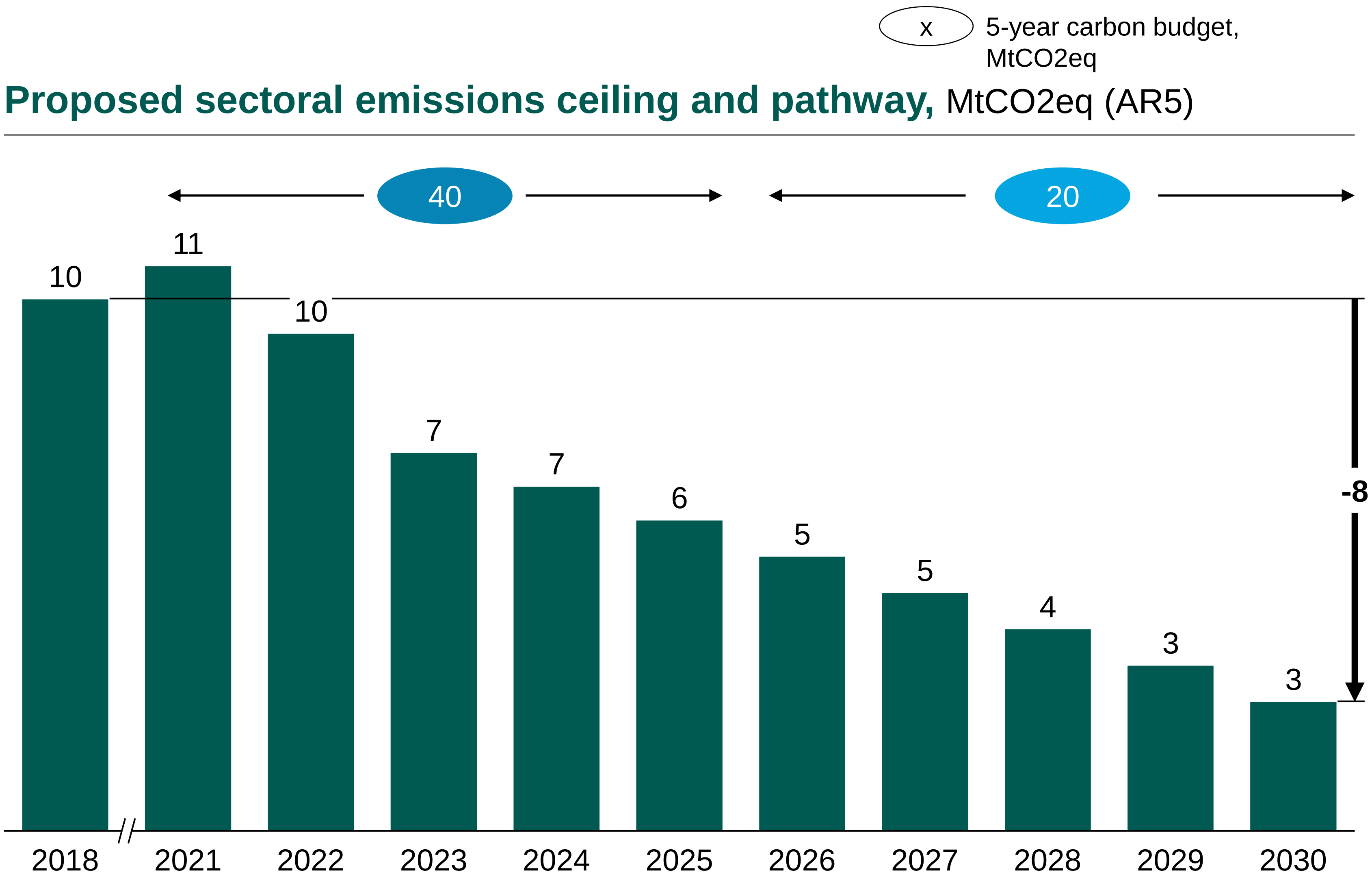
1. GHG emissions and abatement impact based on AR5 2021 EPA methodology

Source: Climate Action Plan 2021, Government of Ireland; Programme for Government 2020, Government of Ireland

Annual emissions from the electricity sector could decline by ~8Mt by 2030

Proposed sectoral emissions ceiling and pathway, MtCO2eq (AR5)



Source: Climate Action Plan 2021, Government of Ireland

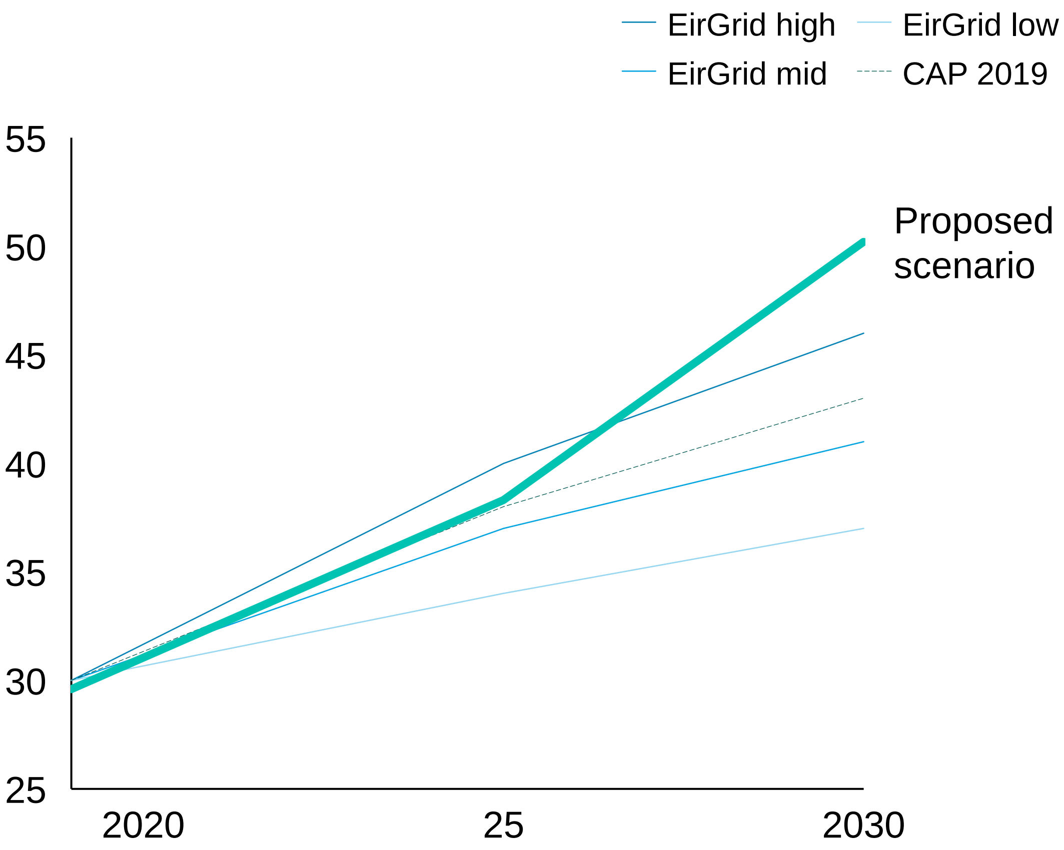
Key takeaways

Scenario:

- Moneypoint operational from 2021-22 (utilization decreasing from 70% in 2021 to 30% in 2022)
- Later offshore wind ramp-up following DECC
- Biomethane use: ~1.1TWh 2030, ~2.5 TWh in 2025
- 100 EUR/t ETS
- Additional marginal carbon price:
  - 2025: EUR 20
  - 2030: EUR 50

① Electricity demand is assumed to increase by ~65-70% by 2030

Electricity demand, TWh



Key sources of demand growth

	EirGrid mid, 2030	CAP 2019, 2030	Proposed scenario, 2030	Low demand scenario, 2030
Data centres	12 TWh	9 TWh	12 TWh[1]	6 TWh
BEV cars	500k	550k	~950k	600-800k
EV trucks & vans	N/A	95k	~90-100k	145k
Heat pumps	400k	600k	650-700k	650-680k
Industry electrification	N/A	~1 TWh	>5 TWh	>5 TWh

1. Data centre capacity is based on the EirGrid forecast of 790-1770 MW by 2030, assuming a load factor of 80%

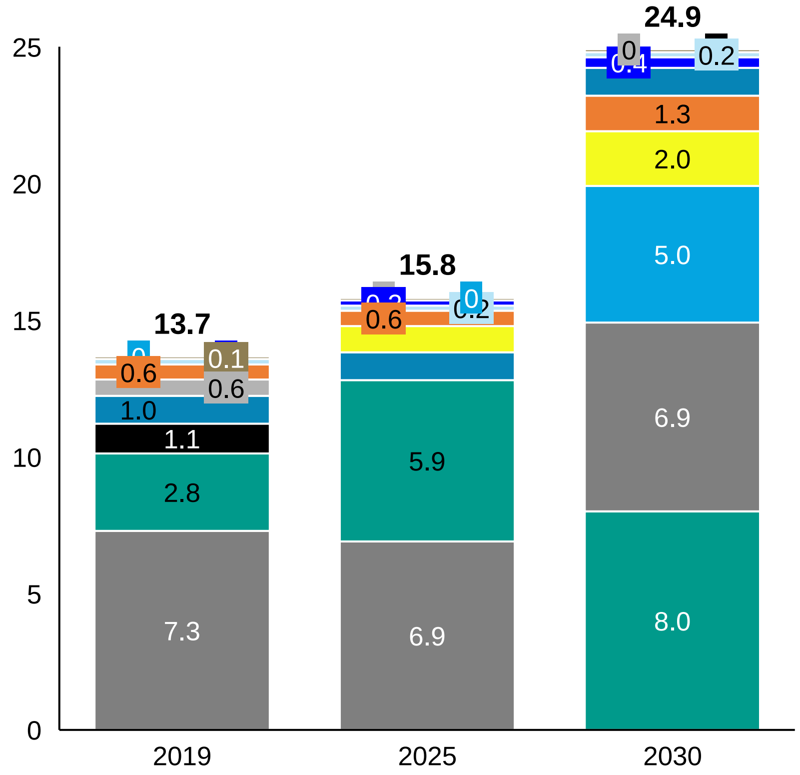
Source: Climate Action Plan 201, Government of Ireland; EirGrid- All-Island Generation Capacity Statement 2020-2029

① CAP21 capacity and EUR100 ETS delivers ~80-85% of generation from renewable by 2030

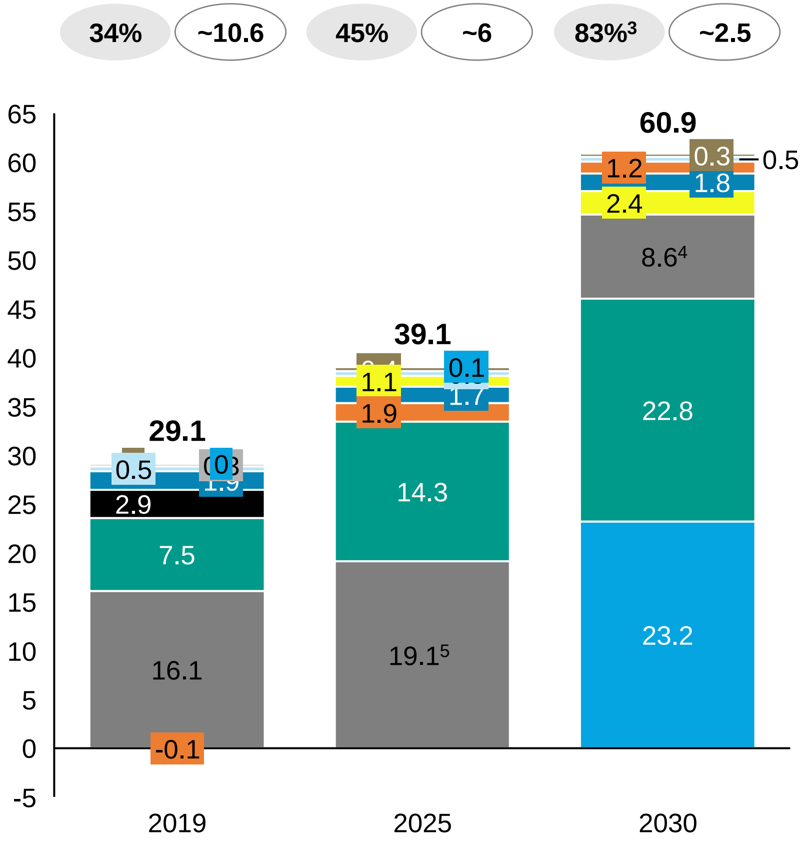
■ Battery ■ Gas ■ Other RES ■ Wind Onshore
■ Biomass ■ Hydro ■ Solar ■ Transmission
■ Coal ■ Oil ■ Wind Offshore

x Share of non-fossil generation in mix, %
x Emissions, MtCO2eq

Power capacity mix, GW



Power generation mix[2], TWh



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1. Includes Biomass and/or battery storage
2. Power generated, not delivered (see curtailment next page)
3. With curtailment generation is ~70% of total by 2030
4. Note that this includes biomethane blended in (2.5 TWh input by 2030)
5. Note that this includes biomethane blended in, 1.1 TWh input by 2025

Source: Power Solutions Model, June 2022

Key takeaways

Scenario shown aligns with CAP targets to deliver:

- ~5 GW offshore wind
- ~8 GW onshore wind
- ~ 2 GW solar

Combined these deliver ~80-85% renewable power generation mix by 2030

Actual capacity mix will vary due to competitive auctions. Assumed carbon price of ~EUR100/t

Marginal carbon price on top of ETS:

2025: ~EUR 260

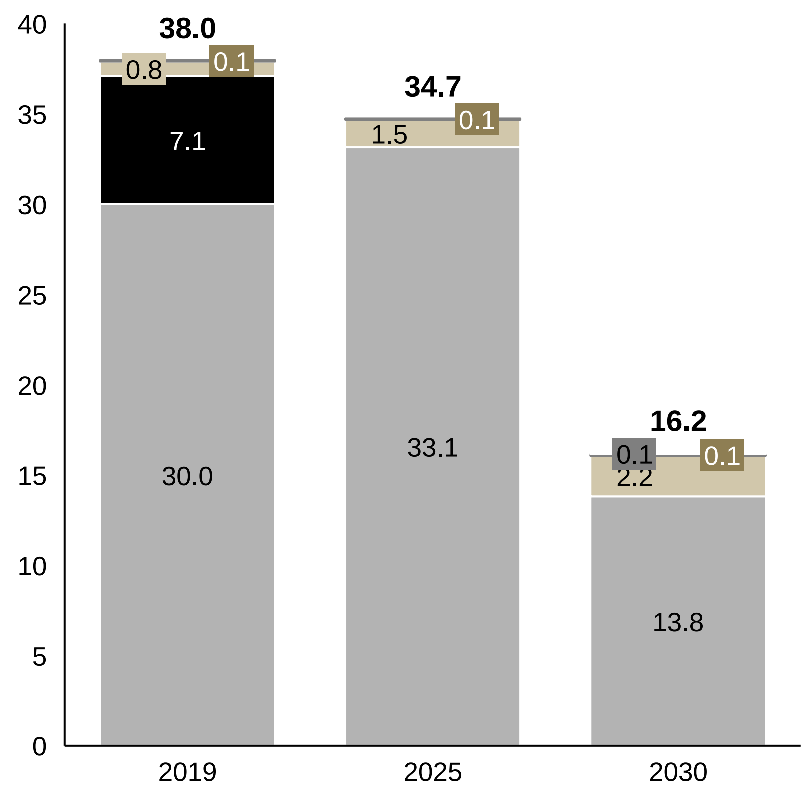
2030: ~EUR 115

① CAP21 capacity and EUR100 ETS requires ~14 TWh of natural gas by 2030

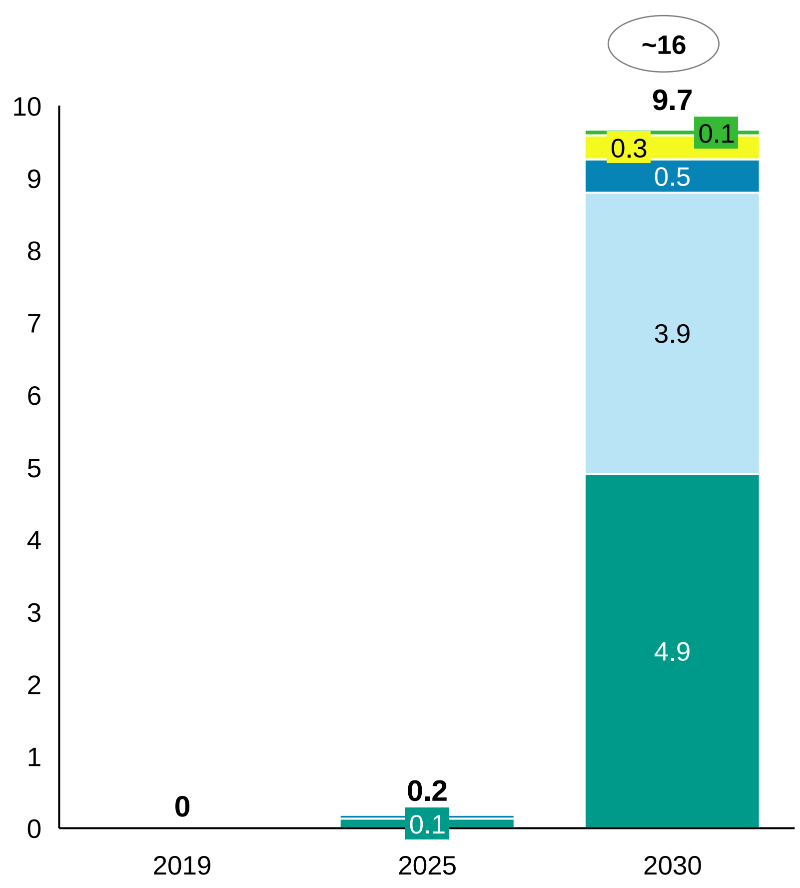
▨ BioMethane ▨ Biomass
■ Hard Coal ▨ Hydrogen electrolysis injection
▨ Natural Gas

(x) % total generation

Fuel inflows, TWh



Curtailment, TWh



1. Includes Biomass and/or battery storage

Source: Power Solutions Model, June 2022

Key takeaways

Scenario shown aligns with CAP targets to deliver:

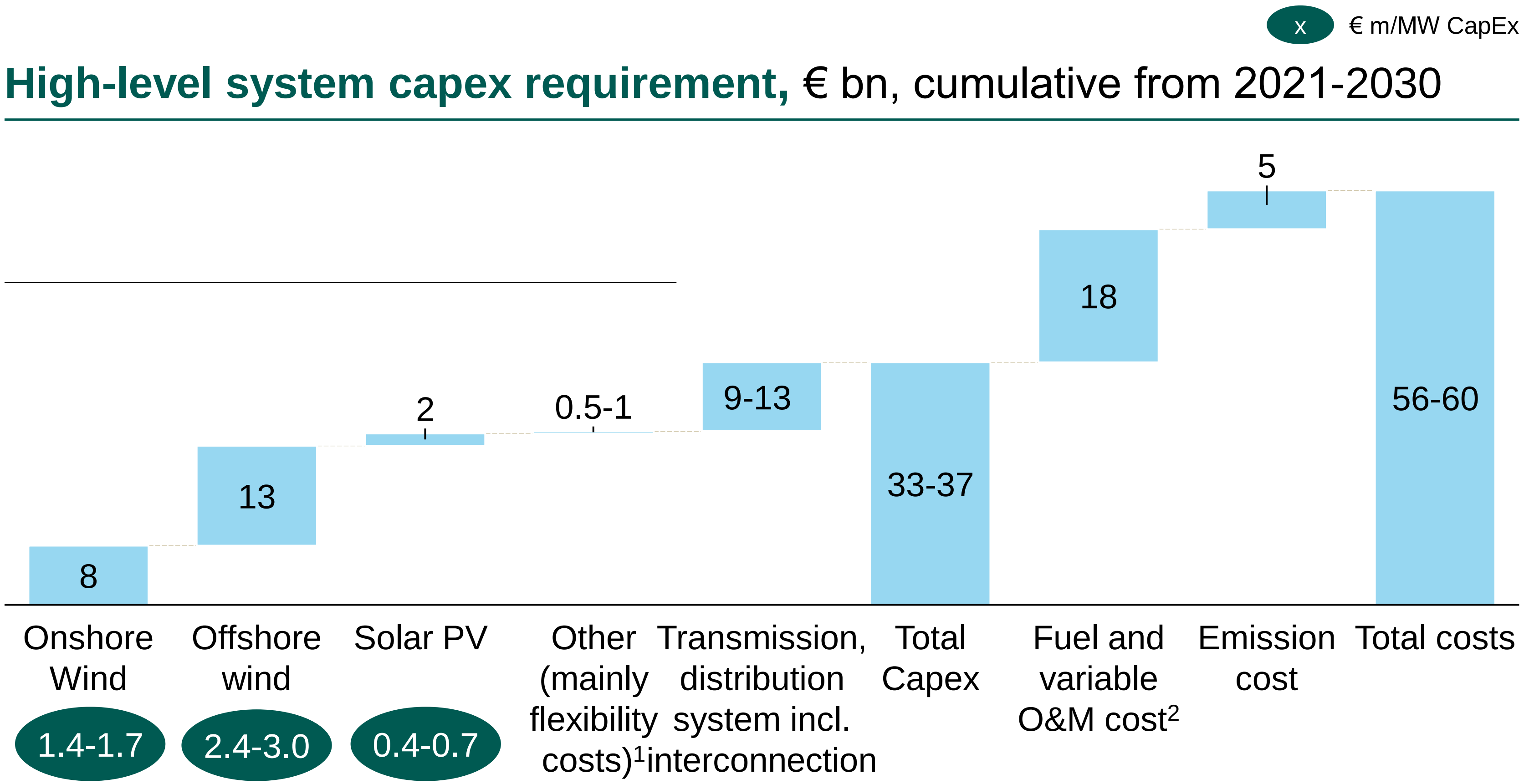
- ~5 GW offshore wind
- ~8 GW onshore wind
- ~ 2 GW solar

No coal generation from 2023 onwards. Significant fuel inflows from gas under EUR100 ETS

Curtailment at ~16% of total generation by 2030, driven by offshore and onshore wind

① This sector ceiling implies a total capex requirement of €56-60bn

High-level system capex requirement, € bn, cumulative from 2021-2030



1. Includes costs for short-time and long-time flexibility solutions such as battery storage, electrolysis for hydrogen production
2. Cost of natural gas based on forward curves at 18 EUR/mmbtu in 2025 and 16 EUR/mmbtu in 2030; subject to uncertainty and accounting for EUR 16Bn of total cost

Commentary

System cost estimates shown here based on scenario with the following renewables capacity mix:

- 8 GW of onshore wind
- 5 GW of offshore wind
- 2 GW of solar PV

Depending on the share of solar PV and wind capacity, these cost estimates will scale accordingly

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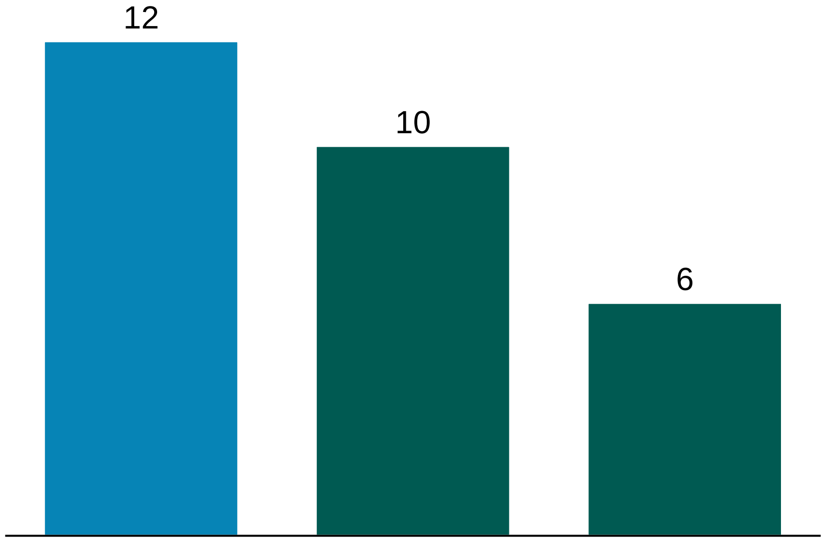
The proposed sectoral emissions ceiling delivers ~20% and 50% emissions reductions in 2025 and 2030



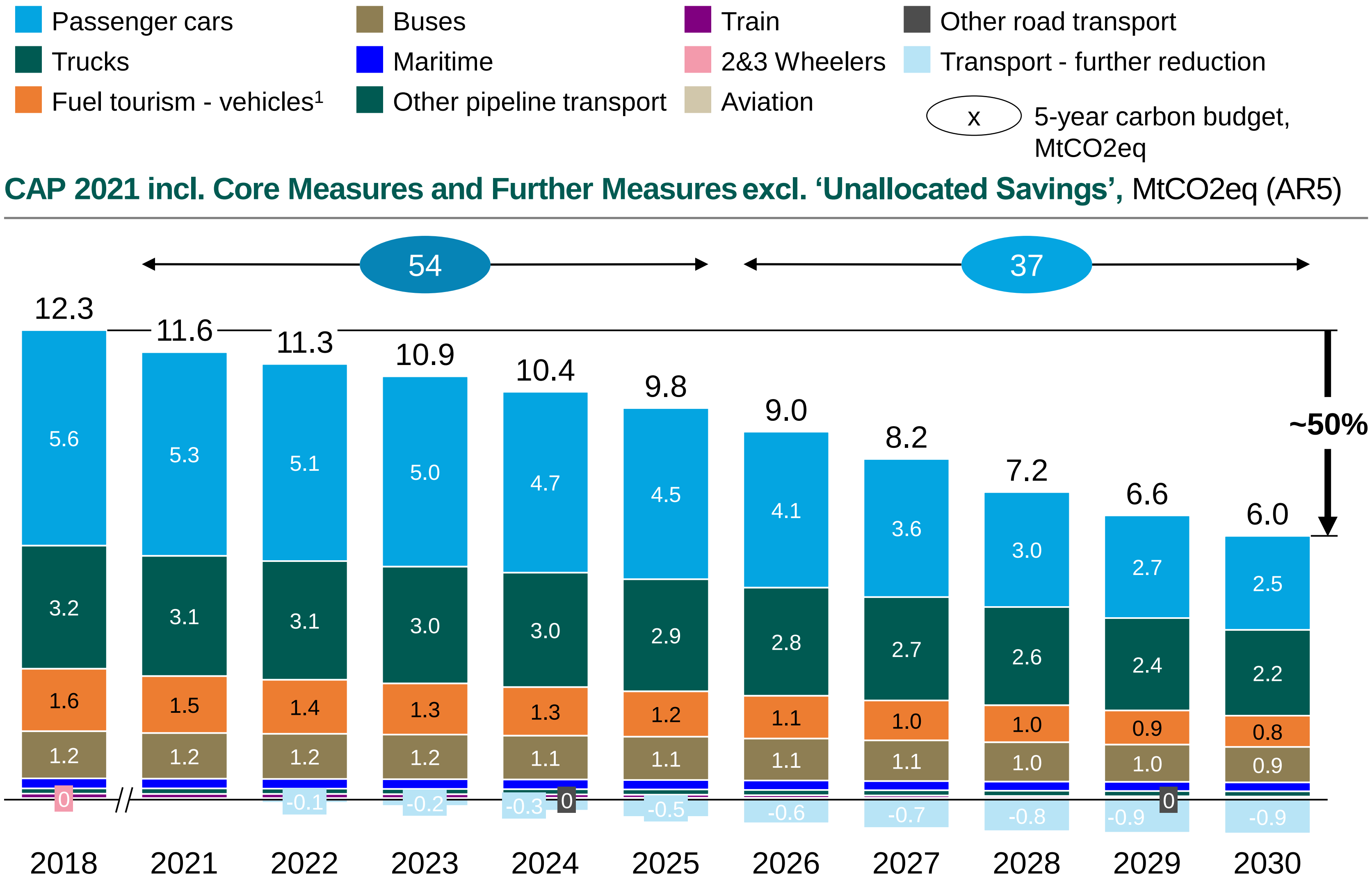
	GHG emissions[1], MtCO2eq (AR5)			% change vs. 2018		% impact outlined in CAP 2021	Sectoral emissions ceilings, MtCO2eq	
	2018	2025	2030	To 2025	To 2030	CAP 2021	2021-2025	2026-2030
Transport	12	10	6	~20	~50	40-50	54	37

---

1. GHG emissions and abatement impact based on AR5 2021 EPA methodology

Source: Climate Action Plan 2021, Government of Ireland; Programme for Government 2020

Dept. of Transport will be responsible for overseeing a ~50% reduction in emissions to 2030



CAP 2021 incl. Core Measures and Further Measures excl. 'Unallocated Savings', MtCO2eq (AR5)

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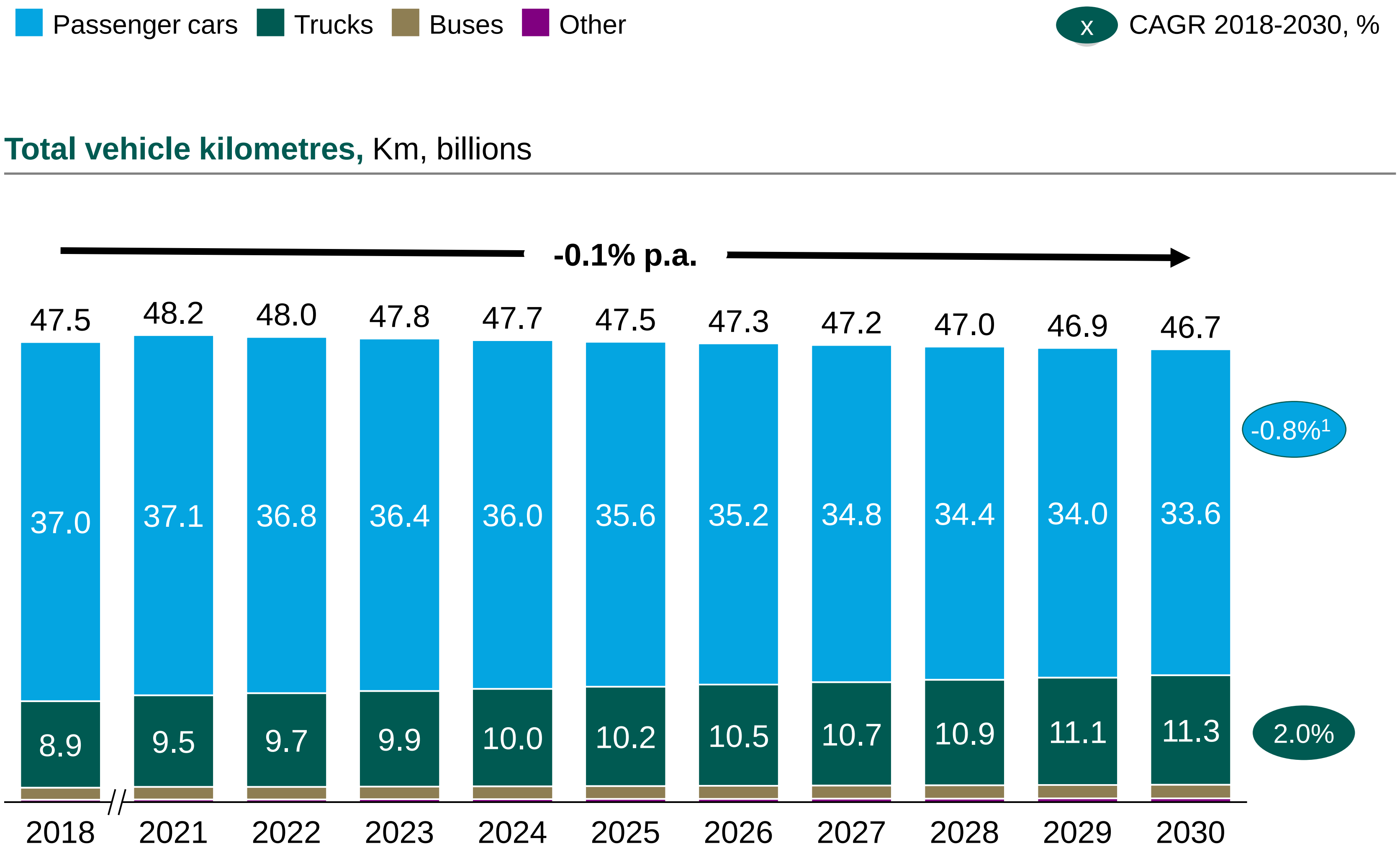
1. Fuel tourism accounted for ~2% of Ireland's national GHG emissions in 2015. Irish Journal of Social, Economic and Environmental Sustainability; January 2018

Reduction pathway in Climate Action Plan 2021 results in ~ 50% reduction by 2030 in emissions that could be covered by Department of Transport

Meeting the target emissions includes:

- Fully implementing the core measures outlined in CAP21
- Undertaking further modal shift (tier 2) through behavioral changes to reduce kilometers travelled to a greater extent

The sectoral emission ceiling assumes -0.1% annual growth in total vehicle kilometres through 2030



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1. Assumed a 0.6% increase in passenger kms through 2030, though this is reduced to -1.3% once a decrease in passenger kms travelled of 15.45% compared to a no action scenario is taken into consideration

Source: DSE Modelling assumptions

Key takeaways

Total vehicle kilometers are assumed to decrease by -0.1% per annum from the 2018 baseline to 2030

With further measures, passenger kilometers are forecast to decrease to ~31.7 billion in 2030 (-0.8% p.a.)

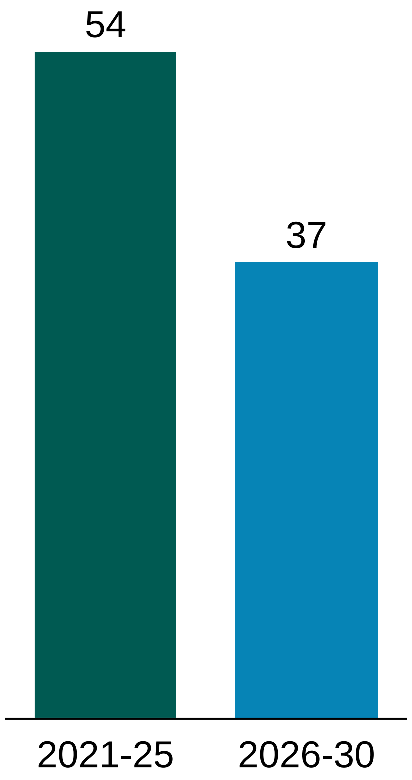
Achieving the proposed sectoral emissions could require an increase in the ambition for total stock of passenger EVs in 2030 from 845k in CAP21 to ~950k

There are 5 measures that drive emissions reductions of ~5.6-6Mt by 2030

Abatement impact, MtCO2eq

○	<0.5
◔	0.5-1
◑	1-1.5
◕	1.5-2
●	>2

Transport carbon budgets, MtCO2eq



Potential Measures

		Measure	KPI 2025	KPI 2030	Abatement impact 2030 , MtCO2eq
Core measures **CAP21**	T1	**Electrify road transport: accelerated adoption of zero-emission passenger cars and commercial vehicles**	175k passenger EVs with focus on BEVs; ~20k vans and 700 HGVs	950k passenger EVs with focus on BEVs; ~95k vans and ~3.5k HGVs	●
	T2	**Increase bio-fuel blend-rate**	E10 bioethanol blend; B12 biodiesel blend	E10 bioethanol blend; B20 biodiesel blend	◕
	T3	**Electrify mass transportation**	300 EV buses and expanding electrified rail services	1.5k EV buses and expanding electrified rail services	○
	T4	**Sustainable transport journeys and demand management measures**	125k additional public transport and active travel journeys per day	15.5% reduction in car passenger kilometres vs do nothing	◑
Further Measures **CAP21**	T5	**Further modal shift** (tier 2) through behavioural changes to reduce kilometres travelled to a greater extent	To be defined	To be defined	◑ SUM ~5.6-6.0

Source: Climate Action Plan 2021, Government of Ireland

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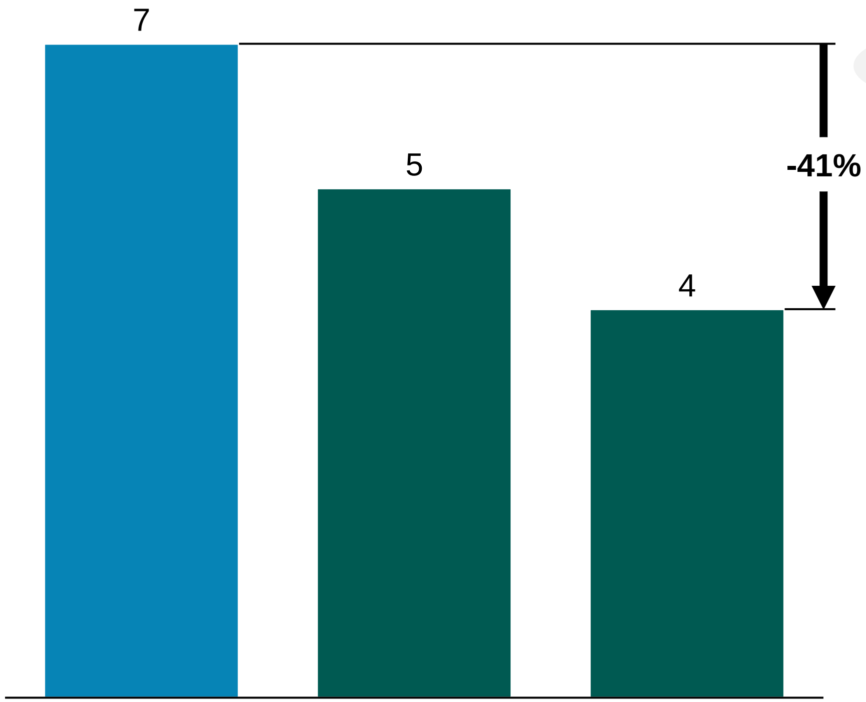
The sector emission ceilings for residential buildings could imply ~20% emissions reductions by 2025 and ~41% by 2030

Climate Action Plan 2021 incl. Core Measures and Further Measures

	GHG emissions[1], MtCO$_2$e (AR5)			% change vs. 2018		Sectoral emissions ceilings[2], MtCO$_2$e	
	2018	2025	2030	To 2025	To 2030	2021-2025	2026-2030
Buildings (residential)	7	5	4	~20	~40	29	23



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1. GHG emissions and abatement impact based on AR5 2021 EPA methodology;
2. Buildings range in CAP 21 was 45-55%, however there were no splits for commercial buildings

Source: Climate Action Plan 2021, Government of Ireland; Programme for Government 2020, Government of Ireland

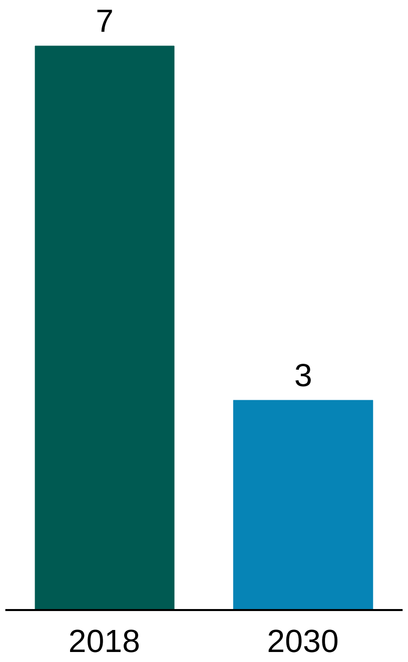
There are four measures that would reduce emissions by 3.7-4.1Mt by 2030

PRELIMINARY

Abatement impact, MtCO2eq

○ <0.5 ◑ 1-1.5 ◔ 0.5-1 ◕ 1.5-2 ● >2

Residential carbon budgets, MtCO2eq



Potential Measures

		Measure	KPI 2025	KPI 2030	Abatement impact by 2030, MtCO2eq
Core measures from CAP 2021	B1	Retrofit residential dwellings and deploy zero-emission heating in existing homes *Retrofitting skewed to solid-fuel homes to increase abatement*	**120k** retrofitted homes (to BER B2) **~275k** zero-emission heating in residential dwellings (heat pumps), 170k in new buildings, ~105k existing buildings	**495k** retrofitted homes (to BER B2) **680k** zero-emission heating in residential dwellings (heat pumps), 280k in new buildings, ~400k existing buildings	●
	B2	Continue to phase out fossil fuels in new homes	**+170k** new homes without fossil heat (heat pumps)	**+280k** new homes without fossil heat (heat pumps)	○
			Zero new gas connections established in new homes beyond 2023		
	B3	Increase targets for roll-out of district heating *Further emissions reduction possible with increased district heating potential of 5.1TWh in line with National Heat Study – see B5*	**~1.6 TWh** of district heat supplied **e.g., ~95-115k homes** connected to district heating network	**2.5 TWh** of district heat supplied **e.g., ~200-220k homes** connected to district heating network	○
Further measure	B4	Blend in zero-emission gas for fuel use in buildings *Further emissions reduction possible with increased biomethane production potential of 5.7TWh in line with National Heat Study*	**0.4 TWh** consumption of zero-emission gas[1]	**0.7 TWh** consumption of zero-emission gas[1]	◔
	B5	Accelerate phase out of fossil fuels in homes	No fossil fuel boilers in new dwellings from Q4 2023 onwards Stable number of gas boilers in existing dwellings		◑
Total					**3.7-4.1Mt**
Potential stretch measures identified – *not included in scenario*	B6	Increase ambition for district heating	**~1.4 TWh[2]** of district heating additionally supplied	**2.16 TWh[2]** of district heating additionally supplied	○
	B7	Complete phase out of fossils fuels use	**~35% reduction** in consumption of solid fuels in existing homes	**90% reduction** in consumption of solid fuels in existing homes	◑

Additional levers beyond sectoral emission ceiling

1.Representative share of 5.7TWh of biomethane production. Revised downwards from 1-3TWh identified in CAP21 to avoid double counting across sectors.
2.Additional potential of 2.4TWh beyond measure 3 to reach 5.1TWh as outlined in SEAI National Heat Study, also split 90/10 residential/commercial;

Source: Climate Action Plan 2019; 2021, Government of Ireland

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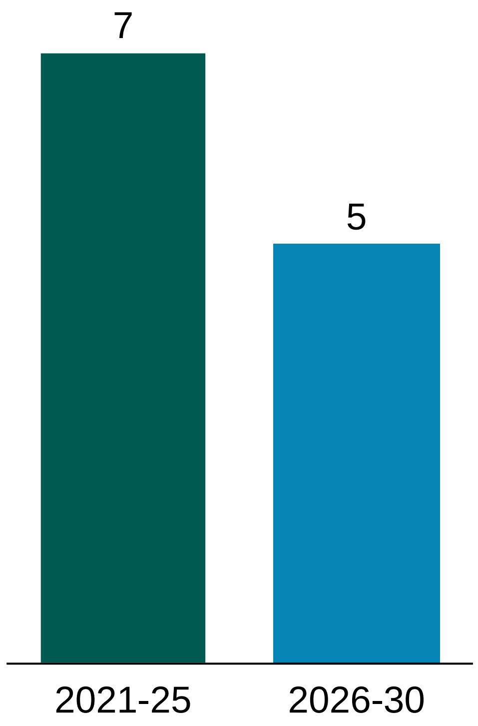
There are two measures that could reduce emissions by ~0.6Mt in 2030

▨ Deep dive next page

Commercial buildings carbon budgets, MtCO2eq



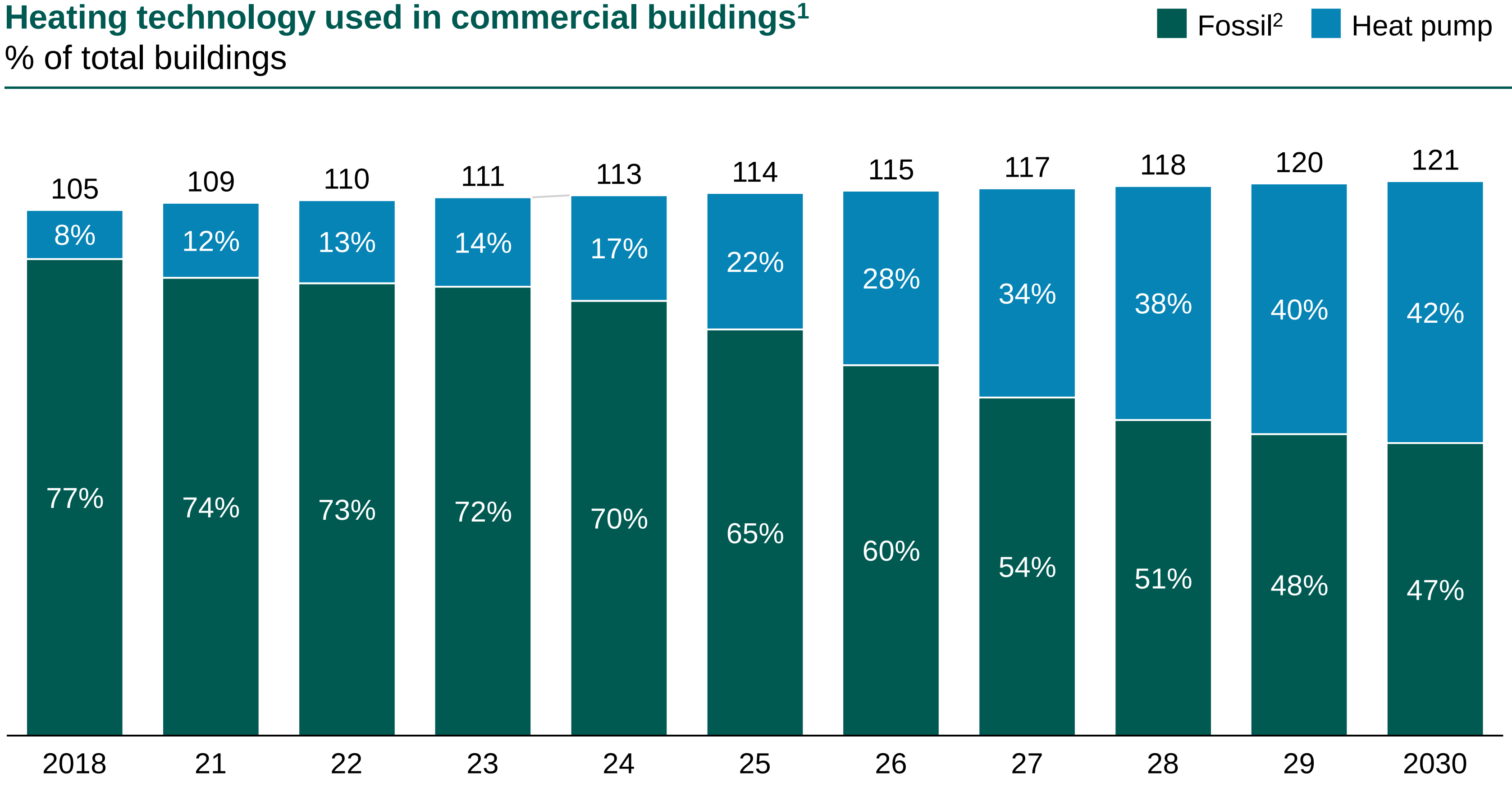
Potential Measures

	Option	KPI 2025	KPI 2030	Abatement impact, MtCO2eq	
				2025	2030
Core measures	Zero-emission heat in commercial buildings	Number of buildings with zero-emission heating: ~28k	Number of buildings with zero-emission heating: ~55k	~0.3	~0.6
	District heating in commercial buildings	Energy demand in TWh: ~0.1	Energy demand in TWh: ~0.2	~0.03	~0.04
			Sum	~0.3	~0.6

Source: Climate Action Plan 2019, Government of Ireland

A fast ramp-up zero-emission heat in commercial buildings could reach ~46% penetration by 2030

Heating technology used in commercial buildings[1]
% of total buildings



Commentary

- Rapid phase out of oil boilers and natural end-of-life replacement of gas with low carbon alternatives (e.g. heat pumps)
- Potential to reduce emissions by ~42% from commercial heating. There are currently ~120k commercial and public buildings in Ireland
- Abatement cost from switching oil and gas boilers to a heat pumps could range from ~5 to ~350 EUR/tCO2

1. Including public buildings
2. Fossil classified as gas and oil boilers

Source: Climate Action Plan 2021, Government of Ireland, SEAI

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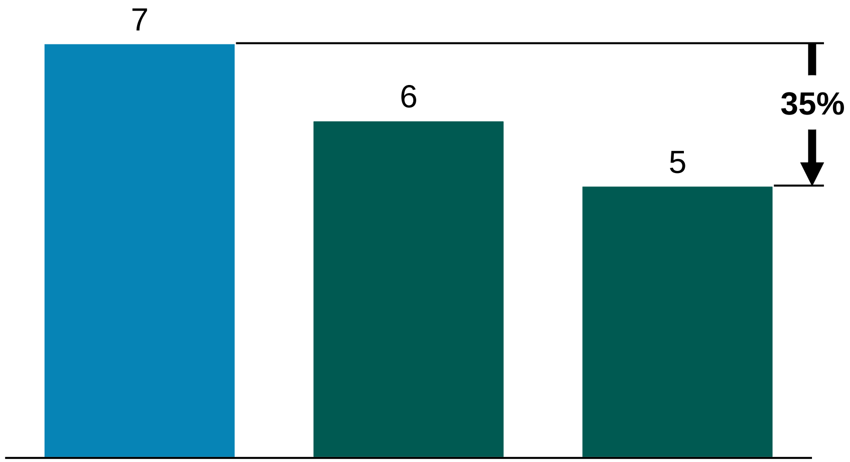
The sectoral emissions ceilings proposes ~20% emissions reductions by 2025 and ~35% by 2030



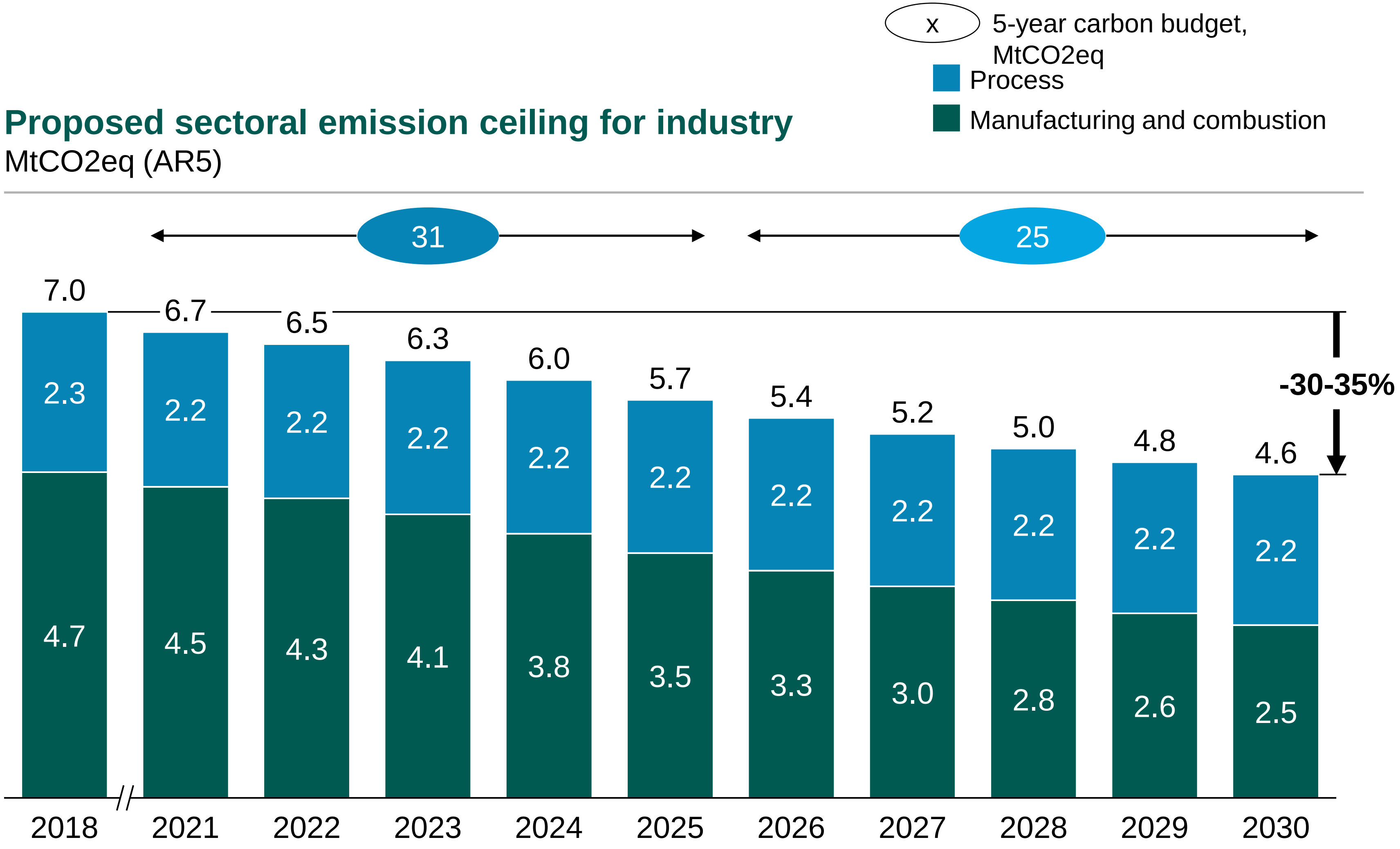
	GHG emissions[1], MtCO2eq (AR5)			% change vs. 2018		Sectoral emissions ceilings, MtCO2eq	
	2018	2025	2030	To 2025	To 2030	2021-2025	2026-2030
① **Industry[2]**	7	6	5	~20	~35	31	25

[1] GHG emissions and abatement impact based on AR5 2021 EPA methodology

Source: Climate Action Plan 2021, Government of Ireland

DETE could be responsible for overseeing a ~30-35% reduction in emissions to 2030

Proposed sectoral emission ceiling for industry
MtCO2eq (AR5)



1. Includes high and low temperature heat, mining and other categories

Source: Climate Action Plan 2021, Government of Ireland

Reduction pathway in Climate Action Plan 2021 results in ~30-35% (~2-2.5Mt) reduction in emissions by 2030

Meeting the target emissions includes:

- Ramp-up of zero emissions heat and district heating in commercial buildings
- In industry: uptake of alternative fuels; phase decrease in embodied carbon; blend in zero emissions gas

There are 5 measures that could reduce emissions in industry by ~2-2.5 MtCO2eq

Abatement impact, $MtCO_2eq$ ○ <0.5 ◔ 0.5-1 ◑ 1-1.5 ◕ 1.5-2 ● >2

Industry carbon budgets, MtCO2eq

Potential Measures

		Measure	KPI 2025	KPI 2030	**2030 abatement impact,**MtCO2eq
Core measures **CAP21**	I1	Accelerate uptake of carbon-neutral heating in industry	**~40-50%** share of carbon neutral heating in total fuel demand (excluding measures I3, I4 and I5)	**~50-60%** share of carbon neutral heating in total fuel demand (excluding measures I3, I4 and I5)	◔
	I2	Decrease embodied carbon in construction materials	**E.g. 5%** decrease in embodied carbon in construction materials	**10%** decrease in embodied carbon in construction materials	○
	I3	Enable electrification of high-temperature heat generation	**70%** of steam production from gas-electric hybrid heating	**100%** of steam production from gas-electric hybrid heating	◔
Further Measures **CAP21**	I4	Decrease embodied carbon in construction materials	Demand remains flat to 2030, 20% decrease vs ‘do nothing’ scenario	Demand remains flat to 2030, **30% decrease** vs ‘do nothing’ scenario	○
	I5	Blend in zero-emission gas	**~1.2 TWh** consumption of zero-emission gas	**~2.1 TWh** consumption of zero-emission gas	○
				Sum (exc. CCS)	**~-2-2.5**
Not included in Climate Action Plan 2021 pathway		Deploy Carbon Capture and Storage (CCS)	**1** out of 4 cement/lime plants retrofit CCS	**2** out of 4 cement/lime plants retrofit CCS	◑

1. Including waste management | 2. Impact of further measure included in CAP21 within the indicated range

Source: Climate Action Plan 2019, Government of Ireland

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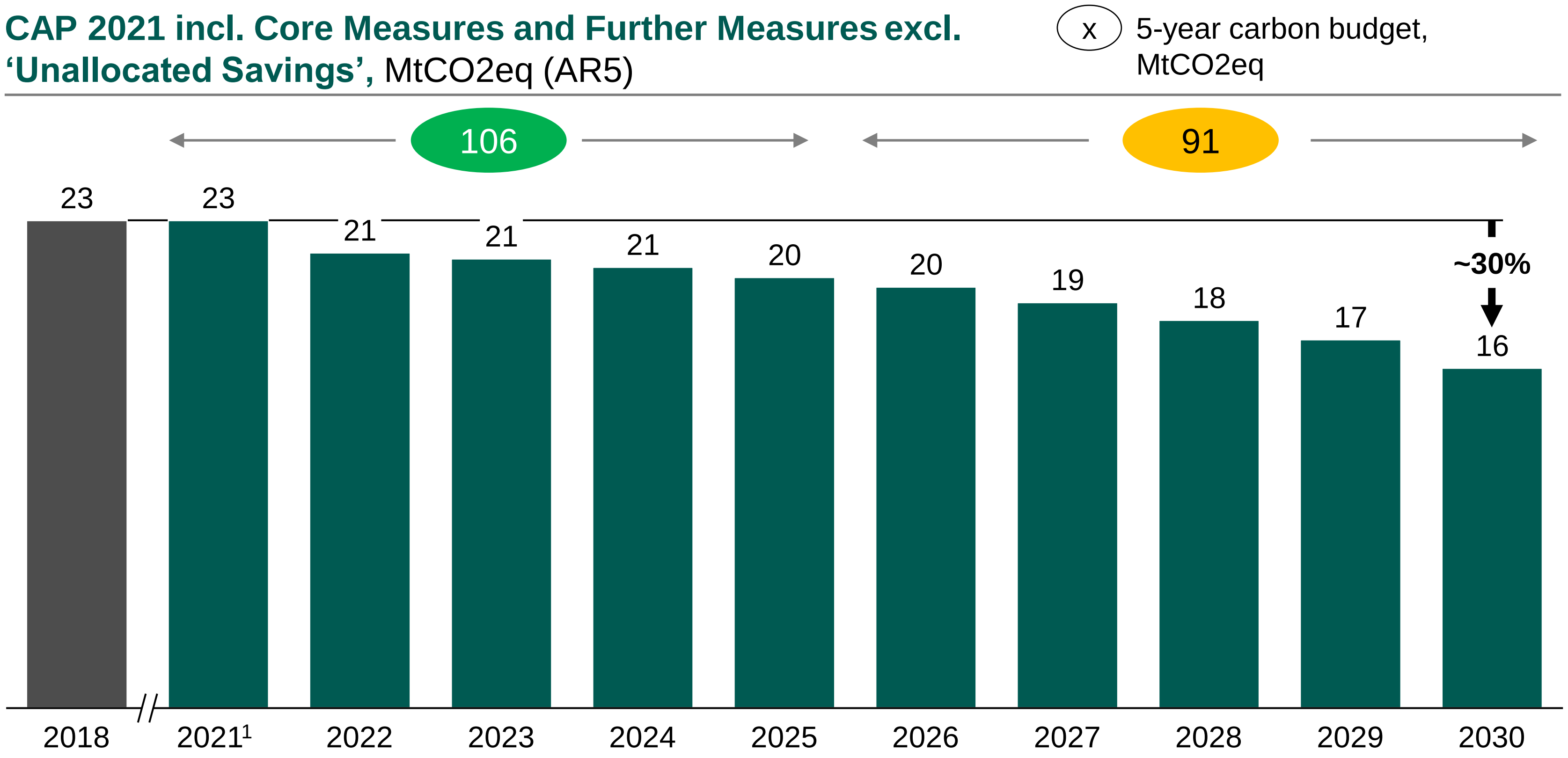
The agriculture reduction pathway could result in a ~30% reduction by 2030

CAP 2021 incl. Core Measures and Further Measures excl. ‘Unallocated Savings’, MtCO2eq (AR5)

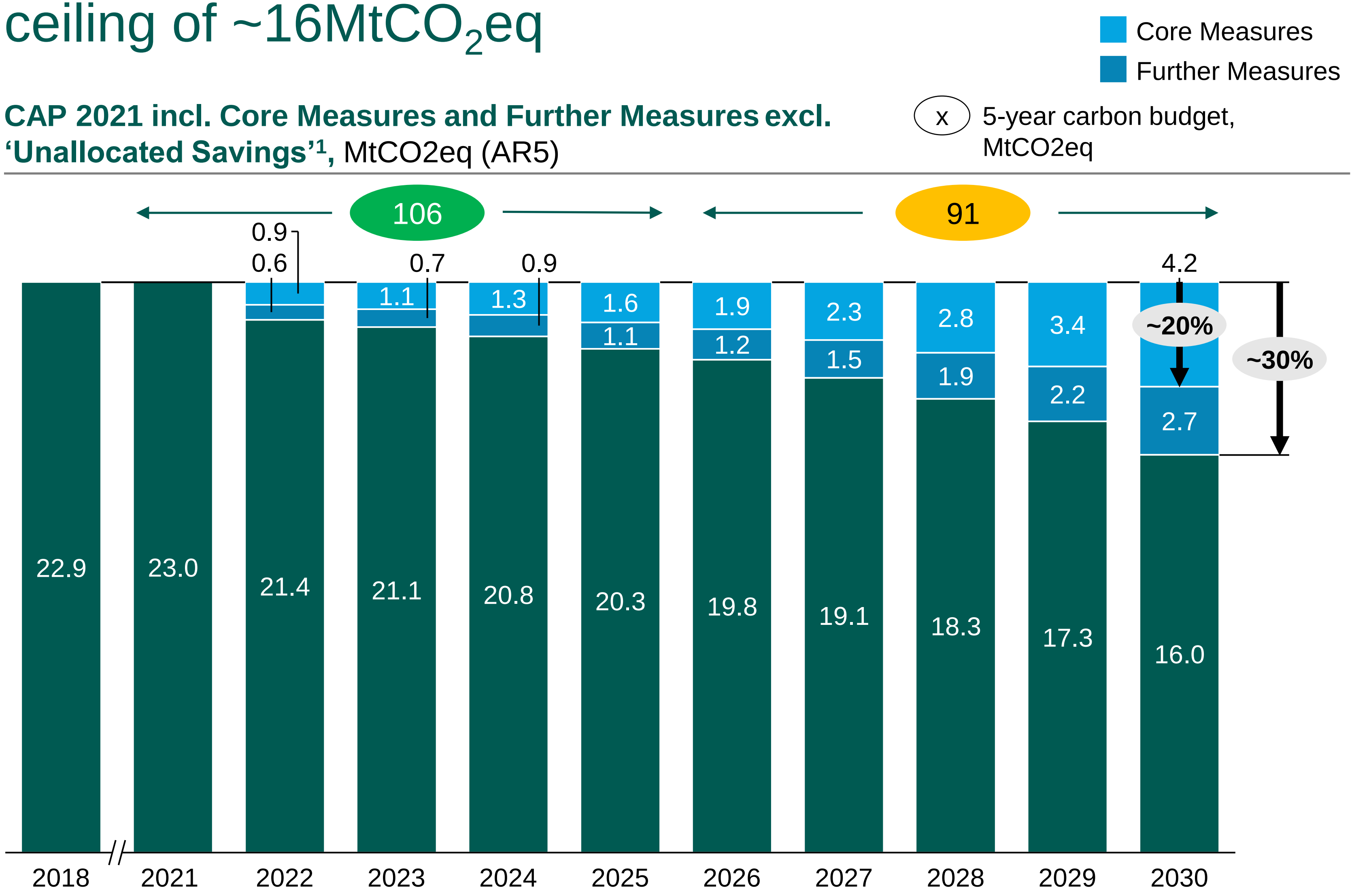


Agriculture

The proposed sectoral emissions reduction pathway as laid out in Climate Action Plan 2021 for **agriculture results in a ~30% reduction by 2030**

Both Core and Further Measures could be required to deliver the ~30% reduction to Agriculture's emissions ceiling of ~16MtCO$_2$eq

CAP 2021 incl. Core Measures and Further Measures excl. 'Unallocated Savings'[1], MtCO2eq (AR5)



Core Measures alone will deliver ~20% reduction by 2030

Further Measures could be required to deliver the ~30% reduction needed to reach Agriculture's 2030 emissions ceiling of ~16MtCO2eq

1. To achieve -30% reduction, diversification in line with Teagasc Scenario D, such diversification can be reduced if technological measures are accelerated

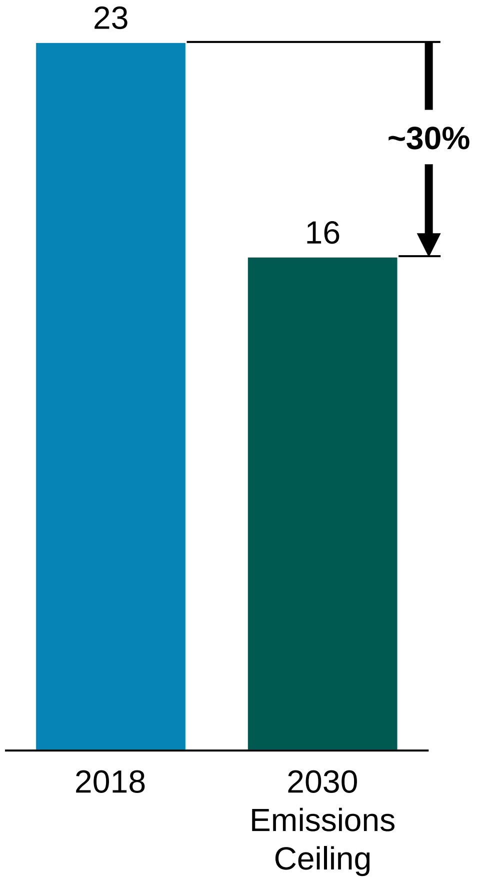
Source: Climate Action Plan 2021, Government of Ireland

The Climate Action Plan 2021 identified two core measures that could support 3.6-4.2 Mt emissions reduction in agriculture

○ <0.5MtCO2 ◔ 0.5-1MtCO2 ◑ 1-1.5MtCO2
◕ 1.5-2MtCO2 ● >2MtCO2

PRELIMINARY – SUBJECT TO DATA VALIDATION

GHG emissions agriculture, MtCO2eq (AR5)



		Option	KPI 2025[2]	KPI 2030	Abatement impact by 2030[1], MtCO2eq
Core measures	A1	**Increase adoption of GHG-efficient farming practices**	**~0.6x** Climate Action Plan 2019 ramp up	**~1.5x** Climate Action Plan 2019 ramp up	●
Example sub-measures		Reduction in nitrous oxide emissions	< 350kt nitrogen use, replacement of ~30% of ammonium nitrate through urea, aim for ~90% uptake of low emission slurry spreading	< 325kt nitrogen use, replacement of ~65% of ammonium nitrate through urea, reach ~90% uptake of low emission slurry spreading	●
		Improved animal breeding	Aim for suckler beef weight/dairy herd recording of 70/90%	Increase suckler beef weight/dairy herd recording to 70/90%	◑
		Improved animal feeding	Reduce crude protein content of livestock food	Reduce crude protein content of livestock food	◕
		Early finishing age of cattle	Reduce average age of slaughter to 24 months	Reduce average age of slaughter to 24 months	◕
		Increasing organic farming	Increasing organically farmed area to ~145kha	Increasing organically farmed area to ~350kha	◑
	A2	**Create new biomethane business opportunities**	**~0.7 TWh** of bio-methane production achieved without land use change	**~1.6 TWh** of bio-methane achieved without land use change *Note: the sectoral emissions ceilings assumes 5.7TWh of biomethane production by 2030*	◑
		Total			Σ **~3.6-4.2**

Core measures proposed in CAP21 provide 3.6-4.2 MtCO2eq of abatement by 2030, but are **insufficient to meet the proposed ~7MtCO2eq of abatement** implied by the sectoral emissions ceiling

1. Abatement impact combines 2019 and 2021 core and further measures; 2. KPIs weighted based on respective share of 2030 emissions

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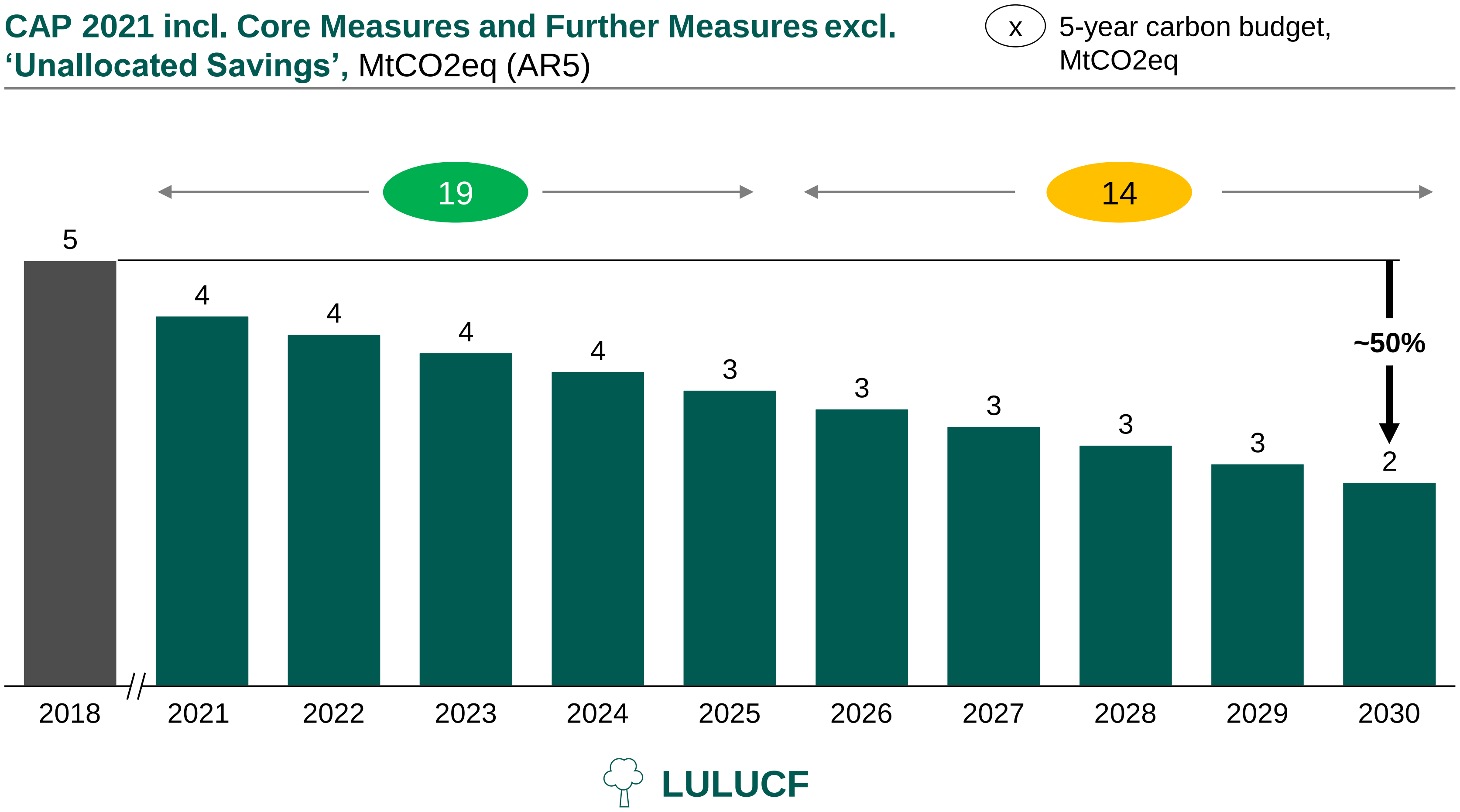
- ❑ **LULUCF**
- Other (F-gases, Petroleum Refining and Waste)

The LULUCF reduction pathway from CAP 2021 could result in a ~50% reduction by 2030

CAP 2021 incl. Core Measures and Further Measures excl. ‘Unallocated Savings’, MtCO2eq (AR5)



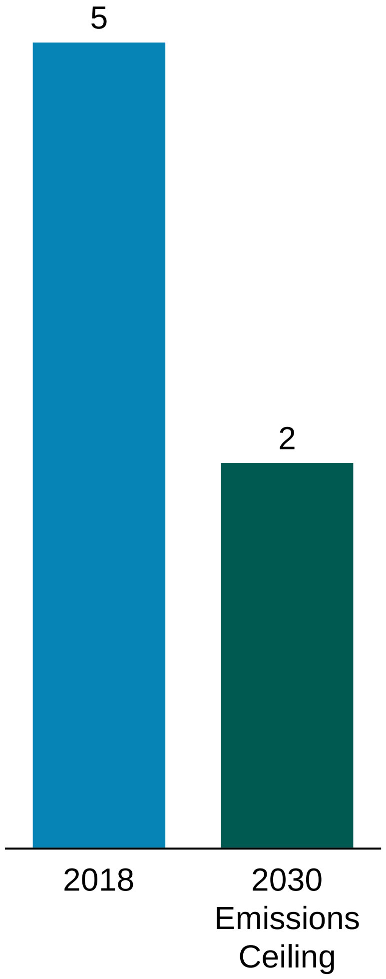
LULUCF emission estimates under review. Emission ceilings will likely be updated once work is published.

The proposed sectoral emissions reduction pathway for **LULUCF could result in a ~50% reduction by 2030**

CAP21 identified 8 measures to further reduce emissions through LULUCF

○ <0.5MtCO2 ◔ 0.5-1MtCO2 ◑ 1-1.5MtCO2 ◕ 1.5-2MtCO2 ● >2MtCO2

GHG emissions LULUCF, MtCO2eq, AR5 2020 methodology



Land Use (total area)[1]	**Option**	**KPI 2025**	**KPI 2030**	**Abatement impact by 2030,** MtCO2eq
Forestry	**L1 New afforestation to 2030**	**~4,700 ha/yr** planting rate	**~8,000 ha/yr** planting rate	◔
Cropland (0.78m ha)	**L2 Increase use of cover crops**	**~29 kha** of cover crop planted	**~50 kha** of cover crop planted	○
	L3 Incorporate excess straw into tillage	**5%** of cereal area to incorporate straw directly into soil	**15%** of cereal area to incorporate straw directly into soil	○
Grassland (4.15m ha)	**L4 Increase mineral grassland carbon sequestration**	**~263 kha** grassland managed better to improve sequestration	**~450 kha** grassland managed better to improve sequestration	○
	L5 Manage organic grasslands better (farmed peatlands)	**~23 kha** organic grassland soils rewetted	**~80 kha** organic grassland soils rewetted	○
Peatlands/ Wetlands (1.22m ha)	**L6 Bord na Mona and LIFE Peatlands rehabilitation**	…	**~ 35,900kha** peatland rewetted	○
	L7 Additional wetlands rehabilitation	...	**~ 41,700kha** wetland rewetted	○
Total			∑	**~2.5**
Not included in emission ceiling	**L8 Accounting for afforestation of removals realised post 2030**			●

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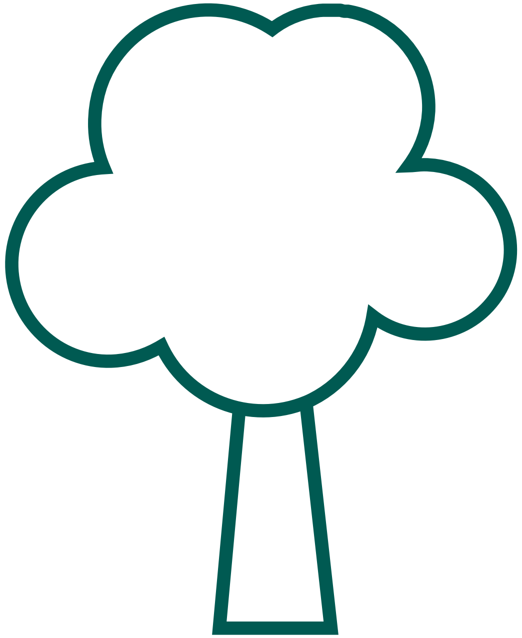
1. Areas based on 2018 land use. Total area = 7.11m ha (settlement/other = 0.18m ha, abatement from these land uses do not get

Our understanding of LULUCF will continue to evolve



Our understanding of LULUCF will continue to evolve, based on:

- **Updated National Inventory Report and projections** which may revise the LULUCF baseline and outlook
- **Publication of Phase 1 Evidence Gathering of the Land Use Review** being led by the EPA. Phase 2 Land-use Strategy will build on the evidence from Phase 1, and will consider policies, measures and actions in the context of the Government’s wider economic, social and climate objectives
- Insights from CAMG on **land use change requirements to reach net zero by 2050**

The implications of these on LULUCF emissions ceilings will be considered when available. The Climate Action and Low Carbon Development Amendment Act 2021 allows for the recalculation of carbon budgets in the event of a material change in scientific understanding.

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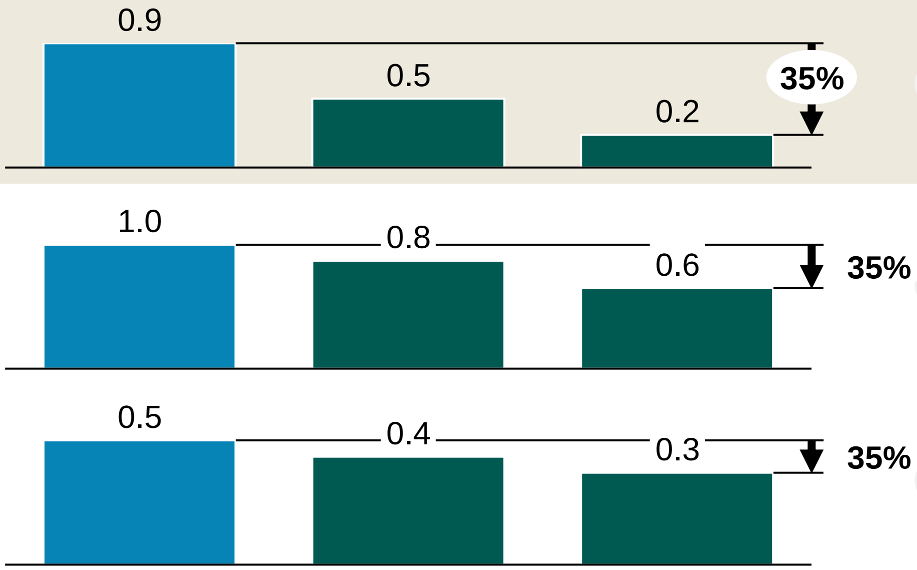
- ❑ **Other (F-gases, Petroleum Refining and Waste)**

The sectoral emissions ceilings have been set for F-gases, waste management and petroleum refining

▨ Detail to follow

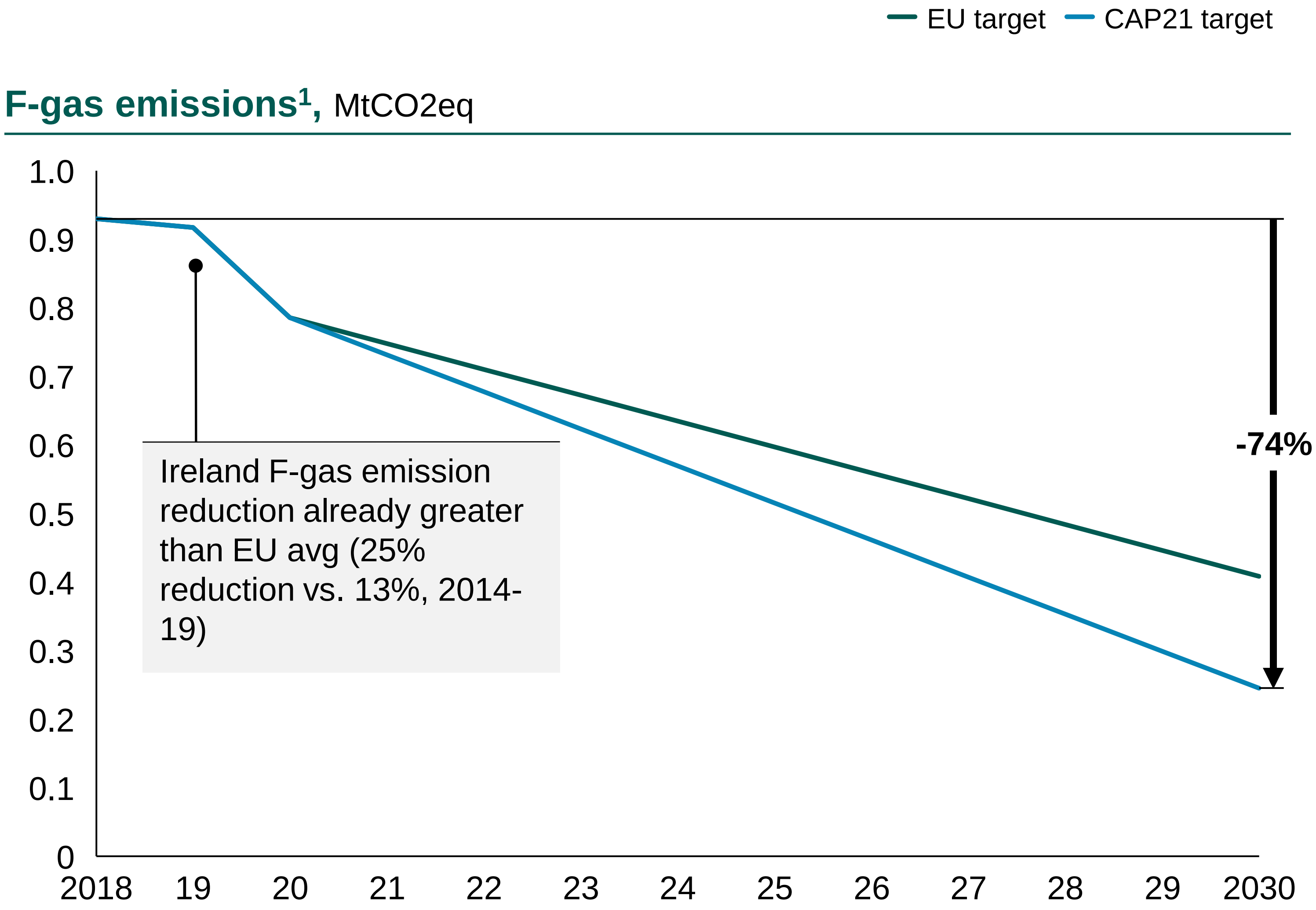


	GHG emissions[1], MtCO2eq (AR5)			% change vs. 2018		Sectoral emissions ceilings, MtCO2eq	
	2018	2025	2030	To 2025	To 2030	2021-2025	2026-2030
1 **F-gases**	0.9	0.5	0.2	~45	~75	3	2
2 **Waste**	1.0	0.8	0.6	~15	~35	4	4
3 **Petroleum refining**	0.5	0.4	0.3	~15	~25	2	2

Source: Climate Action Plan 2021, Government of Ireland

1. Increasing ambition on phasing out F-gases beyond EU targets could deliver further abatement

F-gas emissions[1]**,** MtCO2eq



Ireland F-gas emission reduction already greater than EU avg (25% reduction vs. 13%, 2014-19)

Key takeaways

EU regulation has a reduction target of 67% of F-gas emissions by 2030 vs 2014

CAP21 sets a higher ambition to commit to 80% reduction of F-gas emissions. A linear phasing down of emissions is assumed

F-gases accounted for ~1.4% of Ireland's emissions in 2020. A ~15% decrease in 2019-20 was driven by reduction in refrigeration and air conditioning emissions, due to phasing out of F-gases with high global warming potentials (GWPs) and replacement with blend of HFCs and hydrofluoroolefins with low GWPs

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1. GHG emissions based on AR5 2021 EPA methodology

Source: EPA, European Commission

1. A number of countries have already increased their ambition vs. EU targets

EU regulation increased in ambition…

F-gas emissions reduction by ~67% in 2030 vs. 2014.

Achieved by:

- 80% phasedown of HFC sales and imports in 2030 vs. 2014
- Banning use of F-gases in new types of equipment (e.g. stationary refrigeration)
- Preventing F-gas emissions through mandating better maintenance and recovery

Note, new EU F-gas regulation proposed in 2022, including more stringent HFC targets to 2050 and further equipment bans

…however countries are also going further

Spain’s approach has enabled a ~65% reduction in F-gases between 2014-19. Measures used include:

- Tax scheme for highest GWP F-gases
- Permit system required to handle F-gases
- Mandatory training for technicians
- Subsidies for implementation of alternative technologies

Sweden has introduced prohibitions on the refilling of refrigerant equipment with F-gases by non-authorised persons and has strict rules and penalties regarding leakage control

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