SEAI SUSTAINABLE ENERGY AUTHORITY OF IRELAND

National Energy Projections 2023

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2023 Report

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November 2023

Sustainable Energy Authority of Ireland
SEAI is Ireland's national energy authority investing in, and delivering, appropriate, effective and sustainable solutions to help Ireland's transition to a clean energy future. We work with the public, businesses, communities and the Government to achieve this, through expertise, funding, educational programmes, policy advice, research and the development of new technologies.

SEAI is funded by the Government of Ireland through the Department of the Environment, Climate and Communications.

SEAI response to National Energy Projections 2023

CEO William Walsh reflects on the 2023 National Energy Projections outputs and what they mean.

This year's National Energy Projections present a stark reality. Despite several impressive successes in recent years, and signs of good momentum, we are not currently on track to meet our legally binding greenhouse gas emissions obligations. Even though current policy measures and those proposed in the Government's 2023 Climate Action Plan (CAP23) are unprecedented in pace and ambition.

Since the Climate Action and Low Carbon Development Act was signed into law in 2021, Ireland has seen record progress on the transition towards a low carbon economy. SEAI's home energy upgrade schemes saw a 150% increase in activity in the first half of 2023, compared to the same period last year. Similarly, in decarbonised transport, electric vehicles continue to grow in popularity, with the EV market share at a new high of almost 20% in the first half of 2023.

Over the past decade, the portion of electricity generated by renewables has grown to almost 40% – a dramatic increase from just 20% in 2012. With over 300 onshore wind farms now within the Republic, Irish grid operators are world leaders in maintaining a grid with increasing shares of variable electricity supply. Future ambition for the sector is unprecedented. Expansion into offshore wind and large-scale solar generation must lead to 80% renewable electricity by 2030, to meet carbon obligations, and importantly to underpin decarbonisation of our heat and transport sectors as they shift to electricity.

If the CAP23 scenario reported here plays out, there will be massive changes to our energy infrastructure and our relationship with energy itself. Half a million existing homes will be upgraded and all new buildings will meet zero emissions status by 2030. District heating systems will be deployed in cities and towns. There will be a mass shift towards public transport, walking and cycling, and electric vehicles will displace our petrol and diesel fleet. The public sector, businesses of all sizes, large industry, and agriculture will all be far more efficient and will use more renewables. In short, the CAP23 scenario represents a seismic shift away from fossil fuels over the next seven years.

And yet, even if we achieve all this, our projections suggest that it will not be enough to live within our legally binding carbon budgets and sectoral ceilings.

Recent EPA projections for total national greenhouse gas emissions show we have already used 45% of our first carbon budget, after just 40% of the time period 2021-2025. Based on our latest projections, the overshoot in total cumulative emissions from energy use will be between 14% and 24% by 2030. Only immediate and significant corrective action will give us any chance of complying with the second and subsequent carbon budgets. Time is not on our side.

When considering what might be possible to turn these projections around, one option is to look to the past. Historically we previously witnessed the scale of annual emission reductions required during times of significant disruption, such as the pandemic, or during economic recession. Unfortunately, when these threats passed, emissions rebounded. Whilst there is some momentum in our energy transition, there is no historic precedent for what must come next.

A second option is to create and agree a vision for the future that we all we want for our society. And then find a way to deliver it. Thinking like this, we keep ourselves open to a myriad of possibilities, unconstrained by the past.

As well as building on the current momentum and urgently pursuing all options, we need to discuss and plan for broader change.

Sustainable energy investment unlocks a multitude of benefits and addresses a broad range of Government priorities. Society benefits from reduced energy costs and emissions and increased national energy security. Homes and buildings are warmer with improved air quality. Health outcomes improve with reductions in national and private health costs. Business and industry are more competitive, with more people employed in related supply chains. These benefits are far reaching but we need key decision makers to fully consider these benefits to properly contextualise the necessary investments.

Among the brave decisions required is a recognition of the need to urgently increase the financial and human capital working to end fossil fuels in Ireland. The numbers are clear, incremental change is not an option. Looking at our longer-term decarbonisation obligations, we cannot trade off choices for investments in one sector versus another. Each and every sector must fully decarbonise. Stronger incentives are needed across all sectors. The recent budget will help, but even more is needed.

Increased spending must be matched with stronger regulation, requiring the heaviest emitters to reduce emissions, or to scale back operations until such time as they can comply, for example. We need to consider increased carbon taxes on high-polluting luxury items like SUVs. Could we consider some limits on air travel until decarbonisation actions take effect?

Accelerating our energy transition requires far more people on the task - in supply chains to ensure we can deliver large scale change and infrastructure, and in the public sector to ensure right environment and services are in place to support the acceleration. Government taskforces are having significant impact as they focus on deployment of key technologies. But translating their findings into actions like developing new legislation, improved planning and consenting processes, business cases to speed up Government decision making, and for governance supporting the transition, requires significantly more minds put to the task, across the public sector and Government.

The costs of failing to make the required leap are incalculable. We must recognise our responsibility to each other, and globally. As a wealthy nation, and due to our geographical location, Ireland has only started to experience the impacts of the changing climate, but we have witnessed catastrophic events in other parts of our planet where communities are less able to act.

The brave new world we envisage forces us to look beyond the technological, to the societal behavioural change required. The challenge is to act together, fast and with the necessary courage, to muster an emergency response to the climate and biodiversity emergencies. This will take more investment, and substantially more effort, particularly from those who can do more. Change is always hard, especially when it means looking at how we go about our daily lives. But Ireland has shown its capacity to deliver concerted effort, most recently to protect each other from a global pandemic. The rewards will be many, not least a sense of being able to say to future generations 'we are doing everything we can'. There is no one coming to save us from ourselves. It is up to you and me.

Executive Summary

Since the adoption of the Climate Action and Low Carbon Development Act in 2021, Ireland has seen record progress on the transition towards a low carbon economy. On the home heating front, SEAI's National Retrofit Scheme saw a 150% increase in energy upgrades supported in the first half of 2023, compared to the same period last year. When it comes to decarbonised transport, electric vehicles continue to grow in popularity, with the EV market share increasing to a new high of 18.5% in the first half of 2023. Government has allocated a record €310 million for the development of over 1,200 active travel infrastructure projects.

If the CAP23 (Climate Action Plan 2023) scenario modelled and reported here plays out, we will see massive changes to our energy infrastructure and relationship to energy itself. Renewable electricity will be scaled up at never-before-seen rates to hit 80% of generation by 2030. We will see half a million existing homes upgraded delivering reduced carbon emissions and all new buildings meeting a zero emissions status by 2030. We will see fundamental changes to the way we travel, including a mass shift towards public transport, walking, and cycling, as well as phasing out of petrol and diesel vehicles. There will be significant levels of energy efficiency and renewable energy technologies across the public sector, business community, large industry, and agriculture. In short, the CAP23 scenario represents a dramatic departure from our current ways of generating and using energy within the next seven years.

Our projections analysis indicates that current policy measures and those proposed in the Government's 2023 Climate Action Plan, while unprecedented in pace and ambition, are not sufficient to meet our targets based on current projections of economic growth and policy out-turn. This is a sobering reality. It is important to acknowledge the substantial progress and momentum achieved, while also recognising that unprecedented further change is needed to deliver the actions required to meet targets and play our part in addressing the climate emergency.

Understanding the challenge can be the first step towards finding a solution. Time is short, but there are actions we can take to rectify the situation. Due to the cumulative nature of our targets, rapid and significant corrective action is essential to keep within our second carbon budget period 2026 to 2030. If we make the leap required now, we can protect each other, and future generations in Ireland, and globally.

This report presents the inputs, assumptions, and outputs from SEAI's latest National Energy Projections process. The projections are an output from the Government's National Energy Modelling Framework developed and maintained by SEAI. They provide an assessment of the anticipated future impact of energy policy and take account of macroeconomic baselines provided by the ESRI. The outputs play an essential role in assessing our progress against legally binding decarbonisation obligations, while indicating how our energy landscape might look in the future depending on our level of success in driving necessary change. The data produced through this exercise is a key input to the EPA's annual Greenhouse Gas Emissions Projections. The projections presented in this report are the result of the 2023 national energy and climate modelling cycle, which culminated in the EPA projections published in June 2023. A new modelling cycle for 2024 began in September 2023 and will produce a new set of projections in early 2024. The 2024 cycle will consider new policies and measures to be introduced in the upcoming Climate Action Plan 2024.

Key messages

- The 2023 Climate Action Plan set out targets and supporting actions to further accelerate the transition from fossil fuels to renewable energy sources.
- Significant momentum is evident in many actions including those supporting delivery of renewable electricity, household retrofit and EV deployment.
- However, uncertainty remains over the scale and pace of delivery of some of the ambitious targets set out in the Plan, including those for biomethane, district heating, offshore wind, building retrofit, heat pump deployment and transport demand reduction.
- Even with full delivery of the CAP23, the energy sector will likely still be off track to keep within its share of Ireland's national legally binding carbon budget for the first two budget periods. It will also likely be off track to meet the 2030 final energy use reduction target set by the revision to the EU Energy Efficiency Directive.
- Current projections indicate that if the 2023 Climate Action Plan targets are fully delivered the energy sector could deliver on its current EU 2030 renewable energy target, though interim targets are unlikely to be met.
- Early corrective action is crucial; the earlier that annual emissions are reduced, the greater the impact on the growth of cumulative emissions. The fast tracking of all actions could make a significant impact.
- Unless greenhouse gas emissions are reduced sharply between now and the end of 2025, it is highly unlikely that we will be able to stay within budget out to 2030.
- Further new measures, combined with an acceleration of planned and existing measures, are now necessary to comply with Ireland's legally binding carbon budgets and to reduce total final energy demand in line with the EU target.

Contents

1 National energy projections overview

SEAI deliver the National Energy Projections annually, in collaboration with the Environmental Protection Agency (EPA) and the Economic and Social Research Institute (ESRI). The cycle of consultation with key stakeholders, refinement of input assumptions, and model development, is a continuous process. The projections presented in this report are the result of the 2023 national energy and climate modelling cycle, which culminated in the EPA projections published in June 2023. A new modelling cycle for 2024 began in September 2023 and will produce a new set of projections in early 2024. The 2024 cycle will consider new policies and measures to be introduced in the upcoming Climate Action Plan 2024.

The National Energy Projections are used to plan and assess policies and measures to achieve Ireland's national energy and climate obligations and targets. The projections for greenhouse gas emissions from energy use published by the EPA as part of the National Greenhouse Gas Emissions Projections are based directly on the SEAI National Energy Projections. The National Greenhouse Gas Emissions Projections are used by government to analyse and track progress against our domestic greenhouse gas reduction obligations. The SEAI and EPA projections are submitted to the EU to meet EU climate and energy planning and reporting requirements. For EU reporting, projections are submitted covering the period out to 2040. In this report, however, we focus on the period out to 2030, as this is the period on which the main EU and national targets and obligations, and so policy measures, are currently focused.

SEAI's National Energy Projections are modelled using the Government's National Energy Modelling Framework (NEMF) which is developed and maintained by SEAI.[1]

Throughout this report, alongside data on energy use, we present data on greenhouse gas emissions. In all cases, data on greenhouse gas emissions are taken from the latest EPA greenhouse gas emissions inventory[2] and greenhouse gas emissions projections[3]. The EPA projections for greenhouse gas emissions from energy are calculated directly from the SEAI National Energy Projections, therefore the energy and greenhouse gas emissions data are consistent.

1.1 Policy inputs

The Climate Action Plans (CAP) published by Government are the definitive source of information on government policies and measures on climate and energy. The Climate Action and Low Carbon Development (Amendment) Act 2021 requires the government to produce a Climate Action Plan (CAP) each year which must set out sector specific actions that are required to comply with the carbon budget and sectoral emissions ceilings.

[1] For more information on the NEMF see Appendix 1

[2] EPA 'Ireland's Provisional Greenhouse Gas Emissions 1990-2022'. 2023. [Online]. Accessed from: https://www.epa.ie/publications/monitoring--assessment/climate-change/air-emissions/irelands-provisional-greenhouse-gas-emissions-1990-2022.php

[3] EPA 'Ireland's Greenhouse Gas Emissions Projections 2022-2040'. 2023. [Online]. Accessed from: https://www.epa.ie/publications/monitoring--assessment/climate-change/air-emissions/irelands-greenhouse-gas-emissions-projections-2022-2040.php

SEAI typically model two levels of policy achievement for the National Energy Projections: a 'With Existing Measures' (WEM) scenario and a 'With Additional Measures' (WAM) scenario.

The WEM scenario is a projection of future energy use based on the policies and measures currently implemented and actions committed to by Government. To become part of the WEM scenario a policy or measure must be in place by the end of 2021[4] and the stated ambition must be commensurate with the resources or legislation already in place or committed to by Government Departments or Agencies. This scenario does not assume the implementation of any new policies or measures post 2021. This year's WEM scenario accounts for the anticipated impacts of the 2021 Climate Action Plan (CAP21). But not all targets set in the CAP21 are automatically assumed to be met. For example, we do not assume that the CAP21 target for 945,000 Electric Vehicles (EVs) is fully achieved in the WEM, as together with stakeholders, we judge that the supports currently implemented are unlikely to fully deliver the target on their own.

The WAM scenario is more ambitious. It is a projection of future energy use based on the measures outlined in the latest Government plans at the time the National Energy Projections are compiled. This includes all policies and measures included in the WEM scenario, plus those included in the latest Government plans but not yet fully implemented. For example, the WAM scenarios include the target of 945,000 EVs on the road by 2030 in the 2023 Climate Action Plan (CAP23).

This year, we have modelled two WAM scenarios: WAM-CAP21 and WAM-CAP23. The WAM-CAP21 scenario broadly assumes that the targets set out in the CAP21 will be met, and the WAM-CAP23 scenario broadly assumes that the additional targets set in the CAP23 will be met.

More details on the main policy assumptions in each scenario are provided in the following sections for each sector.

[4] 2021 was the cut off year as it was the last historical reporting year at the time that the projections were carried out. The cut off moves up one year each year.

2 Ireland's national climate and energy targets

In 2021 the government adopted Irelands 'Climate Action and Low Carbon Development (Amendment) Act' to support the national transition towards a green economy. This act established a legally binding framework, embedding explicit decarbonisation obligations into Irish law. In line with international consensus, the Act sets the 'National Climate Objective' which aims to see Ireland achieve a climate neutral economy no later than 2050.

To realize the ambition, the Act requires the Government to set a series of legally binding, five-year, economy-wide carbon budgets. These carbon budgets draw focus into the 2020-2030 timeframe. The carbon budgets are proposed by the Climate Change Advisory Council, finalised by the Minister for the Environment, Climate and Communications, and approved by Government. The budgets cover all sectors of the Irish economy, including the energy and non-energy sectors of agriculture and LULUCF[5], setting a limit on the total cumulative emissions that can occur within each budgeting period.

The first carbon budget programme is made up of 3 successive budgeting periods: 2021-2025 (CB1), 2026-2030 (CB2) and 2031-2035(CB3). The budgets for the first two periods are aligned with an in-year decarbonisation obligation of 51% reduction by 2030, in comparison to 2018 emissions. The third budgeting period remains provisional at the time of this report. The budgets are measured in $MtCO_2eq$[6] and structured such that `exceedance' in any budgeting period must be carried forward, effectively reducing the budget for the subsequent period. The budgets are shown in Table 1.

Table 1: Carbon budgets

	2021-2026 (CB1) ($MtCO_2eq$)	2026-2030 (CB2) ($MtCO_2eq$)	2031-2035 (CB3) ($MtCO_2eq$)
Budget	295	200	151
Indicative per annum reduction[7]	4.8%	8.3%	3.5%

The burden of decarbonisation has been apportioned across the economy in the form of sectoral emissions ceilings for the following sectors: industry, electricity, transport, built environment, agriculture, LULUCF, and Other[8]. A sector ceiling for LULUCF emissions remains to be determined. As such, compliance with currently defined sectoral ceilings may not ensure compliance with the overall carbon budget.

The sectoral ceilings represent the maximum emissions allowable within each sector to keep both within the carbon budget and 2030 decarbonisation obligation. Whilst any exceedance of the carbon budget must be carried forward into the next budgeting period, exceedance of a sectoral ceiling is not necessarily carried forward within that sector. Hence it may be possible for an exceedance within one sector for a budgeting period to be redistributed across other sectors at the

[5] LULUCF stands for Land Use, Land Use Change, and Forestry
[6] Mega-tonnes of Carbon Dioxide Equivalent. This unit accounts for all greenhouse gases by relating their global warming potential to the impact of one unit mass of carbon dioxide.
[7] Indicative per annum reduction percentages applicable if each year is on trajectory. These will increase as a result of underperformance in early years of carbon budgets.
[8] The Other sector includes emissions from Waste, F-Gases, and Petroleum refining.

onset of the next period. However, for the purpose of the analysis presented in this report, it is assumed that exceedance in any sector rolls forward within that sector. The sectoral ceilings are shown in Table 2.

Table 2: Sectoral emissions ceilings

Sector	Sectoral Emissions Ceiling CB1 ($MtCO_2eq$)	Sectoral Emissions Ceiling CB2 ($MtCO_2eq$)
Electricity	40	20
Transport	54	37
Buildings (Residential)	29	23
Buildings (Commercial and Public)	7	5
Industry	30	24
Agriculture	106	96
LULUCF	Undetermined	Undetermined
Other	9	8

The low carbon development act requires the government to produce a Climate Action Plan (CAP), detailing all policies and measures which will be deployed to reach the decarbonisation obligation. The government is also required to review and update the CAP every year. CAP23 was the first CAP to be published since the publication of the sectoral emissions ceilings, resulting in a higher level of ambition in comparison to its predecessor, CAP21. As the CAP specifies actions to be taken within all sectors, and must be consistent with the carbon budgets, it represents the definitive reference document for government decarbonisation policy.

When publishing the sectoral emissions ceilings, indicative 2030 in-year emissions reductions for each sector were also published for illustrative purposes. These values are estimated as a reduction in comparison to 2018 emissions. However, these in-year values assume that the indicative carbon budget trajectory is met each year. Given the cumulative nature of carbon budgets, if a sector exceeds the initial assumed trajectory in any year, then the indicative 2030 emissions target would need to be further reduced to maintain a compliant trajectory.

Currently the projections indicate that emissions trajectories in all sectors, excluding commercial and public buildings, will exceed the 2021-2025 ceilings. Hence this will require a much steeper reduction in emissions within the second budget period, corresponding to much lower in-year emissions by 2030 in comparison to the initial indicative values. This is discussed for each sector individually in the following sections.

3 Total energy use and energy-related emissions

3.1 Key messages:

- In 2022, 86% of all energy used in Ireland was from fossil fuels, 13% from renewable sources and the remainder from others such as waste and electricity imports. By 2030, fossil fuels could still provide most of our energy, ranging from 68% in the WEM scenario to 57% in the most ambitious and optimistic WAM-CAP23 scenario.
- Total energy use is projected to increase slightly in the WEM scenario (+5%) and decrease slightly in the WAM-CAP23 scenario (-4%).
- Changing demand over time is influenced by underlying population and economic growth, by the impact of policies and measures and by decisions made by citizens and business over the time horizon.
- In both the WEM and WAM-CAP23 scenarios the energy sector exceeds the sectoral ceilings for both the first and second carbon budget periods.
- The projected exceedance in the first budget period means that between 12% and 16% of the second budget will have been consumed before the second period begins, in the WAM-CAP23 and WEM scenarios respectively.
- By the end of the second budget period the total exceedance is projected to be 63.7 MtCO_2eq (24%) and 37.6 MtCO_2eq (14%) in the WEM and WAM-CAP23 scenarios respectively.

3.2 Total fuel use

In 2022, 86% of all energy used in Ireland was from fossil fuels, 13% from renewable sources and the remainder from others such as waste and electricity imports. In order to achieve Ireland's national climate objective, virtually all fossil fuel for energy use will need to be eliminated before 2050.

These latest projections of Ireland's energy use show that by 2030, fossil fuels could still provide most of our energy, ranging from 68% in the WEM scenario to 57% in the most ambitious and optimistic WAM-CAP23 scenario. The share of renewable energy in 2030 increases to 30% in the WEM scenario and to 42% in the WAM-CAP23 scenario.

The following sections examine in more detail the energy use of each of the main energy using sectors, namely electricity generation, transport, built environment and industry[9].

[9] Although agriculture is a large source of greenhouse gas emissions, the vast majority are not from energy use. Agriculture accounted for just 2% of energy use in 2021.

Figure 1: Total energy use

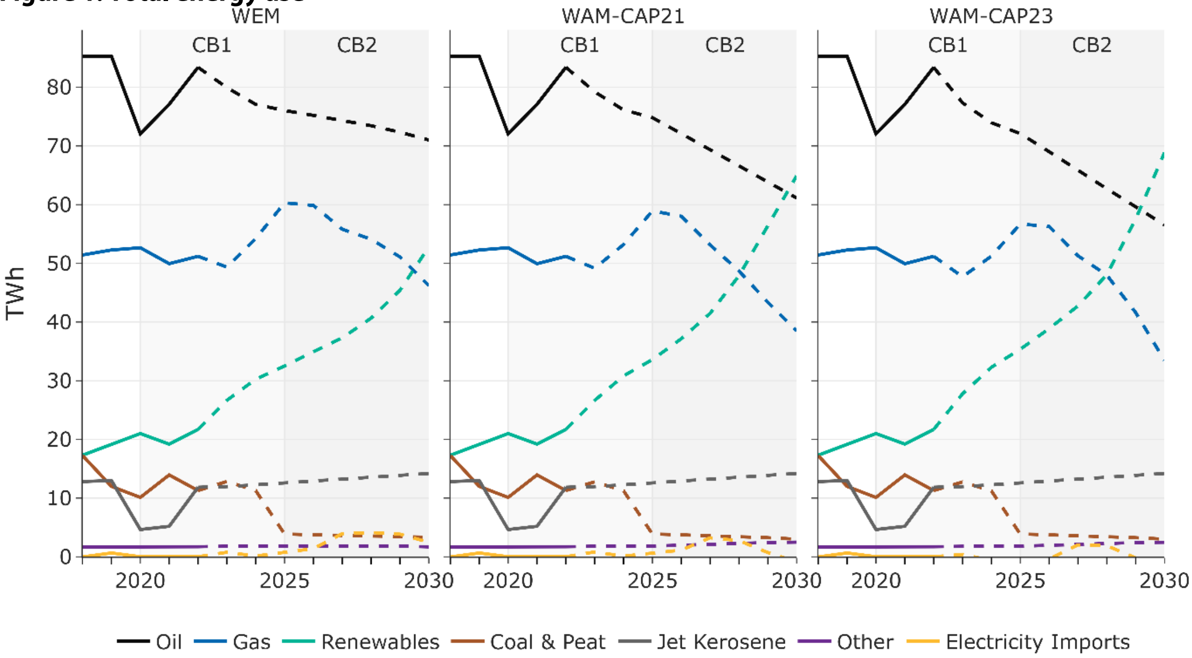

Table 3: Total energy use

Energy (TWh)	2022 Actual (TWh)	2030 Projected (TWh)		
		WEM	WAM-CAP21	WAM-CAP23
Renewables	21.7	52.8	64.9	68.9
Electricity imports	0.3	2.5	-0.9	-1.5
Oil (excluding jet kerosene)	83.4	71.0	61.1	56.6
Natural gas	51.2	46.2	38.5	33.5
Coal & peat	11.3	3.3	3.0	3.0
Other	1.7	1.7	2.5	2.5
Total (excluding jet kerosene)	169.6	177.5	169.2	162.9
Jet kerosene	11.8	14.2	14.2	14.2
Total (including jet kerosene)	181.4	191.7	183.4	177.1

3.3 Greenhouse gas emissions from energy use and industrial processes

In this section we examine the greenhouse gas emissions from all energy use in the context of the sectoral ceilings. Because the sector ceiling for industry includes both energy use and process emissions, it is necessary to also include the process emissions from industry.[10]

The combined sectoral ceilings for energy sectors including industrial process emissions are shown in Table 4[11]. Energy use and industrial processes were responsible for 52.2% of total national emissions in 2022.

If the indicative trajectory for the carbon budgets was followed every year, then emissions in 2030 would need to be 54% lower than in 2018. However, if this indicative trajectory is exceeded in early years, then to compensate steeper reductions are required thereafter, leading to a larger reduction required by 2030.

Table 4: Sectoral ceilings and related indicators for energy use and industrial processes

Sectoral ceiling for energy use and industrial processes	
2018 baseline emissions ($MtCO_2eq$)	38
CB1 ceiling 2021-2025 ($MtCO_2eq$)	160
CB2 ceiling 2026-2030 ($MtCO_2eq$)	109
Indicative average annual % reduction required in CB1	-4.7%
Indicative average annual % reduction required in CB2	-9.4%
Initial indicative reduction required by 2030 (Relative to 2018; assuming indicative target trajectory met in all years)	-54%

Figure 2 shows the *annual* emissions projected from energy use and industrial processes for the first two carbon budget periods for the WEM and WAM-CAP23 scenarios. It also illustrates the indicative annual emissions trajectory required to stay within the carbon budgets from 2021 to 2030. Dashed lines are used to illustrate a revised CB2 trajectory that would be required to meet the CB2 sectoral emissions ceiling if the WEM or WAM-CAP23 scenarios were followed in CB1. The resulting revised average annual reduction rate for CB2 and the revised total reduction by 2030 compared to the 2018 baseline are shown in Table 5.

[10] Unlike greenhouse gas emissions from energy use, greenhouse gas emissions from industrial processes do not come from combusting fossil fuels. They are produced by chemical reactions used for industrial processes other than combustion. The majority of process greenhouse gas emissions are from cement production.

[11] For this section we use the combined sector ceilings for the following sectors: Electricity, Transport, Built Environment and Industry. We did not include the emissions from the "Other" sector.

Figure 2: Annual greenhouse gas emissions from energy sectors and industrial processes

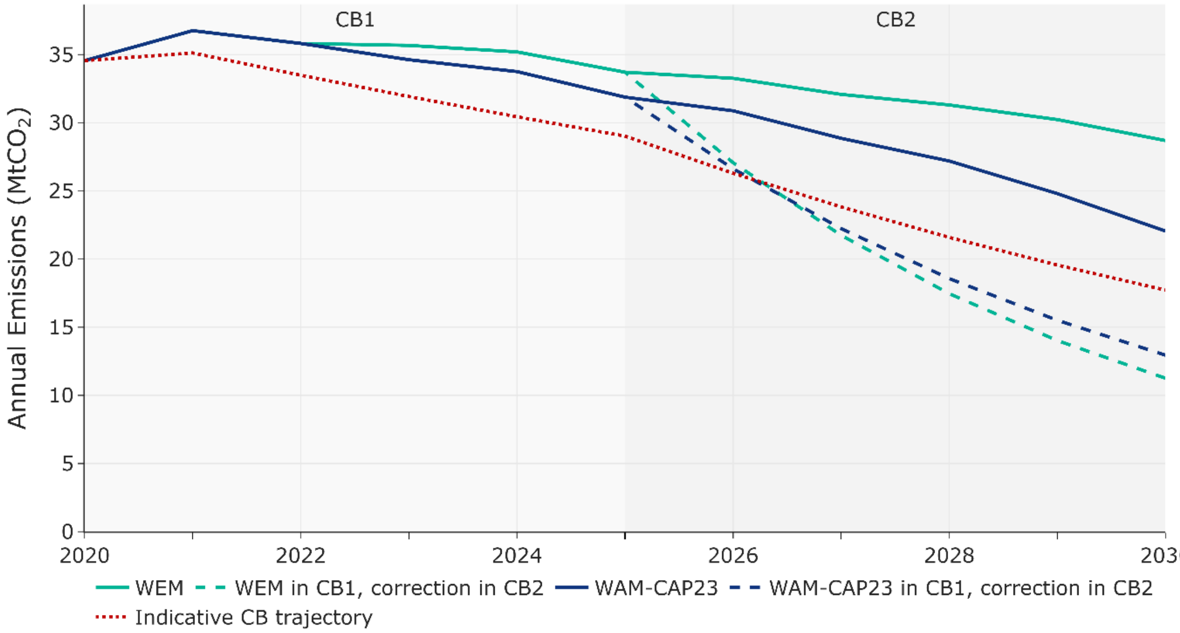

Figure 3 shows the *cumulative* emissions trajectories over the first two carbon budget periods for the WEM and WAM-CAP23 scenario. The black horizontal dashed lines show the sectoral ceilings for the first two budget periods. The chart illustrates the years in which the sectoral ceilings are reached in each scenario, and the cumulative exceedance by the end of the second budget period is noted for each scenario.

Figure 3: Cumulative greenhouse gas emissions from energy sectors and industrial processes

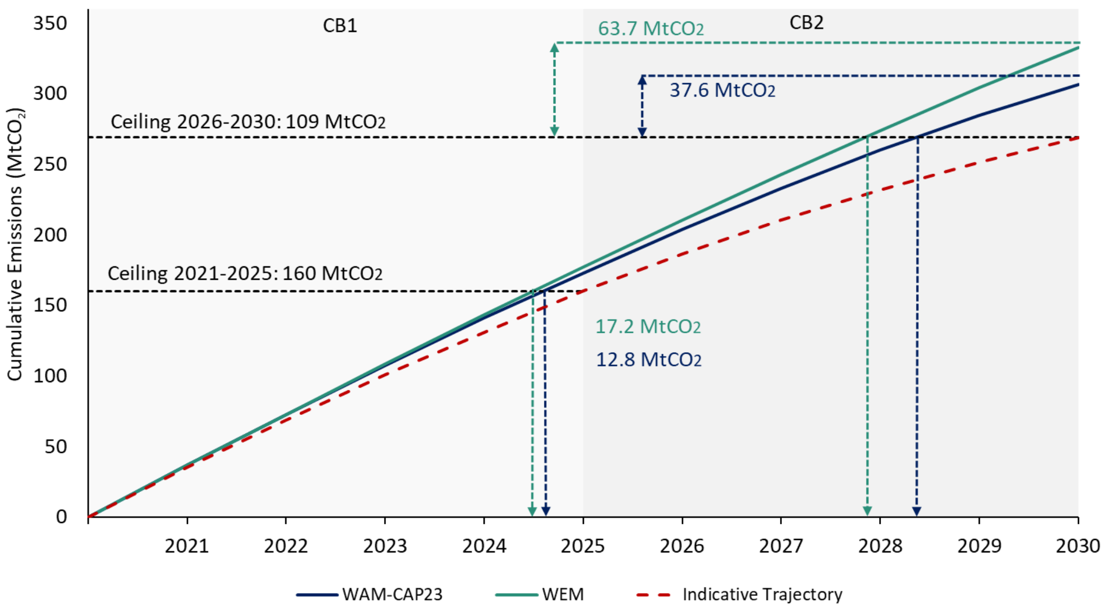

Table 5: Projected exceedance of sectoral ceilings for energy sectors and industrial processes

Total energy and industrial process emissions	WEM	WAM-CAP23
Projected CB1 exceedance ($MtCO_2eq$)	17.2	12.8
Projected CB2 exceedance (including CB1 carry over) ($MtCO_2eq$)	63.7	37.6
Projected average annual change in emissions for CB1	-1.8%	-2.8%
Indicative average annual change in emissions required in CB2 to stay within the CB2 ceiling if named scenario followed in CB1	-19.7%	-16.5%
Revised indicative reduction required by 2030 compared to 2018 to stay within CB2 ceiling if named scenario followed in CB1	-71% to -79%	-66% to -72%

In the WEM scenario, the greenhouse gas emissions from the combined energy use and process emissions sectors exceed the CB1 ceiling by 17.2 $MtCO_2eq$ (11%) by 2025. This overshoot means that 16% of the CB2 budget is consumed before the CB2 period begins. The second sectoral ceiling is then breached during 2028, with the exceedance reaching 63.7 $MtCO_2eq$ (24%) by 2030.

The WAM-CAP23 scenario exceeds the CB1 ceiling by 12.8 $MtCO_2eq$ (8%). This overshoot means that 12% of the CB2 budget is consumed before the CB2 period begins. In this scenario the CB2 ceiling is exceeded by 37.6 $MtCO_2eq$ (14%) by 2030.

If the WEM or WAM-CAP23 trajectory is followed until 2025, then greenhouse gas emissions from energy use and industrial processes would need to fall by 71% or 66% respectively by 2030 to keep within the CB2 sector ceiling [12]. This would require an average annual reduction in emissions during CB2 of 19.7% per annum in the WEM scenario and 16.5% in the WAM-CAP23 scenario.

[12]Assuming a geometric reduction trajectory. The final reduction required would depend on the trajectory taken within CB2. If the WEM or WAM-CAP23 trajectory were followed until 2025 and emissions were to then follow a linear reduction trajectory in CB2, then total greenhouse gas emissions would need to fall by 79% or 72% respectively by 2030 to keep within the second carbon budget.

4 Electricity generation

4.1 Key messages:

- Significant progress has been made to date when it comes to decarbonising our electricity system, with the carbon intensity of electricity from the grid decreasing by over 50% between 2005 and 2020.
- Given the success to date, and the potential to further increase the renewable proportion of electricity, the fastest decarbonisation pathways for energy across Ireland include significant electrification of heat and transport. Hence eliminating fossil fuels from electricity generation as quickly as possible is critical to success.
- In all modelled scenarios presented in this report, variable renewables are the largest input to electricity generation by 2030, with a sharp increase anticipated later in this decade due to assumed connection of large offshore wind projects.
- However, because the connection of the large offshore wind projects is assumed to happen in the last years of the decade, fossil fuels remain the largest input to electricity generation until 2029 in the WEM scenario and 2028 in the WAM-CAP23 scenario.
- Natural gas is the major source of emissions in the electricity sector by 2030. Gas used for electricity generation is projected to peak in 2025, and then fall by between 16% and 32% by 2030 compared to 2021, depending on the scenario.
- In both the WEM and WAM-CAP23 scenarios the electricity sector exceeds the sectoral emissions ceilings for both the first and second carbon budget periods.
- The projected exceedance in the first budget period means that between 28% and 37% of the second budget will have been consumed before the second period begins, in the WAM-CAP23 and WEM scenarios respectively.
- By the end of the second budget period the total exceedance is projected to be 20.1 $MtCO_2eq$ (33%) and 13.8 $MtCO_2eq$ (23%) in the WEM and WAM-CAP23 scenarios respectively.
- The deployment of renewables needs to outpace the growth in energy demand for it to deliver the absolute reductions in greenhouse gas emissions required. Therefore, the timing of the delivery of the renewable energy generation relative to the scale and pace of growth in electricity demand is a critical factor.
- In the context of our legally binding national and international climate and energy obligations, the negative consequences versus the benefits of allowing large new electricity users to establish in Ireland between now and 2030 needs to be considered.

4.2 Scenario assumptions at a glance

4.2.1 Electricity demand growth

WEM, WAM-CAP21 and WAM-CAP23 scenarios

- Datacentre electricity demand increases are based on the EirGrid "Median" growth scenario from the Generation Capacity Statement 2022-2031[13].
- See section 5.2.2 for assumptions on EV stock by scenario.
- See section 6.5.1 for results of modelling of heat pump uptake by scenario.

High-datacentre-growth sensitivity scenario

- The datacentre electricity demand increases are based on the EirGrid "High" scenario from the Generation Capacity Statement 2022-2031.
- All else as per WAM-CAP23 scenario

4.2.2 Delivery timeline of renewable generation capacity

WEM

- A best estimate for onshore renewable energy was used, whereas for offshore renewable energy a one-year delay was imposed on the WAM assumption of 5-GW by the end of 2030. See Table 6 for details.

WAM-CAP21, WAM-CAP23, High-datacentre-growth scenarios

- Assumed accelerated roll-out of variable renewables (wind and solar) so that the target for 80% RES-E is met. See Table 6 for details.
- Installed capacities assumed are lower than the CAP23 targets. This is because, we find that not all of the installed capacity in the individual targets for solar and wind generation capacity are required to meet the 80% RES-E target. However, the CAP23 renewable generation capacity ambition is a necessary condition for the carbon budget success.

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[13] EirGrid, SONI, 'Generation Capacity Statement 2022-2031'. 2022. [Online]. Accessed from: https://www.eirgridgroup.com/site-files/library/EirGrid/EirGrid_SONI_Ireland_Capacity_Outlook_2022-2031.pdf

Table 6: Targets and assumptions for year-end renewable electricity generation capacity delivery

Parameter / Variable	Year	CAP 2021 target	CAP 2023 target	WEM	WAM-CAP21	WAM-CAP23
RES-E (%)	2025	-	50%	42%	44%	50%
Onshore Wind Capacity (GW)	*2025*	-	*6*	*5*	*5.3*	*5.8*
Offshore Wind Capacity (GW)	*2025*	-	*0*	*0.03*	*0.03*	*0.03*
Solar PV Capacity (GW)	*2025*	-	*5*	*1.5*	*1.7*	*3.0*
RES-E (%)	2030	up to 80%	80%	68%	79%	82%
Onshore Wind Capacity (GW)	*2030*	*up to 8*	*9*	*6.5*	*7.4*	*7.8*
Offshore Wind Capacity (GW)	*2030*	*at least 5*	*5*	*3.7*	*5.0*	*5.0*
Solar PV Capacity (GW)	*2030*	*1.5-2.5*	*8*	*4.3*	*5.2*	*6.0*

4.2.3 Phase out of coal in electricity generation

All scenarios

- Assume coal use for electricity generation will be phased out from the end of 2024.

4.3 Fuel use for electricity generation

The decarbonisation of electricity generation combined with the electrification of energy demand for heating and transport is one of the main strategies for decarbonising energy use.

In all scenarios renewables are projected to be the largest input to electricity generation by 2030, with a sharp increase later in the decade due to connection of large offshore wind projects. The CAP23 scenario assumes a faster rollout of onshore renewable generation capacity earlier in the decade compared to the CAP21 scenario but achieves broadly the same total share of electricity from renewable sources (RES-E) by 2030.

Coal is assumed to be phased out by the end of 2024 in all scenarios. Moneypoint power station is assumed to remain open until 2030, however it fully switches to oil by 2025. Natural gas use increases in all scenarios to 2025 to meet increased demand and to compensate for the assumed phase out of coal but declines in the second half of the decade as the delivery of variable renewable energy capacity begins to outpace the growth in electricity demand. This increase in demand necessitates additional firm generation capacity to ensure a reliable electricity supply. It is anticipated that new conventional generation will be open-cycle gas turbines. The faster rollout of renewable generation assumed in the CAP23 scenario leads to faster reduction in gas use in this scenario.

Figure 4: Fuel use for electricity generation

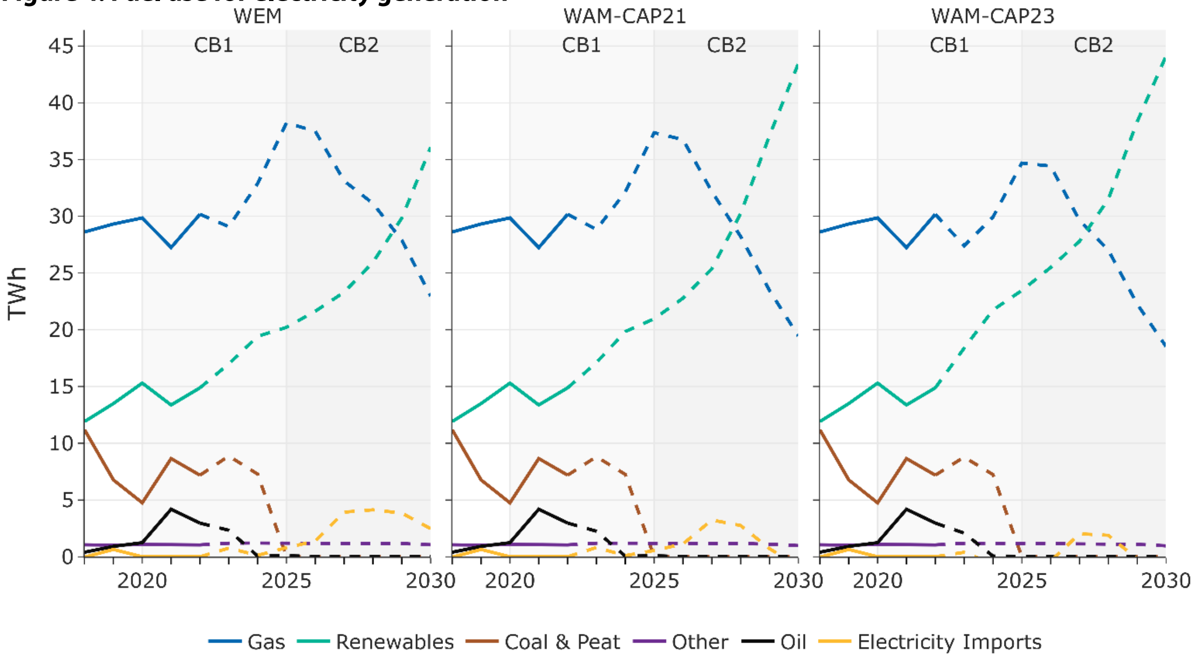


Table 7: Fuel use for electricity generation

Energy (TWh)	2022 Actual (TWh)	2030 Projected (TWh)		
		WEM	WAM-CAP21	WAM-CAP23
Renewables	14.9	36.1	43.5	44.1
Electricity net imports	0.3	2.5	-0.9	-1.5
Gas	30.2	23.0	19.5	18.5
Coal & peat	7.2	0.0	0.0	0.0
Oil	3.0	0.0	0.0	0.0
Other	1.0	1.1	1.0	1.0
Total	56.5	62.6	63.0	62.1

4.4 Greenhouse gas emissions from electricity generation[14]

Figure 5 shows the annual emissions trajectories for the electricity sector within the first two carbon budget periods for WEM and WAM-CAP23 scenario. This figure also shows the indicative annual emissions trajectory required to stay within the carbon budgets from 2021 to 2030. The sectoral ceilings are also shown in Table 8.

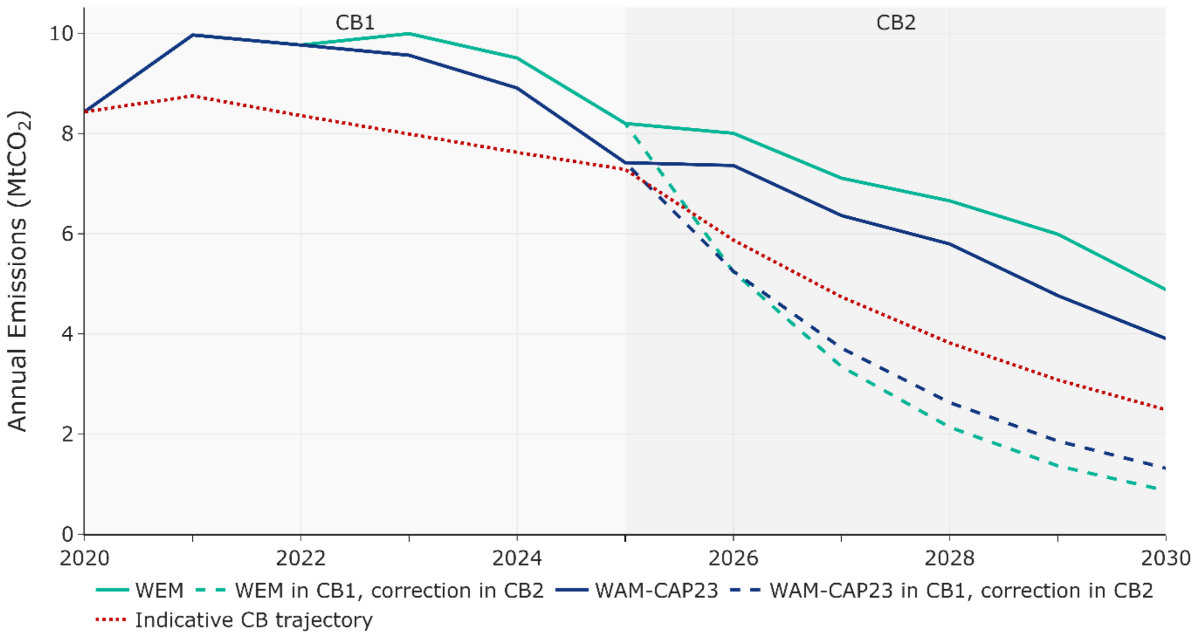
[14] Here we use the EPA definition of what emissions are included within the electricity sector carbon budget. This comprises of the line items "Public electricity and heat production". "Solid fuels and other energy industries" and "Fugitive emissions" from the National Greenhouse Gas Inventory and Projections.

Table 8: Sectoral ceilings and related indicators for electricity sector

Sectoral ceiling for electricity sector	
2018 baseline emissions ($MtCO_2eq$)	10
CB1 ceiling 2021-2025 ($MtCO_2eq$)	40
CB2 ceiling 2026-2030 ($MtCO_2eq$)	20
Indicative average annual % reduction required in CB1	-4.5%
Indicative average annual % reduction required in CB2	-19.3%
Initial indicative reduction required by 2030 (relative to 2018; assuming indicative target trajectory met in all years)	-75%

As shown in the above table, electricity emissions in 2018 were 10 $MtCO_2eq$. If the indicative trajectory for the carbon budgets was followed each year, then emissions in 2030 would need to be reduced by 75% from 2018. However, due to the cumulative nature of the budgets, if this indicative trajectory is exceeded in early years, then steeper reductions would be required to compensate. Hence, a larger reduction would be required by 2030.

Figure 5: Annual greenhouse gas emissions from electricity generation



The solid lines in Figure 5 show the annual emissions projected under WEM and WAM-CAP23 scenarios. The dashed lines show, if the WEM and WAM-CAP23 annual emissions are followed until 2025, how that trajectory would need to change in the second budget period to stay within the ceiling. If the WEM trajectory is followed until 2025, then greenhouse gas emissions from the electricity sector would need to be eliminated by 2029 to keep within the second carbon budget. The corresponding figures for the revised CB2 trajectory are given in Table 9 below.

Figure 6 shows the indicative target trajectory for cumulative electricity emissions for electricity emissions over the first two carbon budget periods and compares this with the projected cumulative electricity emissions for the WEM and WAM-CAP23 scenarios. The horizontal dashed lines show the sectoral ceilings for the first two budget periods. The chart also shows the years in which the sectoral ceilings are reached in each scenario, and the cumulative exceedance by the end of the second budget period in each scenario. The figures for both scenarios are summarised in Table 9.

Figure 6: Cumulative greenhouse gas emissions from electricity generation

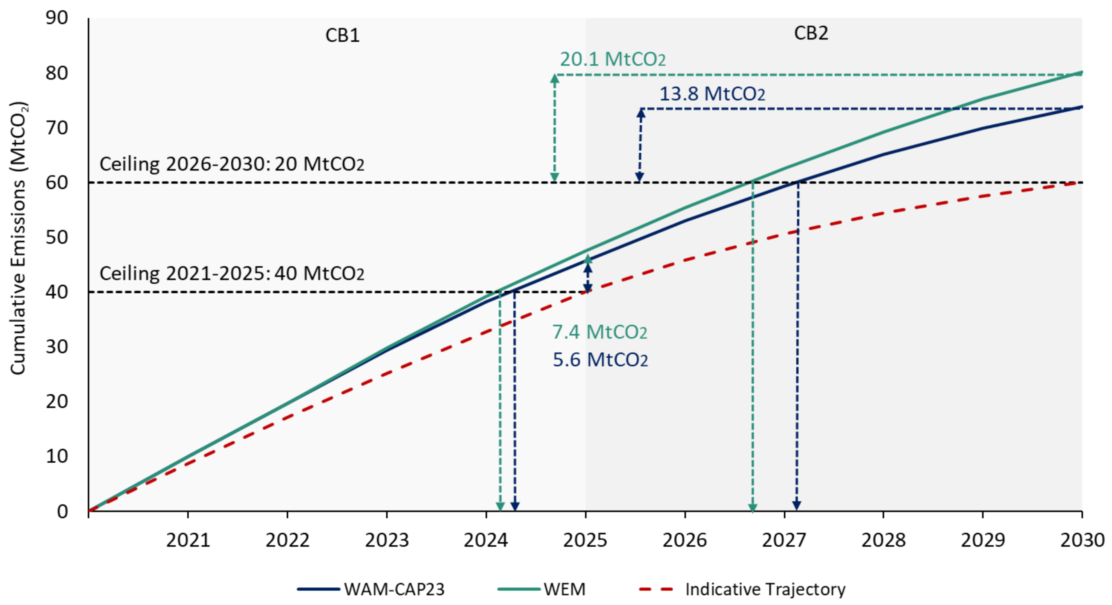


Table 9: Projected exceedance of sectoral ceiling for electricity sector

Electricity sector	WEM	WAM-CAP23
Projected CB1 exceedance ($MtCO_2eq$)	7.4	5.6
Projected CB2 exceedance (including CB1 carry over) ($MtCO_2eq$)	20.1	13.8
Projected average annual change in emissions for CB1	-2.2%	-4.1%
Indicative average annual change in emissions required in CB2 to stay within the CB2 ceiling if named scenario followed in CB1	-36.1%	-29.2%
Revised indicative reduction required by 2030 compared to 2018 to stay within CB2 ceiling if named scenario followed in CB1	-92% to -100%	-87% to -100%

In the WEM scenario, cumulative emissions are seen to reach the first sectoral ceiling in the year 2024. This results in a significant overspend of 7.4 $MtCO_2eq$ (19%) within the final 2 years of the first period, consuming ~37% of the second budget before the second period has even begun. Into the second budgeting period, cumulative emissions continue to rise such that the second sectoral ceiling is surpassed in the year 2026. By the end of the second budgeting period, the cumulative emissions are 20.1 $MtCO_2eq$ (33%) over the ceiling, meaning any subsequent budget would likely be unattainable from the outset.

Similarly, for the WAM-CAP23 scenario, cumulative emissions hit the first sectoral ceiling in 2025, leading to an overspend of 5.6 $MtCO_2eq$ (14%) between 2024-2026. Hence the second budgeting period starts out with ~28% of the budget already consumed. While this is an improvement on the WEM, the CB1 exceedance combined with cumulative emissions in the second period see the second ceiling breached by 2027, ending the decade with an exceedance of 13.8 $MtCO_2eq$ (23%).

If the WEM or WAM-CAP23 trajectory is followed until 2025, then greenhouse gas emissions from the electricity sector would need to fall by 92% or 87% respectively by 2030 to keep within the CB2 sector ceiling, assuming a geometric reduction trajectory is followed in CB2, as illustrated in Figure 5. But the final reduction would depend on the trajectory taken within CB2. A linear reduction trajectory in CB2 would require electricity sector emissions to fall by 100% before 2030 in both the WEM and the WAM-CAP23 scenario.

These projections clearly demonstrate the importance of early action. Unless emissions from electricity generation are reduced sharply before 2025, it will not be possible for this sector to stay within budget out to 2030. The earlier action is taken to reduce annual emissions, the greater the power to reduce the growth of the cumulative total and improve the chances that this sector can meet it obligation.

4.5 Uncertainties and risks to target achievement

The rate at which we can decarbonise electricity generation will be determined by three aspects:

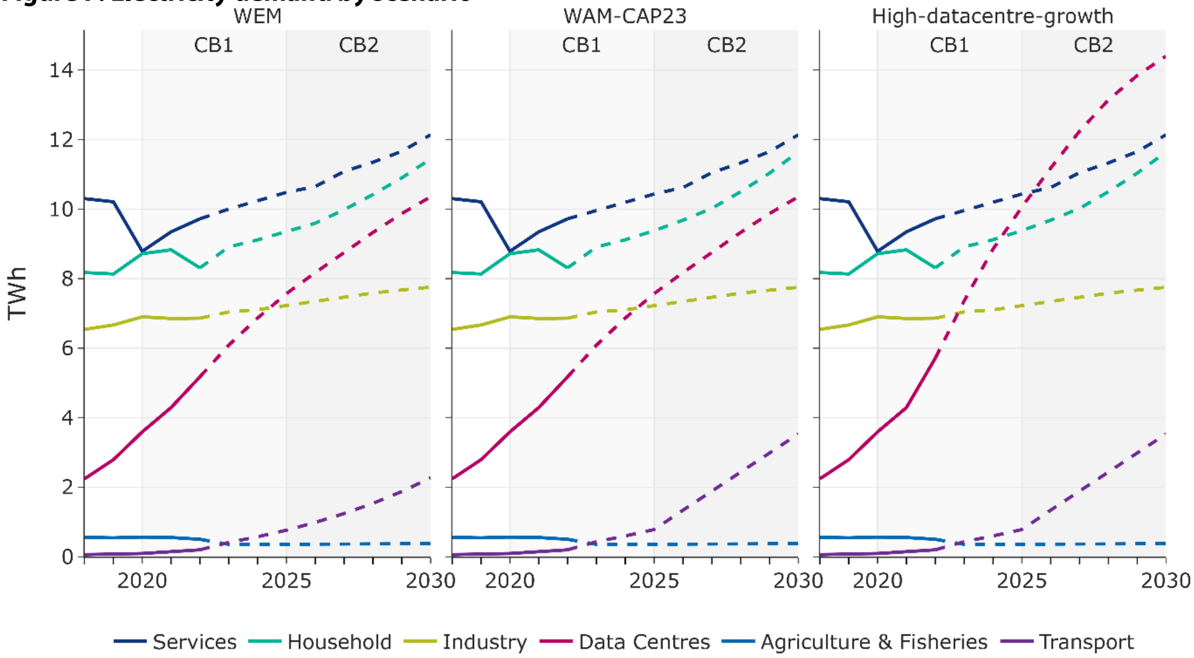
- The rate at which electricity demand grows.
- The rate at which we can deploy renewable energy generation capacity and integrate its energy.
- The rate at which we reduce the carbon intensity of our remaining non-renewable generation.

In this section we discuss some of the main uncertainties relating to each of these factors.

4.5.1 Electricity demand growth

Figure 7 shows the projected electricity demand in WEM, WAM-CAP23, and the High-datacentre-growth scenarios.

Figure 7: Electricity demand by scenario



Total final electricity consumption in 2030 in the WAM-CAP23 scenario is projected to grow to 45.8 TWh, an increase of 55% or 16.2 TWh from 2021. Of this increase, 4.7 TWh is anticipated to come from the electrification of heat and transport through heat pumps and electric vehicles, 6.1 TWh is anticipated to come from datacentres, and the remaining 5.5 TWh from other sources such as continued growth in industry, services, and the residential sector.

For the WEM, WAM-CAP21 and WAM-CAP23 scenarios, the projected growth in datacentre electricity demand is taken from the EirGrid's best estimate "Median" scenario[15]. However, there is uncertainty around the potential for growth in datacentre energy demand. Significantly more capacity than is shown in the EirGrid Median scenario for 2030 has already been contracted as of the end of 2022, as shown in Figure 8. EirGrid also produce a "High" growth scenario, which assumes that a higher share of the currently contracted capacity is used, though it still assumes that some attrition of contracted demand will occur. This EirGrid "High" scenario assumes an additional 462 MW of datacentre demand in 2030 is connected[16], which is equivalent to approximately 4.0 TWh of additional energy demand. As Figure 7 illustrates, this uncertainty regarding datacentre consumption strongly eclipses the differences in electricity consumption between the other scenarios.

This additional electricity demand could result in approximately 4.5 $MtCO_2eq$ of cumulative additional greenhouse gas emissions over the first two carbon budgets. In contrast, if we were to limit datacentre growth to that shown in the Low scenario, it could reduce cumulative emissions by approximately 3 $MtCO_2eq$ over the first two carbon budgets.

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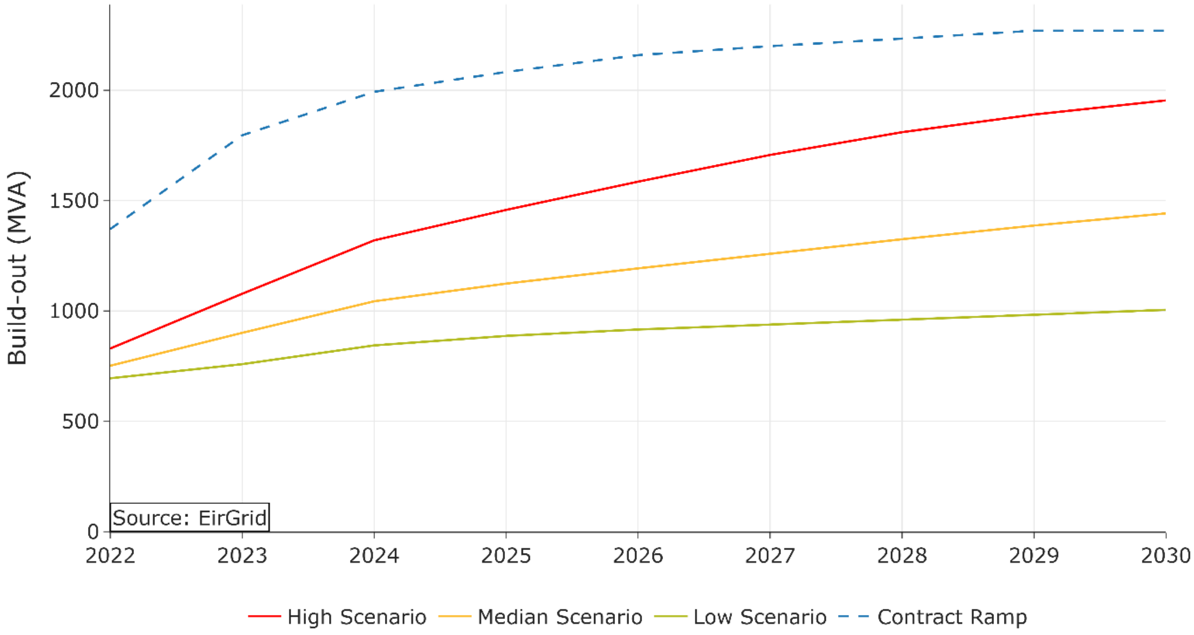
[15] EirGrid, SONI, 'Generation Capacity Statement 2022-2031'. 2022. [Online]. Accessed from: https://www.eirgridgroup.com/site-files/library/EirGrid/EirGrid_SONI_Ireland_Capacity_Outlook_2022-2031.pdf

[16] EirGrid, SONI, '2022 - 2031 All Island Generation Capacity Statement Data Workbook'. 2022. [Online]. Accessed from: https://www.eirgridgroup.com/site-files/library/EirGrid/GCS-2022-2031-Data-Workbook.xlsx

Figure 8: EirGrid scenarios for capacity build-out of Data Centre and New Tech load



Critical success factors and opportunities

From a national greenhouse gas emissions perspective, increased electricity demand from replacing fossil fuel heating systems with heat pumps or fossil fuelled cars with EVs results in an overall net reduction in emissions, because the emissions from the increased electricity demand are more than compensated for by a reduction in emissions in the heat and transport sectors, leading to lower overall emissions. In contrast, increased electricity demand from new large energy-users and continued growth in the industry, services, and residential sectors does not displace fossil fuel use elsewhere in the economy, and if electricity demand increases ahead of the roll out of renewable generation capacity it will lead to higher emissions. This will make it extremely challenging for the electricity sector to meet its national greenhouse gas emissions reduction obligation.

From the perspective of the requirement to reduce total final energy use in line with the EU Energy Efficiency Directive target[17], the same principal applies. Increased electricity demand from replacing fossil fuel heating systems with heat pumps or fossil fuelled cars with EVs is a positive, because the much higher efficiency of heat pumps and EVs compared to boilers and fossil fuelled cars results in less energy use overall. In contrast, increased electricity demand from datacentres does not displace energy use elsewhere in the economy, increases total final energy demand, and will make it very challenging to meet the Energy Efficiency Directive target.

For these reasons the negative consequences versus the benefits of allowing large new electricity users to establish in Ireland between now and 2030 needs to be considered.

4.5.2 Delivery timeline of renewable electricity generation capacity

Table 6 shows the targets for renewable electricity generation capacity delivery for 2025 and 2030, alongside the National Energy Projections assumptions for each scenario. The installed capacities

[17]See section 10.3 for more information on the EU Energy Efficiency Directive

of solar and wind electricity generation in the WAM-CAP23 scenario meets the CAP23 target of achieving 80% RES-E by 2030. As well as the RES-E target, CAP23 contains KPIs for higher installed capacities, which are likely required to reduce the gap to the sectoral emissions ceiling. For the WEM scenario, we assume a slower rate of delivery of renewable electricity generation, leading to a RES-E share of 68% in 2030. There are multiple risk factors that could delay the growth of variable renewable generation:

- Onshore variable renewables
  - Wind Energy Guidelines:
    Revision of noise guidance and minimum setback distances could significantly diminish the available areas in which onshore turbines could be sited.
  - Renewable energy developments on lands previously used for industrial peat harvesting and other brownfield sites require permits.
- Offshore variable renewables
  - Planning permission:
    The four offshore wind projects that were successful in bidding for the first Offshore Renewable Energy Support Scheme auction (ORESS1), amounting to a total of 3.1 GW of installed capacity, have yet to be awarded planning permission. The ORESS1 projects must start generating electricity by 31st December 2031, though extensions are possible if a project falls under the judicial review clause (clause 7.3) of the terms and conditions[18].
  - Consenting:
    Before seeking planning permission, projects entering future auctions will also require maritime area consents from the Maritime Area Regulatory Authority.

Critical success factors and opportunities

Streamlining the multiple stages of the planning process will be critical to ensuring that the required volumes of renewable energy projects can enter the onshore and offshore Renewable Electricity Support Scheme (RESS) auctions.

The grid integration of renewables is a multi-faceted problem[19], with multiple work-plans[20, 21] underway by the transmission and distribution system operators, ranging from network development, incentivising new technologies via market design, and new operational practises. Maximising the value of new renewable generation connections will depend on the success of these programmes and any underpinning regulatory changes.

4.5.3 Phase out date for coal in electricity generation

In all our modelled scenarios, we assume that generation of electricity from coal at Moneypoint power station will end by the end of 2024. We assume that Moneypoint remains open after this point but will switch to oil. If the phase out of coal was brought forward by 1 year, or its position in

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[18] DECC, 'Terms and Conditions for the First Offshore Wind RESS Competition'. 2023. [Online]. Accessed from: https://www.gov.ie/pdf/?file=https://assets.gov.ie/252215/7eacfb9c-6702-4e72-9499-5bea86aa9d96.pdf

[19] ESIG, 'Reports & Briefs'. [Online] Accessed from: https://www.esig.energy/reports-briefs/

[20] EirGrid, SONI, 'Shaping Our Electricity Future Roadmap'. 2023. [Online]. Accessed from: https://www.eirgridgroup.com/site-files/library/EirGrid/Shaping-Our-Electricity-Future-Roadmap_Version-1.1_07.23.pdf

[21] ESB Networks, 'National Network, Local Connections Programme'. [Online]. Accessed from: https://www.esbnetworks.ie/who-we-are/national-network-local-connections-programme

the merit order results in the plant being called upon less often, this could result in emissions savings of approximately 1.3 $MtCO_2eq$ of emissions.

Critical success factors and opportunities

Given the long design life of power generation plants (nominally 25-30 years), capacity markets will need to quickly adapt to incentivise generation companies to transition to minimise and ultimately eradicate power plant carbon emissions.

The following sections of this report present data on the energy use and greenhouse gas emissions from each of the main energy use sectors: transport, built environment and industry. In each case we present projections for energy use in each sector that include the projected electricity use. We also present projections for greenhouse gas emissions in each sector taken from the EPA, but the greenhouse gas emissions for each sector do not include the emissions from electricity consumed by that sector, as those emissions are counted separately under the electricity sector for the purposes of national and international reporting.

5 Transport

5.1 Key messages

- In all scenarios transport energy use will still be dominated by oil use in 2030, despite assumptions of significant growth in EV numbers and reductions in overall vehicle kilometres of all road vehicles in the WAM-CAP23 scenario.
- In both the WEM and WAM-CAP23 scenarios the transport sector exceeds the sectoral ceilings for both the first and second carbon budget periods.
- The projected exceedance in the first budget period means that between 2% and 9% of the second budget will have been consumed before the second period begins, in the WAM-CAP23 and WEM scenarios respectively.
- By the end of the second budget period the total exceedance is projected to be 22.3 MtCO_2eq (24%) and 6.2 MtCO_2eq (7%) in the WEM and WAM-CAP23 scenarios respectively.
- While recent growth rates for EV sales have been encouraging, it is unlikely that 100% of all new cars and second-hand imports will be EVs by 2030 in the absence of strong measures to discourage the purchase of new internal combustion engine vehicles.
- Government policy recognises the importance of the avoid-shift-improve strategy for decarbonising transport emissions. This strategy prioritises measures to reduce or avoid the need for travel and to shift journeys to more efficient and sustainable modes such as public transport and active travel. There was significant progress in 2022 on a range of critical public and active transport infrastructure projects including BusConnects, DART+, MetroLink, along with funding for up to 1,200 active travel projects all over the country.
- However, there are significant barriers to shifting away from private car use in Ireland. CAP23 recognises that preferences for private car use are deeply embedded through existing settlement patterns, infrastructure, policies, and mindsets.
- Full implementation and delivery of the policies and measures contained in the National Sustainable Mobility Action Plan will be critical to achieving the ambitious targets for modal shift set in CAP23.

5.2 Scenario assumptions at a glance

5.2.1 Road transport demand reduction measures

WEM and WAM-CAP21 scenarios

- Private car activity is based on extrapolation of historical trends.
- Goods vehicle energy demand based on the ESRI I3E model of the economy and energy use. The high fuel price scenario was used as default for all scenarios.
- No additional reduction in goods vehicle or private car activity assumed due to demand reduction measures.

WAM-CAP23 scenario

- We assume that private car and goods vehicle activity is reduced in line with National Transport Authority of Ireland (NTA) modelling in support of the CAP23 target for 20% demand reduction in road transport.

High demand sensitivity scenario

- Goods vehicle energy demand based on the ESRI I3E model of the economy and energy use. The low fuel price scenario was used for the high demand sensitivity scenario.

5.2.2 EV uptake

WEM and High demand sensitivity scenarios

- We assume sales of new internal combustion engine (ICE) vehicles will end in 2035 in line with EU effective ban from that date. 2030 EV stock by vehicle type is shown in Table 10.

WAM-CAP21 and WAM-CAP23 scenarios

- We assume the CAP21 and CAP23 targets will be fully met, as per Table 10[22].

Table 10: EV stock in 2030 by scenario

2030 EV stock	WEM	WAM-CAP21	WAM-CAP23
BEV	404,275	661,600	661,600
PHEV	89,576	183,000	183,000
Total Car	493,851	844,600	844,600
HGV	2,100	3,500	3,500
LGV	57,000	95,000	95,000
Bus	1,500	1,500	1,500
Total EV	554,451	944,600	944,600

[22] Note that there was no change in the targets for number of EVs between CAP21 and CAP23

5.2.3 Biofuels

WEM and High demand sensitivity scenarios

- We assume blending of biogasoline with petrol at a rate of 10% in volume terms by 2025, staying constant at that level to 2030.
- We assume blending of biodiesel with diesel at a rate of 12% in volume terms by 2025, staying constant at that level to 2030.

WAM-CAP21 and WAM-CAP23 scenarios

- We assume blending of biogasoline with petrol at a rate of 10% in volume terms by 2025, staying constant at that level to 2030, as for WEM.
- We assume blending of biodiesel with diesel at a rate of 12% in volume terms by 2025, increasing to 20% by 2030.

5.3 Fuel use for transport

In all scenarios transport energy use will still be dominated by oil use in 2030, despite assumptions of strong growth of EV numbers and a significant reduction in overall vehicle kilometres of all road vehicles in the WAM-CAP23 scenario.

The WAM-CAP23 scenario includes the assumption that the CAP23 target for reductions in kilometres travelled by all road vehicles is met through demand management measures such as shifting car journeys to public transport and active travel. Compared to the WAM-CAP21 scenario which does not include this demand reduction assumption, this leads to a 15% (5.8 TWh) reduction in transport final energy use (excluding aviation), 15% (4.6 TWh) less oil use 15% (0.8 TWh) less requirement for biofuels and 12% (0.5 TWh) less electricity demand from EVs.

The largest growth in electricity demand in transport happens in the WAM-CAP21 scenario, where we assume that the full CAP21 target for numbers of EVs is achieved, but the CAP23 target for overall reduction in private car activity is not included. In this scenario, electricity use for transport increases to 4.0 TWh in 2030. It is important to note that EVs are much more efficient than ICE vehicles. Typically, an EV only requires a third as much energy per distance travelled as an equivalent ICE vehicle. Therefore, when an EV replaces an ICE car, it reduces overall transport energy use. This is important to consider when looking at the relatively low share of electricity use in transport even in 2030. Each unit of electricity used delivers three times the utility of each unit of oil or combustible renewables.

Figure 9: Fuel use for transport

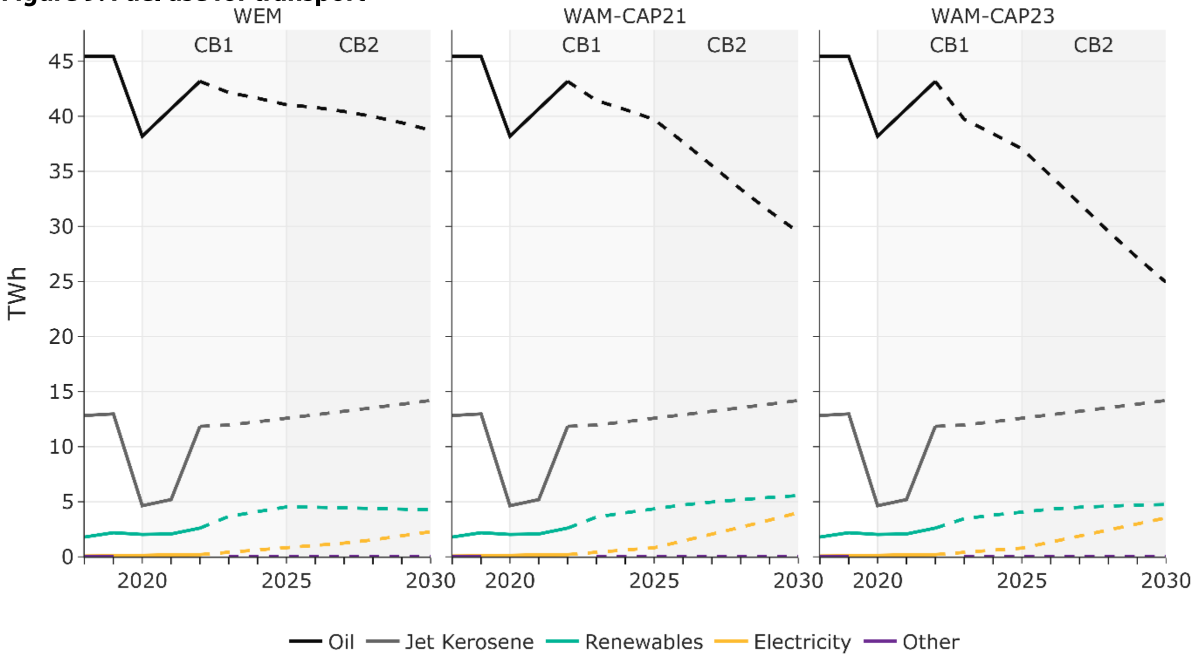

Table 11: Fuel use for transport

Energy (TWh)	2022 Actual (TWh)	2030 Projected (TWh)		
		WEM	WAM-CAP21	WAM-CAP23
Renewables	2.6	4.3	5.6	4.7
Electricity	0.0	2.3	4.0	3.5
Oil (excluding jet kerosene)	43.2	38.7	29.5	24.9
Gas	0.4	0.0	0.0	0.0
Total (excluding jet kerosene)	46.2	45.3	39.1	33.2
Jet kerosene	11.8	14.2	14.2	14.2
Total (including jet kerosene)	58.0	59.5	53.3	47.4

5.4 Greenhouse gas emissions from transport

The sectoral ceilings for transport are shown in Table 12[23]. If the indicative trajectory for the carbon budgets was followed every year, then emissions in 2030 would need to be 50% lower than in 2018. However, if this indicative trajectory is exceeded in early years, then to compensate steeper reductions are required thereafter, leading to a larger reduction required by 2030.

[23] This section does not include the emissions from electricity consumed by the sector, as those emissions are counted separately under the electricity sector.

Table 12: Sectoral ceilings and related indicators for transport

Sectoral ceiling for transport sector	
2018 baseline emissions ($MtCO_2eq$)	12
CB1 ceiling 2021-2025 ($MtCO_2eq$)	54
CB2 ceiling 2026-2030 ($MtCO_2eq$)	37
Indicative average annual % reduction required in CB1	-4.0%
Indicative average annual % reduction required in CB2	-9.7%
Initial indicative reduction required by 2030 (relative to 2018; assuming indicative target trajectory met in all years)	-50%

Figure 10 shows the *annual* emissions projected for the transport sector for the first two carbon budget periods for the WEM and WAM-CAP23 scenarios. It also illustrates the indicative annual emissions trajectory required to stay within the carbon budgets from 2021 to 2030. Dashed lines are used to illustrate a revised CB2 trajectory that would be required to meet the CB2 obligation if the WEM or WAM-CAP23 scenarios were followed in CB1. The resulting revised average annual reduction rate for CB2 and the revised total reduction by 2030 compared to the 2018 baseline are shown in Table 13.

Figure 10: Annual greenhouse gas emissions from transport sector

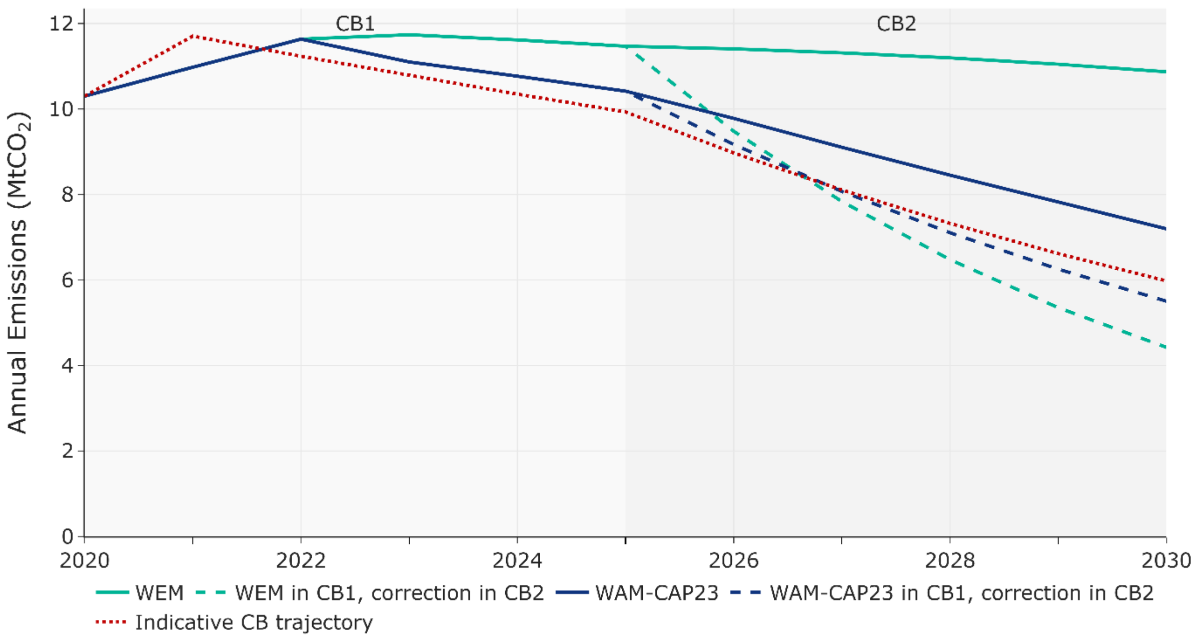

Figure 11 shows the target trajectory for *cumulative* transport emissions over the first two carbon budget periods and compares this with the projected cumulative transport emissions for the WEM and WAM-CAP23 scenarios. The black horizontal dashed lines show the sectoral ceilings for the first two budget periods. The chart illustrates the years in which the sectoral ceilings are reached in each scenario, and the cumulative exceedance by the end of the second budget period is noted for each scenario.

Figure 11: Cumulative greenhouse gas emissions from transport sector

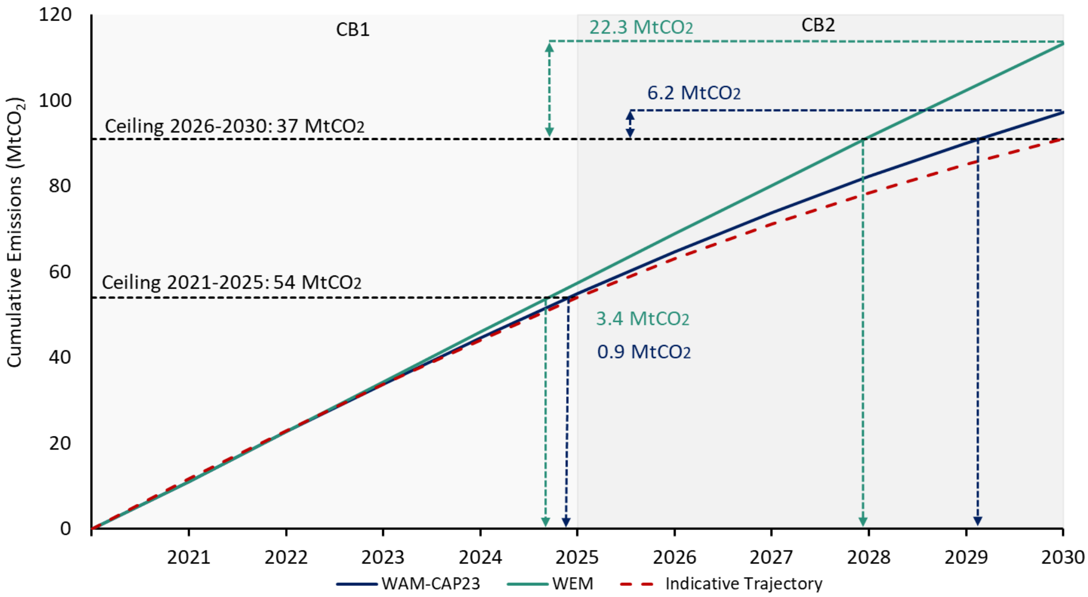

Table 13: Projected exceedance of sectoral ceilings for transport

Transport sector	WEM	WAM-CAP23
Projected CB1 exceedance ($MtCO_2eq$)	3.4	0.9
Projected CB2 exceedance (including CB1 carry over) ($MtCO_2eq$)	22.3	6.2
Projected average annual change in emissions for CB1	-1.2%	-3.1%
Indicative average annual change in emissions required in CB2 to stay within the CB2 ceiling if named scenario followed in CB1	-17.3%	-12.0%
Revised indicative reduction required by 2030 compared to 2018 to stay within CB2 ceiling if named scenario followed in CB1	-64% to -71%	-55% to -58%

In the WEM scenario, cumulative emissions reach the first sectoral ceiling in the year 2024. This results in an exceedance of 3.4 $MtCO_2eq$ (6%) by 2025. This overshoot means that 9% of the CB2 budget is consumed before the CB2 period begins. The second sectoral ceiling is then breached around the end of 2027, with exceedance reaching 22.3 $MtCO_2eq$ (24%) by 2030.

The WAM-CAP23 scenario is better aligned with a carbon budget compliant trajectory, but still exceeds the CB1 obligation by 0.9 $MtCO_2eq$ (2%). The second sectoral ceiling is breached in 2029, with an exceedance of 6.2 $MtCO_2eq$ (7%) by 2030.

If transport sector greenhouse gas emissions were to follow the WEM or WAM-CAP23 trajectory until 2025, then to keep within the CB2 sector ceiling, emissions would have to fall 64% or 55% below

2018 levels by 2030, respectively[24]. This would require an average annual reduction in emissions during CB2 of 17.3% per annum in the WEM scenario and 12.0% in the WAM-CAP23 scenario.

5.5 Uncertainties and risks to target achievement

5.5.1 Growth in transport energy demand and the success of avoid and shift policies

Historically, transport sector energy demand has undergone substantial changes in response to changes in the economy and other shocks such as COVID19 restrictions. This potential for substantial changes in energy use results in future scenarios also showing large potential variations, which means there is inherent uncertainty on future transport energy demand. Transport is the largest energy using sector therefore variations in projected transport energy demand have a significant impact on the projections of total energy use and energy related greenhouse gas emissions.

Private car energy use remained relatively flat from 2008 to 2019, with 2019 energy use just 1.5% lower than in 2008. The total kilometres driven by private cars in 2019 was 13% higher than in 2008. The reduction in energy use was driven by the improved fuel efficiency of the vehicle stock. The likely range for private car energy demand in 2030 is illustrated in the WAM-CAP23 and the WEM scenario. At the lower end, in the WAM-CAP23 scenario, it is 33% below 2021 levels, due to a combination of assumptions including less overall kilometres travelled (in line with the CAP23 target for a 20% reduction in private car activity), and the assumed achievement of the CAP23 EV targets (because EVs are more efficient than ICE vehicles, they result in lower overall energy use). At the upper end, in the WEM scenario, private car energy use in 2030 is 13% higher than in 2021. This scenario does not assume that the CAP23 targets for a 20% reduction in kilometres travelled by private cars and for EVs will be fully achieved.

Within transport, heavy goods vehicle (HGV) activity and energy use has historically been very sensitive to economic growth and contraction. HGV energy use peaked in 2007 at 13.3 TWh, but was heavily impacted by the subsequent recession, and fell by 49% between 2007 and 2013. It returned to growth as the economy emerged from recession after 2013 and between 2013 and 2019 it grew by 36%. The likely range for goods vehicle (HGV and light goods vehicles) energy demand in 2030 is illustrated in the WAM-CAP23 and the high demand sensitivity scenarios. At the lower end, in the WAM-CAP23 scenario goods vehicle energy use in 2030 is 12% above 2021 levels. This is in line with the National Transport Authority (NTA) modelling of a 20% reduction against their reference scenario for 2030, on which the CAP23 target of a 20% reduction in road transport vehicle kilometres is based.[25] At the upper end, we examined a sensitivity scenario which looked at the potential for higher growth in goods vehicle energy use, based on a low fuel price scenario from the ESRI I3E economic modelling. In this scenario, goods vehicle energy use could be 36% higher in 2030 than in 2021.

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[24] Assuming a geometric reduction trajectory. The final reduction required would depend on the trajectory taken within CB2. If the WEM or WAM-CAP23 trajectory were followed until 2025 and emissions were to then follow a linear reduction trajectory in CB2, then total greenhouse gas emissions would need to fall by 71% or 58% respectively by 2030 to keep within the second carbon budget.

[25] National Transport Authority, 'Climate Action Plan Phase 3 Modelling Executive Summary'. 2023. [Online]. Accessed from: https://www.nationaltransport.ie/wp-content/uploads/2023/01/Climate-Action-Plan-Phase-3-Modelling-Exec-Summary-v5.6.pdf

The greenhouse gas emissions from international aviation are not counted towards Ireland's national or international greenhouse gas emissions reduction obligations, however the energy use of international aviation is counted for Ireland's EU Energy Efficiency Directive obligation to reduce final energy use. Like freight, aviation has been very responsive to the economy in the past. It reduced by 43% between the Celtic tiger peak in 2007 to the bottom of the recession in 2012, and then increased again by 91% from the 2012 low to a new peak in 2019. There is uncertainty on the potential scale of growth in aviation energy use in the medium to long term. In all our scenarios we base the growth rate for aviation energy use on the results of the ESRI I3E economic model, which results in 2030 energy use being 9% higher than in 2019. If aviation energy use continues to grow, it will make it challenging for the transport sector to deliver its share of reduction in final energy use in 2030 required by the Energy Efficiency Directive.

Critical success factors and opportunities

Ireland's Climate Change Advisory Council (CCAC) and the OECD examined the challenges and opportunities of transforming Ireland's transport system to meet our national and international climate obligations. This led to the publication of the OECD report *Redesigning Ireland's Transport for Net Zero: Towards Systems that Work for People and the Planet*.[26] The key findings of the report include:

- The Irish transport system fosters growing car use and emissions by design and is thus unfit to enable the country to meet its greenhouse gas reduction goals while improving well-being.
- Aiming at decarbonising the system via private vehicle improvements is unlikely to lead to substantially different patterns of behaviour, rapid emissions reductions, and large well-being improvements.
- Policies with a high transformative potential include road space reallocation, the mainstream of on-demand shared services and communication efforts to address car-centric mindsets.

The findings of this report were recognised in the CAP23 which recognises the importance of the avoid-shift-improve strategy for decarbonising transport emissions. This strategy prioritises measures to reduce or avoid the need for travel and to shift journeys to more efficient and sustainable modes such as public transport and active travel. This is reflected in the CAP23 target to reduce the activity of private cars and goods vehicles, and to increase public transport and active travel journeys. There was considerable progress in 2022 on a range of critical public and active transport infrastructure projects including BusConnects, DART+, MetroLink, along with funding for up to 1,200 active travel projects all over the country.[27]

However, CAP23 also recognises the challenges and systemic barriers to achieving significant levels of modal shift away from private car use in Ireland. CAP23 highlights the following:

- There has historically been a clear correspondence between travel demand and economic and demographic growth.

[26] OECD, 'Redesigning Ireland's Transport for Net Zero: Towards Systems that Work for People and the Planet'. 2022. OECD Publishing, Paris. Accessed from: https://doi.org/10.1787/b798a4c1-en.
[27] National Transport Authority, 'Annual Report & Financial Statements 2022'. 2023. [Online]. Accessed from: https://www.nationaltransport.ie/wp-content/uploads/2023/09/Annual-Report-Financial-Statement-2022-FINAL-WEB.pdf

- Travel preferences are deeply embedded through settlement patterns, policies, and mindsets, which favour private car usage over more sustainable transport modes.
- Dispersed and low-density development has led to high levels of transport poverty in certain regions and for certain cohorts of society.
- There are significant lead-in times associated with the delivery of major transport infrastructure and the rollout of additional public transport services.
- Public acceptance is vital to deliver the scale of behavioural change required. Demonstrating and communicating the wider societal benefits (e.g., health, air quality, reduced noise pollution, and improved placemaking) will need to form part of a compelling public engagement strategy.

The National Sustainable Mobility Policy and the accompanying action plan aim to overcome these barriers and to improve and expand sustainable mobility options across the country.[28] Full implementation and delivery of the policies and measures contained in the action plan will be critical to achieving the ambitious targets for modal shift set in CAP23.

5.5.2 EV uptake

One of the most high-profile targets contained in the 2021 and 2023 Climate Action Plans is for 100% of new cars to be EVs by 2030 and to have 845,000 private car EVs by 2030. While recent growth rates for the share of EVs in new vehicles have been encouraging, it is unlikely that 100% of all new cars and pre-owned-imports will be EVs by 2030 in the absence of strong measures to discourage the purchase of new and pre-owned-imported ICE vehicles.[29] In the absence of such disincentives, it would be reasonable to assume that a cohort of consumers purchasing new cars will continue to opt for ICE vehicles post-2030.

For the WAM-CAP23 and WAM-CAP21 scenarios we assumed the CAP23 targets for numbers of EVs were fully achieved. For the WEM scenario we assumed that not all new cars would be EV by 2030, and that instead the phase out of new ICE vehicles would be aligned with the EU target for an effective phase out of new ICE vehicles by 2035. The resulting EV stock in all scenarios for 2030 is shown in Table 10 (above).

In the WEM scenario we estimate that the 2030 private car EV stock avoids 1.5 $MtCO_2eq$. In the WAM-CAP21 scenario, we estimate that achieving the full CAP21 target for 844,600 EVs would avoid 2.5 $MtCO_2eq$. The WAM-CAP23 scenario assumes that all private cars travel less kilometres each year, therefore total emissions are lower, but the amount of CO_2 displaced by the additional EVs is also lower, at 2.1 $MtCO_2eq$.

Critical success factors and opportunities

To achieve the goal of all new vehicles being EVs by 2030 will require measures to strongly disincentivise the purchase of new and pre-owned import ICE vehicles, combined with tackling

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[28] Department of Transport, 'National Sustainable Mobility Policy'. 2022. [Online]. Accessed from: https://www.gov.ie/en/publication/848df-national-sustainable-mobility-policy/

[29] Pre-owned-imports refers to second-hand vehicles imported from the UK into Ireland. In some years up to 50% of all new vehicles added to the Irish car fleet can be second hand vehicles from the UK. It is important that any measures to disincentivise new ICE vehicles also apply to this market.

barriers to EV use. The trend over recent years towards larger SUV style cars should also be disincentivised in favour of smaller, lighter more efficient vehicles.

The primary goal for decarbonising private car transport is to reduce the number and activity of ICE vehicles. As well as incentivising the purchase of new EVs, and disincentivising the purchase of new ICE vehicles, there is also the opportunity to consider measures to accelerate the phase out of old ICE vehicles.

6 Built environment

6.1 Key messages:

- In all scenarios oil use in buildings declines significantly and by the end of the decade it is no longer the largest energy source for Irish homes.
- In the WAM-CAP23 scenario, the number of homes using heat pumps are assumed to increase eightfold by 2030, at which point more homes would use heat pumps than any other heat source.
- In both the WEM and WAM-CAP23 scenarios the built environment sector exceeds the sectoral ceilings for both the first and second carbon budget periods.
- The projected exceedance in the first budget period means that approximately 2% of the second budget will have been consumed before the second period begins.
- By the end of the second budget period the total exceedance is projected to be 3.5 $MtCO_2$ (5%) and 1.0 $MtCO_2$ (2%) in the WEM and WAM-CAP23 scenarios respectively.
- There is strong growth in numbers of people availing of Government grants for home energy upgrades and heat pumps in 2022 and the first half of 2023. It will be a significant challenge to continue to grow uptake to the rates required to meet the CAP23 targets.
- Despite recent progress, there is high uncertainty on the potential roll out rate for district heating. Rapid scale up is proposed in CAP23 and significant action is required to develop district heating schemes to meet this ambition. Lessons can be learned from other EU countries where district heating networks supply a significant proportion of heat.
- Removal of fossil fuel heating systems from existing buildings is the critical measure needed to reduce and eventually eliminate greenhouse gas emissions from the built environment. We need to ensure that non-fossil alternative technologies are viable for all.

6.2 Scenario assumptions at a glance

6.2.1 Heat pumps installed in existing homes & home energy upgrades

WEM scenario

In the WEM scenario, we do not set the total numbers of heat pumps or home energy upgrades for 2030 as a target, instead we model the anticipated impact of the suite of supports currently in place, for instance the grant of €6,500 for installing a heat pump in any type of house, €8,000 for external wall insulation in a detached house, €1,200 for attic insulation in a terraced house, etc. This results in modelled uptake of 227,000 heat pumps in existing dwellings and 346,000 dwellings undergoing home energy upgrades by 2030, of which 173,000 reach a BER of B2 or better.

WAM-CAP21 and WAM-CAP23 scenarios

In the WAM-CAP21 and WAM-CAP23 scenarios we increased the supports within the model to try to achieve the targets for 400,000 heat pumps installed in existing dwellings and 500,000 B2-equivalent home energy upgrades.[30] This resulted in a projected uptake of 322,000 heat pumps installed in existing dwellings and 457,000 home energy upgrades by 2030.[31]

6.2.2 District heating

WEM scenario

We assume that the Tallaght District Heating Network (TDHN) and the Dublin District Heating Scheme (DDHS) will be operational by 2030, and that these two schemes combined will deliver 0.07 TWh per annum of district heat by 2030.

WAM-CAP21 and WAM-CAP23 scenarios

We assume the CAP21 and CAP23 target for 2.7 TWh of district heat will be fully met. We assume that this would be split into 1.2 TWh from residential and 1.5 TWh from services, equating to approximately 125,000 dwellings and 11,500 commercial and public sector buildings.

6.3 Fuel use for the built environment

6.3.1 Fuel use for Households

In 2022, 70% of fuel use in households was from the direct use of fossil fuels, 26% from electricity, and just 4% from direct use of renewable energy. Oil was the single largest fuel source in 2022, accounting for 40% of residential energy use, while natural gas accounted for 20%. Coal and peat, the most polluting fossil fuels, accounted for 10% of household energy use, but 21% of direct household CO_2 emissions[32].

In the WEM scenario in 2030 just over 50% of household energy use still comes from direct fossil fuel use. In the WAM-CAP23 scenario in 2030 direct fossil fuel use is reduced to 42% of total energy use, with electricity and renewable energy accounting for 58%, due to the assumed increase in

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[30] The methodology for calculating the number of B2-equivalent upgrades is being finalised, so it is not currently possible to estimate the number of B2-equivalent upgrades carried out to date, or the number that will be achieved in the modelled scenarios. These estimates will be updated following finalisation of the methodology.

[31] Further work commissioned by SEAI is currently underway to examine the most appropriate suite of increased supports to the deliver the full ambition of 500,000 B2-equivalent home upgrades. These include measures to overcome both financial and non-financial barriers.

[32] Excluding emissions from electricity use, as these are counted as a separate sector for the purposes of carbon budgets.

heat pumps, biomethane and district heating. In the WAM-CAP23 scenario 33% of all dwellings (659,000 new and existing dwellings) use heat pumps, and a further 6% (125,000 dwellings) are assumed to have connected to district heating networks.

In all scenarios oil use declines significantly and by the end of the decade it is no longer anticipated to be the largest energy source for Irish homes. In the WEM scenario oil use reduces by 36% by 2030 and in the WAM-CAP23 scenario it reduces by 39%. In the WAM-CAP23 scenario the number of dwellings heated by oil falls by 42% between 2021 and 2030, from 723,000 dwellings to 418,000.

Household natural gas use in the WEM scenario is projected to be the same in 2030 as in 2022, but in the WAM-CAP21 scenario it is projected to be 28% lower, due to the higher assumed uptake of heat pumps and district heating in this scenario. In both the WAM-CAP21 and the WAM-CAP23 scenarios the number of homes heated by gas falls by 160,000 (25%) between 2021 and 2030. In the WAM-CAP23 scenario we also assume that the CAP23 target for 5.7 TWh of biomethane will be met. We assume that all of this will be blended in the gas grid and that it will be split on a pro-rata basis between all users of gas for heating purposes (essentially all gas users except electricity generation). On this basis, 1.4 TWh of biomethane is assumed to displace natural gas use in the residential sector by 2030. This results in natural gas use in households in 2030 being 43% lower than in 2022 in the WAM-CAP23 scenario.

Solid fuel use is projected to reduce by 20% by 2030 compared with 2022 in the WEM scenario and by 30% by 2030 in the WAM-CAP23 scenario.

Figure 12: Fuel use for households

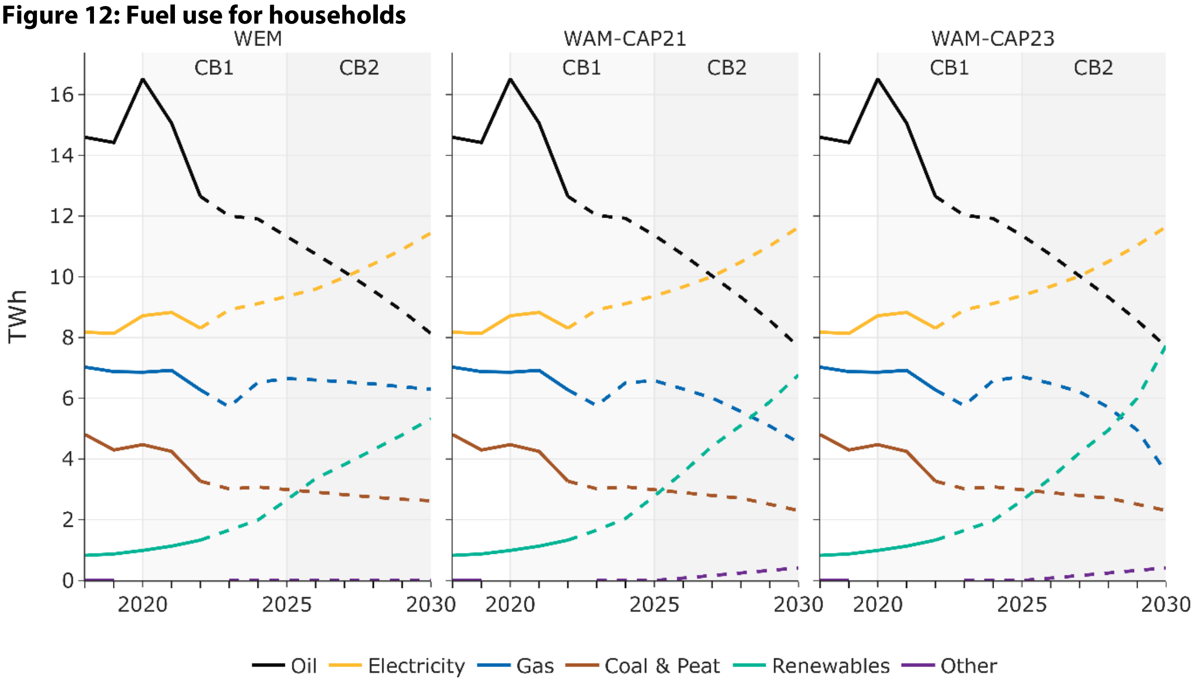
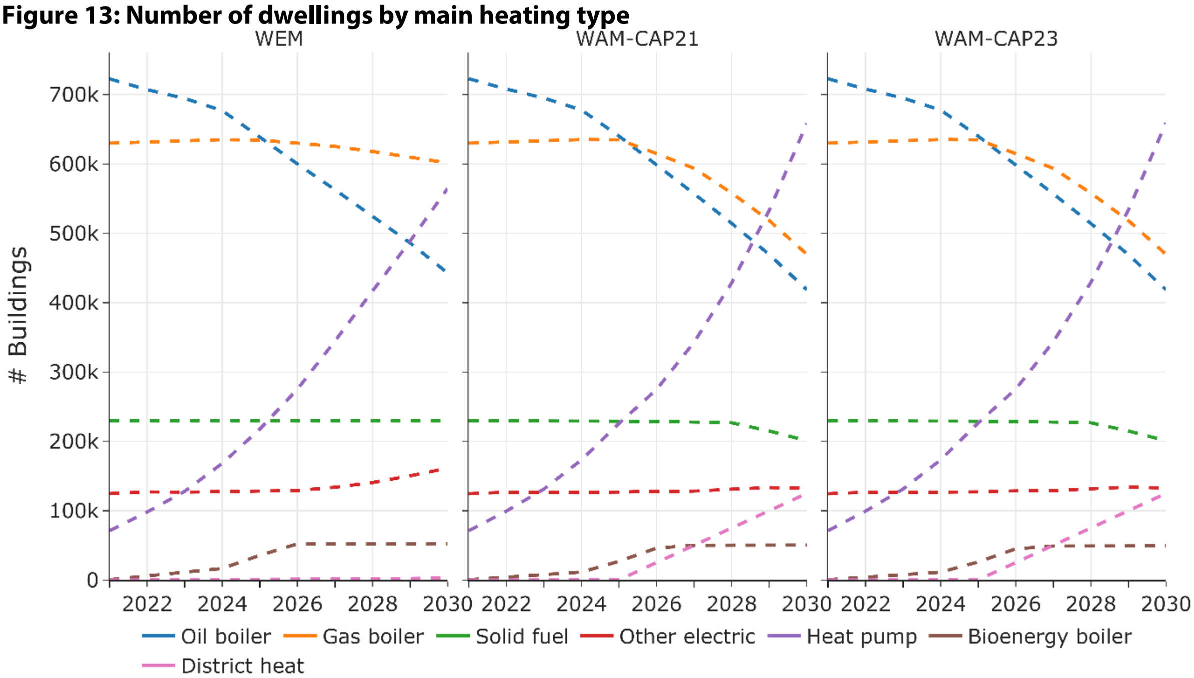


Table 14: Fuel use for households

Energy (TWh)	2022 Actual (TWh)	2030 Projected (TWh)		
		WEM	WAM-CAP21	WAM-CAP23
Renewables	1.3	5.3	6.8	7.7
Electricity	8.3	11.4	11.6	11.6
Oil	12.6	8.1	7.7	7.7
Gas	6.3	6.3	4.5	3.6
Coal & peat	3.3	2.6	2.3	2.3
Other[33]	0.0	0.0	0.4	0.4
Total	31.8	33.8	33.4	33.4

Figure 13: Number of dwellings by main heating type



[33] For the residential sector the "Other" category consists of non-renewable wastes used for district heating

Table 15: Number of dwellings by main heating type

Main space heating source (number of dwellings)	2021 (CSO Census)	2030 (Projected)		
		WEM	WAM-CAP21	WAM-CAP23
Heat pump	71,000	565,000	658,000	659,000
Other electric	125,000	161,000	133,000	133,000
Gas boiler	630,000	601,000	470,000	470,000
Oil boiler	723,000	443,000	419,000	418,000
District heat	0	3,000	125,000	125,000
Solid fuel	230,000	230,000	201,000	201,000
Bioenergy boiler	1,000	53,000	50,000	49,000
Total dwellings modelled	1,779,000	2,056,000	2,056,000	2,056,000

6.3.2 Fuel use for commercial and public services sector

Figure 14 and Table 16 below show projected energy use in the commercial and public services sectors. The energy use of datacentres is accounted for under the commercial services sector, but because of the expected level of growth in datacentre energy use it is useful to consider datacentres separately. See section 4.5.1 for discussion on projected growth in datacentre electricity use.

Excluding datacentres, electricity accounted for 59% of services energy use in 2022, fossil fuels for 38% and 4% from direct use of renewable energy.[34] The share of fossil fuels by 2030 is expected to fall to 28% in the WEM scenario and to 20% in the WAM-CAP21 scenario, due to higher uptake of heat pumps and district heating. It is expected to fall further to 17% by 2030 in the WAM-CAP23 scenario, due to increased use of biomethane in place of natural gas.

[34] Given that a large share of energy use in the sector is from electricity it is worth noting that the emissions from electricity use are not counted under services sector, as they are counted separately under the electricity sector.

Figure 14: Fuel use for commercial and public services

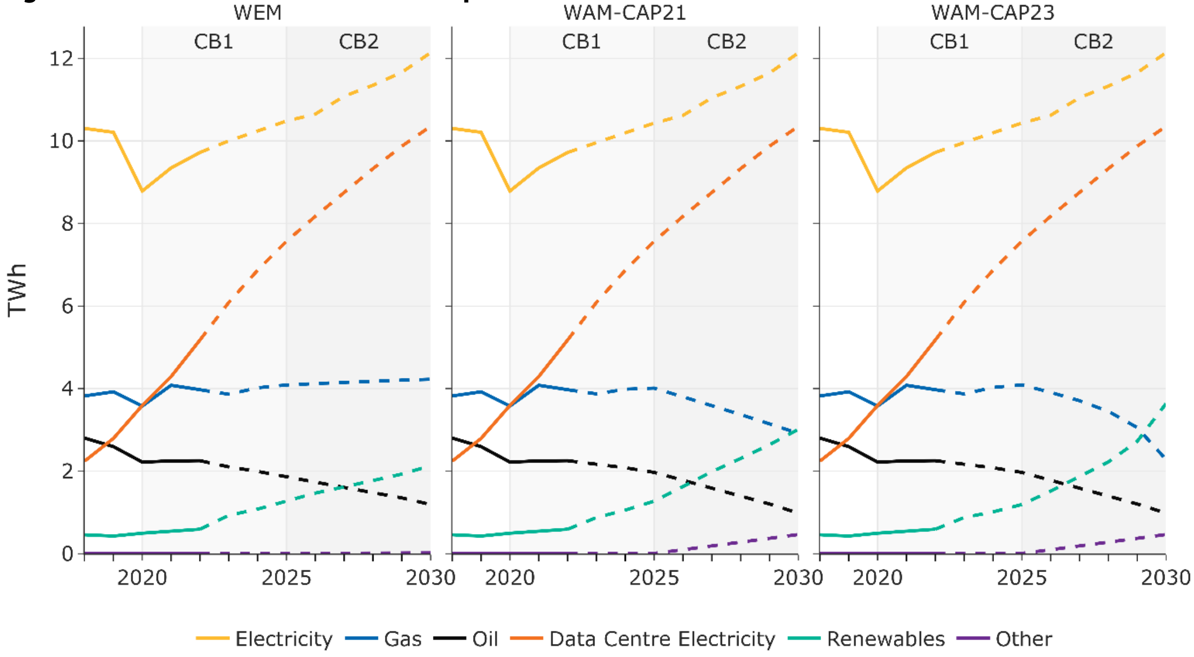


Table 16: Fuel use for commercial and public services

Energy (TWh)	2022 Actual (TWh)	2030 Projected (TWh)		
		WEM	WAM-CAP21	WAM-CAP23
Renewables	0.6	2.1	3.0	3.6
Datacentre electricity	5.2	10.4	10.4	10.4
Other electricity	9.7	12.1	12.1	12.1
Oil	2.3	1.2	1.0	1.0
Gas	4.0	4.2	2.9	2.3
Other[35]	0.0	0.0	0.5	0.5
Total	21.7	30.1	29.9	29.9

6.4 Greenhouse gas emissions from the built environment

The sectoral ceilings for the residential, services, and the combined residential and services built-environment sectors are shown in Table 17, below[36]. If the indicative trajectory for the carbon budgets was followed every year, then emissions from the built environment in 2030 would need to be 41% lower than in 2018. However, if this indicative trajectory is exceeded in early years, then

[35] For the services sector the "Other" category consists of non-renewable wastes used for district heating and coal

[36] This section does not include the emissions from electricity consumed by the sector, as those emissions are counted separately under the electricity sector.

to compensate steeper reductions are required thereafter, leading to a larger percentage reduction required by 2030.

Table 17: Sectoral ceilings and related indicators for built environment.

Sectoral ceiling for built environment sectors	Residential	Services	Built Environment (total)
2018 baseline emissions ($MtCO_2eq$)	7	2	9
CB1 ceiling 2021-2025 ($MtCO_2eq$)	29	7	36
CB2 ceiling 2026-2030 ($MtCO_2eq$)	23	5	28
Indicative average annual % reduction required in CB1	-5.4%	-3.1%	-4.9%
Indicative average annual % reduction required in CB2	-3.9%	-9.0%	-4.9%
Initial indicative reduction required by 2030 (relative to 2018; assuming indicative target trajectory met in all years)	-40%	-47%	-41%

Figure 15 illustrates the *annual* emissions trajectories for the first two carbon budget periods for the built environment sector (residential sector plus commercial and public services sectors) as modelled in the WEM and WAM-CAP23 scenarios. It also shows the indicative annual emissions trajectory required to stay within the carbon budgets from 2021 to 2030. Dashed lines are used to illustrate a revised CB2 trajectory that would be required to meet the CB2 obligation if the WEM or WAM-CAP23 scenarios were followed in CB1. The resulting revised average annual reduction rate for CB2 and the revised total reduction by 2030 compared to the 2018 baseline are shown in Table 18.

Figure 15: Annual greenhouse gas emissions from the built environment

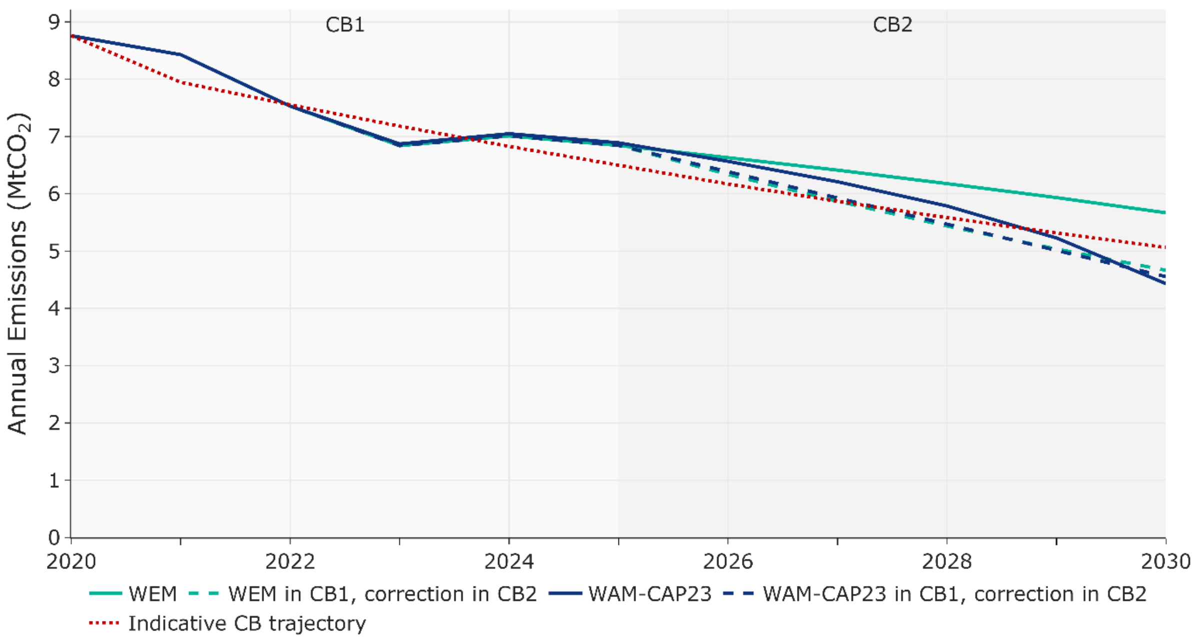


Figure 16 shows the *cumulative* emissions trajectories over the first two carbon budget periods for the built environment sector for the WEM and WAM-CAP23 scenario. The black horizontal dashed lines show the sectoral ceilings for the first two budget periods. The chart illustrates the years in which the sectoral ceilings are reached in each scenario, and the cumulative exceedance by the end of the second budget period is noted for each scenario. Table 18 shows the expected performance against the sector ceiling for the built environment, while Table 19 and Table 20 show the performance for the residential and services sectors separately.

Figure 16: Cumulative greenhouse gas emissions from the built environment

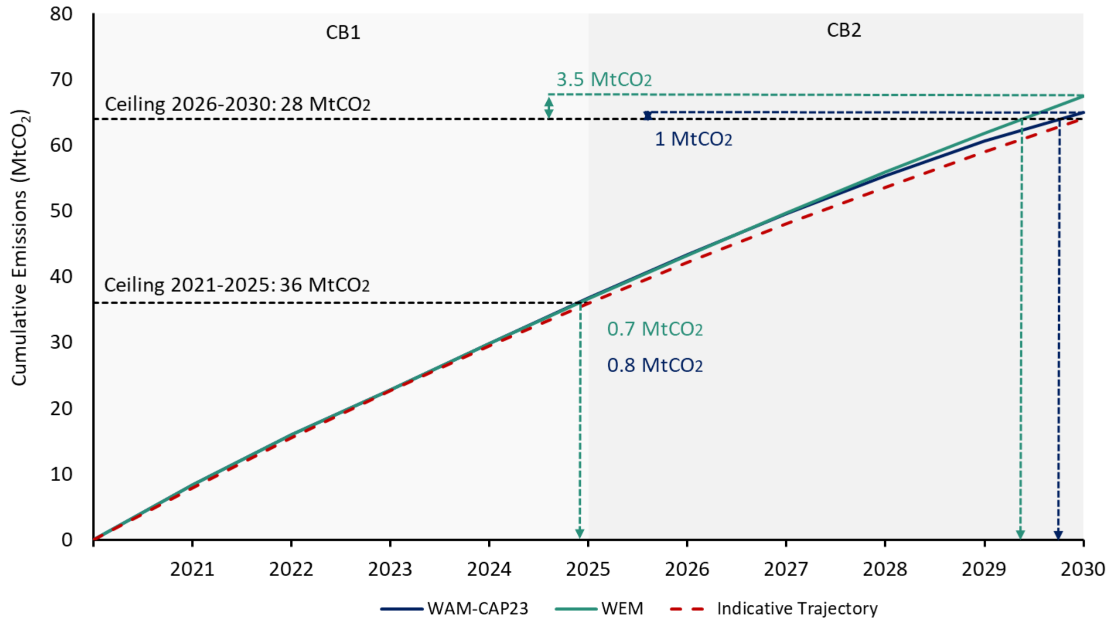


Table 18: Projected exceedance of sectoral ceilings for the built environment

Built environment sector	WEM	WAM-CAP23
Projected CB1 Exceedance ($MtCO_2eq$)	0.7	0.8
Projected CB2 Exceedance (including CB1 carry over) ($MtCO_2eq$)	3.5	1.0
Projected average annual change in emissions CB1	-5.1%	-4.9%
Indicative average annual change in emissions required in CB2 to stay within the CB2 ceiling if named scenario followed in CB1	-7.4%	-7.8%
Revised indicative reduction required by 2030 compared to 2018 to stay within CB2 ceiling if named scenario followed in CB1	-46% to-47%	-47% to -48%

Table 19: Projected exceedance of sectoral ceilings for the residential sector

Built environment - residential sector	WEM	WAM-CAP23
Projected CB1 Exceedance ($MtCO_2eq$)	0.7	0.8
Projected CB2 Exceedance (including CB1 carry over) ($MtCO_2eq$)	2.2	0.6
Projected average annual change in emissions CB1	-4.2%	-4.2%
Indicative average annual change in emissions required in CB2 to stay within the CB2 ceiling if named scenario followed in CB1	-6.9%	-7.0%
Revised indicative reduction required by 2030 compared to 2018 to stay within CB2 ceiling if named scenario followed in CB1	-46%	-46%

Table 20: Projected exceedance of sectoral ceilings for the commercial and public services sector

Built environment - commercial and public services sector	WEM	WAM-CAP23
Projected CB1 Exceedance ($MtCO_2eq$)	-0.1	0.0
Projected CB2 Exceedance (including CB1 carry over) ($MtCO_2eq$)	1.3	0.3
Projected average annual change in emissions CB1	-2.6%	-2.2%
Indicative average annual change in emissions required in CB2 to stay within the CB2 ceiling if named scenario followed in CB1	-9.5%	-10.5%
Revised indicative reduction required by 2030 compared to 2018 to stay within CB2 ceiling if named scenario followed in CB1	-47%	-49%

There is little difference between the WEM and WAM-CAP23 built environment sector emissions in the years 2021-2026. It is not until after 2026 that the trajectories diverge significantly, corresponding to the assumed large scale roll out of district heating and biomethane in the WAM-CAP23 scenario.

In the WEM and WAM-CAP23 modelled scenarios the CB1 ceiling for the built environment is expected to be exceeded by 0.7 $MtCO_2eq$ (2%) and 0.8 $MtCO_2eq$ (2%) respectively[37]. This corresponds to 2% and 3% of the built environment CB2 budget respectively. Both WEM and WAM-CAP23 modelled scenarios breach the CB2 ceiling for the built environment in 2030, exceeding it by 3.5 $MtCO_2eq$ (5%) and 1.1 $MtCO_2eq$ (2%) respectively.

If built environment greenhouse gas emissions were to follow the WEM or WAM-CAP23 trajectory until 2025 then to stay within the CB2 sector ceilings, emissions would have to fall 46% or 47%

[37] The built environment sector is unusual in that the WAM-CAP23 scenario shows slightly higher emissions in CB1 than the WEM. This is because in the WAM-CAP23 scenario a higher number of dwellings are earmarked for switching to district heating. These dwellings are assumed not to take up alternative decarbonisation options available in CB1 and instead wait until district heating is assumed to be available later in the decade. This leads to slightly higher emissions in CB1, but lower emissions in the CB2.

below 2018 levels by 2030, respectively.[38] This would require an average annual reduction in emissions during CB2 of 7.4% per annum in the WEM scenario and 7.8% in the WAM-CAP23 scenario.

Of all the energy sectors the built environment shows the lowest percentage exceedance of CB2 in both WEM and WAM-CAP23 scenarios. This reflects the weight of policy focus on this sector, particularly on the residential sector.

6.5 Uncertainties and risks to target achievement.

Uncertainty and risk factors are discussed below for critical technologies required for decarbonisation of the built environment, namely building retrofit for improved energy efficiency, heat pumps and district heating.

6.5.1 Building retrofit and heat pump deployment rates

CAP23 set a target for the installation of 400,000 heat pumps in existing dwellings by 2030. SEAI estimates that to achieve this the annual number of heat pump installations in existing buildings (i.e., excluding new builds) will need to increase rapidly to 14,000 installations by 2025, and to over 100,000 installations per annum by 2030. In 2022 SEAI supported the installation of 2,286 heat-pumps in existing dwellings, up from 1,972 in 2021. For the first six months of 2023, the rate increased again with 1,831 heat pumps installed. Despite this performance in 2023, current growth rates are not in line with what would be required to hit the 2025 target, and the magnitude of the scale-up required post-2025 presents a substantial risk that the 2030 target will not be achieved without significant additional policy effort.

CAP23 also contains a target for the National Retrofit Plan to deliver 500,000 dwelling upgrades to BER B2, cost optimal or carbon equivalent standard.[39] To achieve this the annual number of BER B2-equivalent upgrades would need to increase to 75,000 per annum between 2026 and 2030. In 2021, SEAI delivered 15,246 grants for home energy upgrades. This increased significantly to 27,199 grants in 2022, of which 8,325 (31%) were to a standard of B2 or better. For the first six months of 2023 the rate increased again with 21,727 upgrades delivered, of which 7,432 (34%) were to a B2 or better, an encouraging trajectory.[40]

For the commercial and public services sector, CAP23 sets an overall greenhouse gas reduction target to come from decarbonising heating in the sector, but it does not present specific targets for numbers of building upgrades or number of heat pump installations. This results in some uncertainty on how the targeted greenhouse savings will be achieved.

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[38] Assuming a geometric reduction trajectory. The final reduction required would depend on the trajectory taken within CB2. If the WEM or WAM-CAP23 trajectory were followed until 2025 and emissions were to then follow a linear reduction trajectory in CB2, then total greenhouse gas emissions would need to fall by 47% or 48% respectively by 2030 to keep within the second carbon budget.

[39] The methodology for calculating the number of B2-equivalent upgrades is being finalised, so it is not currently possible to estimate the number of B2-equivalent upgrades carried out to date, or the number that will be achieved in the modelled scenarios. These estimates will be updated following finalisation of the methodology.

[40] Information on SEAI National Home Retrofit Programmes available from https://www.seai.ie/grants/home-energy-grants/home-upgrades/

For the modelled scenarios we do not set the total numbers of heat pumps or home energy upgrades for 2025 and 2030 as targets, rather we model an anticipated uptake rate based on the suite of supports currently in place. These include the current suite of grants, for instance €6,500 for installing a heat pump, and €8,000 for external wall insulation in a detached house, and other supports.[41] For the WEM scenario, this results in a projected uptake of 227,000 heat pumps in existing dwellings and 346,000 dwellings undergoing home energy retrofits by 2030, of which 173,000 reach a BER of B2 or better.

In the WAM-CAP21 and WAM-CAP23 scenarios we increased the supports within the model to try to achieve the targets for home energy upgrades and heat pumps installed in existing dwellings. This resulted in a projected uptake of 322,000 heat pumps installed in existing dwellings and 457,000 home energy upgrades by 2030, of which 243,000 reach a BER of B2 or better.

Critical success factors and opportunities

The heat-pump target is particularly important for achieving greenhouse gas emissions reductions because heat-pumps usually replace the fossil fuel heating system in a building, thereby permanently removing direct fossil fuel use from the energy system. In contrast if we improve the efficiency of a building but leave a fossil fuel heating system in place, typically there remains a significant (though reduced) demand for fossil fuels. Furthermore, this fossil fuel demand has the potential to increase again over time due to the phenomenon of energy rebound[42] or due to other potential factors such as lower fuel prices. Removing fossil fuel heating systems from large numbers of homes and buildings as early as possible is essential to achieve our greenhouse gas emissions ceiling for the built environment.

SEAI has undertaken a range of research to support the deployment of heat pumps nationally, including the 2020 report: *Encouraging heat pump installations in Ireland - Strategies to maximise heat pump installation and the savings produced*[43]. The report notes that there is a strong tendency for homeowners to continue using their existing heating system until it breaks down. If the boiler breaks down during the heating season, then it is crucial for the occupants to restore the heating system as quickly as possible. In such a distressed purchase situation, occupants are likely to place a higher weight on how quickly the system can be replaced and may not explore all available alternative heating systems. In many cases the thermal performance of the dwelling also needs to be upgraded to allow a heat pump to be used effectively. This adds further cost and significantly increases the lead in time and hassle of opting for a heat pump. For these reasons, if one of the main drivers for replacing heating systems is boiler breakdown, many householders will likely not be willing to consider installing a heat pump together with the associated upgrade works at that point in time.

Other real and/or perceived barriers to heat pump uptake include:

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[41] Further details of current supports are available here: https://www.seai.ie/grants/home-energy-grants/
[42] The rebound effect, in general terms, describes the observation that potential energy savings from efficiency improvements are offset by a resulting increase in energy service demand. In the case of home energy upgrades, direct rebound happens when households enjoy some or all of the benefits of improved efficiency in the form of a warmer, more comfortable home, instead of reducing their energy bills.
[43] SEAI, 'Encouraging heat pump installations in Ireland'. 2020. [Online]. Accessed from: https://www.seai.ie/publications/Heat-Pump-Adoption.-Maximising-Savings..pdf

- The low prices for fossil fuels as compared to electricity. The design of electricity tariffs and energy taxation can put heat pumps at a disadvantage relative to fossil fuel boilers.
- Correct operation of the heat pump system is essential to minimise running costs. However, studies have shown that homeowners are often not provided with adequate training/advice to help them operate their heat pump efficiently.
- There is still public unfamiliarity with heat pumps as a new technology.
- There are some common misconceptions about what is needed to install a heat-pump that may result in homeowners thinking their property is inherently unsuitable, for instance the misconception that it requires underfloor heating.
- Heat pumps have higher upfront costs than a fossil fuel boiler, however current government grant support of up to €10,500 for heat pump installation have significantly closed the price gap between a heat pump-installation and a direct oil or gas boiler replacement.
- Market development and skills shortages.

Strategies to address these barriers are being actively considered by policy makers to drive increased rates of heat pump deployment.[44] Potential measures to overcome the barriers to heat-pump uptake include the following:

- Incentives must be designed to encourage homeowners to proactively consider replacing their existing fossil fuel heating system with a heat pump before it breaks down. Possible measures to incentivise this could include targeted marketing campaigns and boiler scrappage schemes, for example.
- Options to increase barriers to the simple like-for-like replacement of old fossil fuel boilers with new fossil fuel boilers could also be considered. These will likely need to include regulations prohibiting the installation of fossil fuel boilers in existing buildings, other than in some limited and exceptional circumstances, from a certain date in the future. This will be necessary also in the context of net-zero targets.
- Uncertainty on the operating costs of a heat pump is a further potential barrier that must be addressed. One possible measure could include operational supports for heat-pump users to ensure that they do not pay more per unit of useful heat delivered than those with oil or gas boilers. These are likely to be needed in the near term, given current high electricity prices.
- In the longer-term, further measures to address operating costs include reform of the wholesale electricity market, to ensure that the increase in low-cost renewable electricity supply translates to electricity retail price reductions for consumers, and reform of taxes and levies on electricity compared to fossil fuel alternatives.
- The rollout of a 'National Heat Strategy' underpinned by appropriate spatial planning, focussed on heat pump and district heating deployment, would give further certainty to the market and to consumers as to the most appropriate low carbon alternatives in each geographical area and also as to the pace and scale of transition away from fossil fuel heating that is required.

[44] Necessary actions for decarbonising heat in the built environment are being pursued by the Government's Heat and Built Environment Taskforce For more information see: https://www.gov.ie/en/publication/097fa-heat-and-built-environment-taskforce/#

SEAI undertakes a range of research to support the future deployment of heat pumps nationally. Current research projects include the Heat Pump and Heat Loss Indicator Research Pilot, the Heat Pump and Heat Loss Indicator Historical Analysis, and the Willingness to Pay Research Project. Further evidence-based research and trials into accelerating heat pump adoption in Ireland are needed, underpinned by access to robust data and real-world monitoring of actual energy use pre and post heat pump installation. The findings of this ongoing research will further support policy makers to refine the policy mix and drive higher rates of technology deployment and home upgrades.

6.5.2 Delivery timeline of district heating

CAP23 sets a target of 2.7 TWh of heat to be supplied by district heating by 2030. For the WAM-CAP21 and WAM-CAP23 scenarios we assumed that this target would be fully met. CAP23 targets 2.5 TWh of the total target to go to the residential sector, with 0.2 TWh to the commercial and public sectors. SEAI analysis suggests that because district heating is likely to be developed first in the dense centres of towns and cities, and because it is common for district heating schemes to rely on connections to large public or commercial sector heat users as anchor loads, the share of district heating supplied will be more weighted towards the commercial and public sector. We estimate that for the 2.7 TWh to be met, a likely split would be 1.2 TWh from residential and 1.5 TWh from services, equating to approximately 125,000 dwellings and 11,500 commercial and public sector buildings.

District heating has never been undertaken at scale in Ireland, although there are a number of smaller schemes in operation. Although district heating is a long-proven technology in many EU countries, this lack of national experience poses challenges for the rapid scale up of district heating proposed in CAP23.

In our WEM scenario, we assume that just two sizable schemes will be in operation by 2030: the Tallaght District Heating Network (TDHN) and the Dublin District Heating Scheme (DDHS). The first phase of the TDHN was opened in early 2023, and there are plans to expand the scheme further. The DDHS is not yet operational, but it has been in the planning and development phase for many years and much of the infrastructure is already in place, so it is at a more advanced stage of development than any other large scheme. These two schemes combined aim to deliver approximately 66.5 GWh/annum, or 0.07 TWh/annum of district heat by 2030. This would amount to 2.5% of the 2030 target. Therefore, for the 2030 target to be achieved, another 40 schemes of the combined size of the TDHN and DDHS would need to be identified, planned, and delivered by 2030. The scale of this challenge poses a high risk that there will be significant underachievement of the 2.7 TWh district heating target for 2030. For the level of district heating in the WEM scenario to be increased in future projections, further specific projects will need to be identified and plans published that contain realistic implementation timelines.

Critical success factors and opportunities

- There is an absence of appropriate legislative and regulatory frameworks for district heating due to nascent nature of the industry. This is a key barrier to the development of district heating and needs to be addressed as a priority.
- There is a lack of national technical standards and guidance for district heating schemes. This should be addressed as a priority to allow for the training of installers and to ensure compatibility of different district heating systems in future.

- Detailed site-specific feasibility studies should be carried out in local authorities across the country as urgent actions.
- Priority areas suitable for district heating should be identified as soon as possible. A national heat strategy should be developed that recognises the different decarbonisation pathways for buildings within and without district heating areas. Government supports for building decarbonisation should reflect this strategic approach.
- Steps can be taken today in areas identified as suitable for district heating to increase the viability of future district heating projects in those areas. Interim measures could be taken to prevent consumers replacing end of life boilers with fossil fuel technologies (e.g. a boiler loan scheme), and to engage with large energy-users in the area that would be needed to serve as anchor customers.
- District heating projects require large upfront capital investment and have long payback periods. The market requires clear, strong, and stable policy signals aligned with fiscal supports.
- Policies and supports need to be established in tandem to encourage both projects currently in the initial stages of development, but also a future pipeline of projects.

The District Heating Steering Group was formed under the Climate Action Plan 2021, as part of the Government's commitment to further the expansion of district heating in the State. The Steering Group coordinates the rollout of policies and measures to support district heating in Ireland. In August 2023 it published its first report.[45] Building on the work undertaken by local authorities, most notably by South Dublin County Council with support from Codema, the report contains a series of recommendations to facilitate the rapid deployment of district heating in Ireland. The key recommendations of this report include:

- The Department of the Environment, Climate, and Communications to bring forward proposals for all necessary legislation.
- The appointment, in the long-term, of a single state entity or utility to centralise the development and expansion of heat networks.
- The establishment of a National District Heating Centre of Excellence.
- Exploration of the options to finance district heating schemes, and options to provide financial supports, including the range of existing supports for renewable energy and climate related projects.

[45] Department of the Environment, Climate, and Communications, 'District Heating Steering Group Report 2023'. 2023. [Online]. Accessed from: https://www.gov.ie/pdf/?file=https://assets.gov.ie/265549/487f6e25-427d-4ba3-acc8-d3b5e6272b46.pdf#page=null

7 Industry

7.1 Key messages:

- In the WAM-CAP23 scenario, fossil fuels account for 42% of energy use in industry in 2030. This compares to the CAP23 target to reduce the share of fossil fuel use to 25-30% by 2030.
- In both the WEM and WAM-CAP23 scenarios the industry sector exceeds the sectoral ceilings for both the first and second carbon budget periods.
- The projected exceedance in the first budget period means that approximately 14% of the second budget will have been consumed before the second period begins.
- By the end of the second budget period the total exceedance is projected to be 14.9 $MtCO_2eq$ (28%) and 13.6 $MtCO_2eq$ (25%) in the WEM and WAM-CAP23 scenarios, respectively.
- If energy demand in the industry sector continues to grow out to 2030 at the rate seen from 2011 to 2019 it would pose a severe challenge to meeting our national and international climate and energy obligations. We need to ensure that any new energy demand in the industry sector does not lock in fossil fuel use for decades to come.
- Early action is crucial for limiting the growth in cumulative emissions to meet our climate obligations. Focusing industry decarbonisation on renewable and electrification technologies that are commercially available today will result in lower cumulative emissions than alternative pathways that wait for technologies that will not be commercially available at scale this decade.
- Heat pumps offer an alternative for low-medium temperature heat applications currently delivered by direct fossil fuel burning, especially in situations where there is a requirement for simultaneous heating and cooling or where there are waste heat streams that can be utilised. But uncertainty remains as to the potential scale and pace of uptake.
- Sustainably produced biomethane is seen as especially important for decarbonising industry, but the scale of biomethane production to date is of the order of 1% of the 2030 target. Clarity is needed on the proposed support mechanism for biomethane, on feasible ramp up rates for sustainable biomethane production in Ireland, and on which sectors biomethane is most likely to be used.

7.2 Scenario assumptions at a glance

7.2.1 Growth in industry energy demand

All scenarios

All scenarios show continued growth in industry energy demand out to 2030, informed by the ESRI I3E model of the economy and energy use, with an increase of 13% between 2021 and 2030, equating to growth of 1.4% per annum. This compares to the historic rate of growth of 2.9% per annum observed between 2011 and 2019.

7.2.2 Share of carbon neutral heating in industry.

All scenarios

CAP23 sets a target to reduce the share of direct fossil fuel use in the industrial sector to 45% by 2025 and to reach a 70-75% share of carbon neutral heating in industry by 2030. However, we do not directly assume this as an outcome in any scenario. For all scenarios we use the NEMF to estimate the uptake of different heating systems, based primarily on lifetime costs. The only direct point of difference between the scenarios is the quantity of biomethane available.

7.2.3 Biomethane supply

Neither CAP21 nor CAP23 set out what support mechanisms will be used to support the production of biomethane. We assumed that the support mechanism will apply to energy used for heating and that all biomethane produced will be allocated on a pro-rata basis between all end-users of gas for heating. We assume that no biomethane will be used for electricity generation. This biomethane use directly displaces fossil gas use.

WEM scenario

In the absence of a published support mechanism, we do not assume that there is any growth in biomethane production in the WEM scenario.

WAM-CAP21 scenario

We assume the CAP21 target for 1.6 TWh of biomethane is fully achieved. Based on the relative projected gas use of the sectors in 2030, 1.0 TWh of biomethane use would go to industry heat users, 0.4 TWh to households and 0.2 TWh to the commercial and public services sectors. In this scenario biomethane would account for 8% of all grid-gas use for heat users by 2030.

WAM-CAP23 scenario

We assume the CAP23 target for 5.7 TWh of biomethane is fully achieved. Based on the relative projected gas use of the sectors in 2030, 3.5 TWh of biomethane use would go to industry heat users, 1.4 TWh to households and 0.9 TWh to the commercial and public services sectors. In this scenario biomethane would account for 28% of all grid-gas use for heat users by 2030.

7.3 Fuel use in industry

In 2022 direct fossil fuel use accounted for 61% of industry energy demand, electricity 28% and renewables 9%. Renewable energy use in industry is concentrated in two industry subsectors. In 2022 67% of industry renewable energy use was in the form of wood waste used by the wood and wood products industry, and a further 29% was in the form of biomass and renewable waste used in cement production.

Based on modelled uptake of alternative heating systems in Industry, in the WEM scenario the share of fossil fuels drops to 55% by 2030, but the actual amount of fossil fuels used increases by 5%, due to growth in total industry energy demand. In this scenario in 2030 electricity accounts for 27% of industry energy use and renewables for 16%.

The use of biomethane combined with increased use of solid biomass and heat pumps results in the share of renewable energy use in industry in 2030 increasing to 20% in the WAM-CAP21 scenario and to 29% in the WAM-CAP23 scenario. Growth in electricity use only just keeps pace with overall industry energy growth and so its share of industry energy use remains flat at 27% in 2030 in all scenarios. This results in the share of direct fossil fuel use in industry in 2030 reducing to 51% in the WAM-CAP21 scenario and to 42% in the WAM-CAP23 scenario.

Figure 17: Fuel use in industry

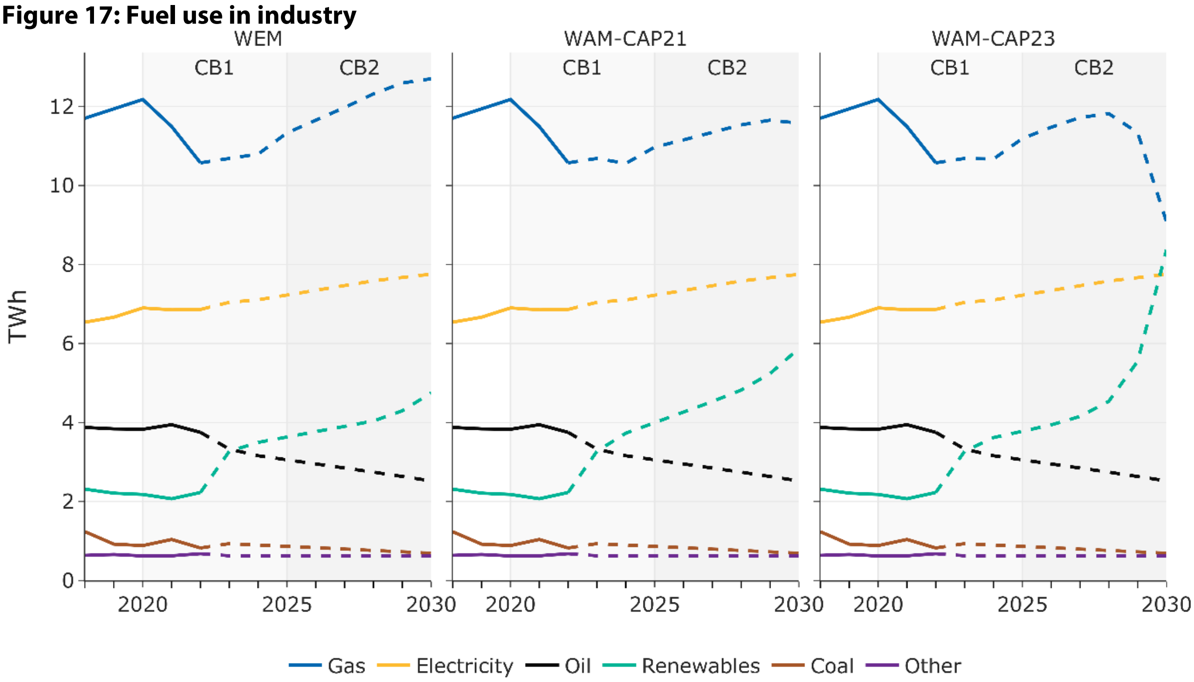

Table 21: Fuel use in industry

Energy (TWh)	2022 Actual (TWh)	2030 Projected (TWh)		
		WEM	WAM-CAP21	WAM-CAP23
Renewables	2.2	4.8	5.9	8.4
Electricity	6.9	7.8	7.8	7.8
Oil	3.8	2.5	2.5	2.5
Natural gas	10.6	12.7	11.6	9.1
Coal & peat	0.8	0.7	0.7	0.7
Other	0.7	0.6	0.6	0.6
Total	**24.9**	**29.1**	**29.0**	**29.0**

7.4 Greenhouse gas emissions from industry

Industry emissions are comprised of two components, emissions from fossil fuel combustion for energy use (referred to as "Manufacturing Combustion" emissions in the National Greenhouse Gas Inventories) and process emissions such as those from mineral and chemical industries. The sectoral ceiling for industry covers both components[46].

The sectoral ceilings for industry are shown in Table 22 below. If the indicative trajectory for the carbon budgets calculated at the start of the CB1 period was followed every year, then emissions in 2030 would need to be 35% lower than in 2018. However, given exceedance in early years, steeper reductions are required for the remaining years of the CB1 period and CB2 periods, thus leading to a larger percentage reduction required by 2030.

Table 22: Sectoral ceilings and related indicators for industry

Sectoral ceiling for industry sector	
2018 baseline emissions ($MtCO_2eq$)	7
CB1 ceiling 2021-2025 ($MtCO_2eq$)	30
CB2 ceiling 2026-2030 ($MtCO_2eq$)	24
Indicative average annual % reduction required in CB1	-4.4%
Indicative average annual % reduction required in CB2	-4.4%
Initial indicative reduction required by 2030 (relative to 2018; assuming indicative target trajectory met in all years)	-37%

Figure 18 shows the *annual* emissions projected for the Industry sector for the first two carbon budget periods for the WEM and WAM-CAP23 scenarios. It also illustrates the indicative annual emissions trajectory required to stay within the carbon budgets from 2021 to 2030. Dashed lines are used to illustrate a revised CB2 trajectory that would be required to meet the CB2 obligation if the WEM or WAM-CAP23 scenarios were followed in CB1. The resulting revised average annual reduction rate for CB2 and the revised total reduction by 2030 compared to the 2018 baseline are shown in Table 23.

[46] This section does not include the emissions from electricity consumed by the sector, as those emissions are counted separately under the electricity sector.

Figure 18: Annual greenhouse gas emissions from manufacturing combustion and industrial process emissions

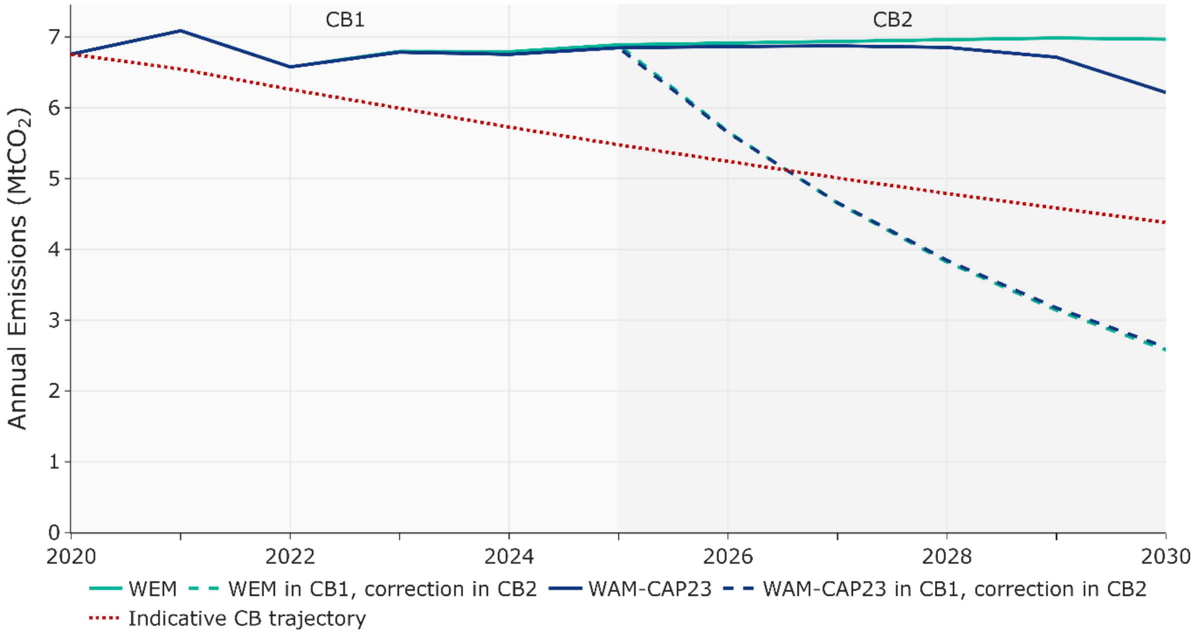

Figure 19 shows the *cumulative* emissions trajectories over the first two carbon budget periods for the WEM and WAM-CAP23 scenario. The black horizontal dashed lines show the sectoral ceilings for the first two budget periods. The chart illustrates the years in which the sectoral ceilings are reached in each scenario, and the cumulative exceedance by the end of the second budget period is noted for each scenario.

Figure 19: Cumulative greenhouse gas emissions from manufacturing combustion and industrial process emissions

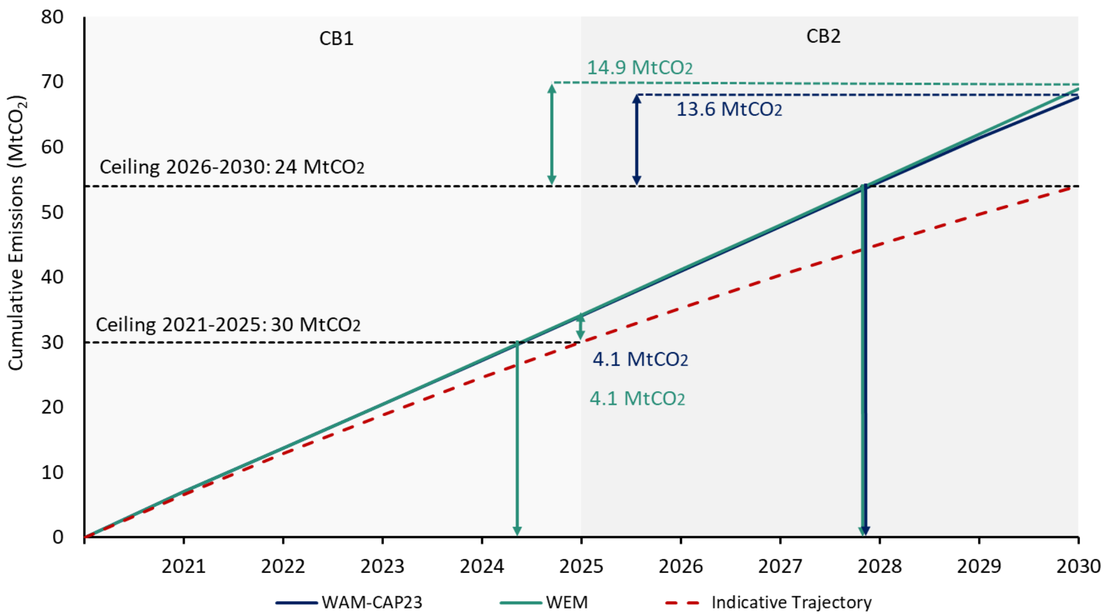

Table 23: Projected exceedance of sectoral ceilings from manufacturing combustion and industrial process emissions

Industry sector	WEM	WAM-CAP23
Projected CB1 exceedance ($MtCO_2eq$)	4.1	4.1
Projected CB2 exceedance (including CB1 carry over) ($MtCO_2eq$)	14.9	13.6
Projected average annual change in emissions for CB1	+0.1%	+0.0%
Indicative average annual change in emissions required in CB2 to stay within the CB2 ceiling if named scenario followed in CB1	-17.8%	-17.5%
Revised indicative reduction required by 2030 compared to 2018 to stay within CB2 ceiling if named scenario followed in CB1	-63% to -71%	-63% to -71%

In the WEM modelled scenario, industry emissions show little reduction over the 2021-2030 period. In this scenario the CB1 ceiling is crossed in 2024 and is exceeded by 4.1 $MtCO_2eq$ (14%) by 2025. This overshoot means that 17% of the CB2 budget is consumed before the CB2 period begins. The second sectoral ceiling is then breached within 2028, with exceedance reaching 14.9 $MtCO_2eq$ (28%) by 2030.

The picture is similar for the WAM-CAP23 scenario. The WAM-CAP23 CB1 trajectory remains close to the WEM scenario trajectory up until the year 2029, when annual emissions drop, due to the assumed ramp up of biomethane displacing gas in manufacturing. Because this reduction happens so late in the time period it makes only a small difference to the cumulative emissions total. The projections indicate that in this scenario the CB2 ceiling could be breached in 2028 and exceeded by 13.6 $MtCO_2eq$ (25%) by 2030, without increased effort to eliminate emissions from the sector.

If industry greenhouse gas emissions were to follow the WEM or WAM-CAP23 trajectory until 2025 then to stay within the CB2 sector ceiling emissions would have to fall 63% below 2018 levels by 2030 [47]. This would require an average annual rate of reduction in emissions of over 17% per annum during CB2.

Table 22 shows the breakdown of emissions trajectories split across the two components of Industry emissions, after the anticipated impact of policies and measures applying in each scenario are modelled. Part of the difficulty for industry is the continued growth in process emissions over the timeframe. This growth offsets the reductions made in manufacturing combustion.

[47] Assuming a geometric reduction trajectory. The final reduction required would depend on the trajectory taken within CB2. If the WEM or WAM-CAP23 trajectory were followed until 2025 and emissions were to then follow a linear reduction trajectory in CB2, then total greenhouse gas emissions would need to fall by 71% by 2030 to keep within the second carbon budget.

Table 24: Projected annual change in sub-sectoral emissions

Industry sector	Projected change in emissions 2021-2030 (WEM)	Projected change in emissions 2021-2030 (WAM)
Manufacturing Combustion	-5%	-22%
Process	5%	5%
Industry Total	-2%	-12%

7.5 Uncertainties and risks to target achievement.

7.5.1 Growth in industry energy demand

Industry energy use fell during the Great Recession but increased by 26% between 2011 and 2019, which equates to 2.9% growth per annum over that time period. All three projected scenarios show continued growth in industry energy demand out to 2030, with an increase of 13% between 2021 and 2030, equating to growth of 1.4% per annum. Economic modelling from the ESRI suggests that in a low fuel price scenario and in the absence of policies to encourage efficiency, underlying energy demand in the sector could grow by up to 4.7% per annum. If energy use in the sector was to continue to grow at the rate seen from 2011 to 2019 it would pose a severe challenge to meeting the climate and energy obligations for the industry sector and for our national obligations as a whole.

Critical success factors and opportunities

- To meet our climate obligations, we need to ensure that new energy demand in the industry sector does not lock in fossil fuel use for decades to come.
- In the context of our legally binding climate obligations, the planning system needs to assess the benefits versus the negative consequences of allowing new large energy-users to establish in Ireland between now and 2030, or to allow significant expansion of existing large energy-users.

7.5.2 Electrification of industry heat demand

The SEAI National Heat Study[48] highlights the benefits of electrification of heating demand across all sectors using technologies that are available today. Early action is crucial to limit the growth in cumulative emissions to meet our climate obligations. Alternative decarbonisation pathways such as green hydrogen will not be available at scale this decade. Scenarios where most of industrial energy use continues to come from fossil fuels until hydrogen becomes available are shown to result in higher cumulative emissions than scenarios where industries switch to renewable energy or electrification technologies available today.

In particular, heat pumps offer an alternative for low and medium temperature heat applications (current up to about 150 °C), especially in situations where there is a requirement for simultaneous heating and cooling, or where there are waste heat streams that can be utilised. The National Heat Study highlighted that up to 40% of industry heat demand comes from low or medium

[48] SEAI, 'Net Zero by 2050'. 2022. [Online]. Available from: https://www.seai.ie/data-and-insights/national-heat-study/

temperature applications, that could be suitable for industrial heat pumps. But uncertainty remains as to the scale and pace of uptake that will be achieved.

Critical success factors and opportunities

- We need to ensure that the operating costs of electrification options are competitive with fossil fuel alternatives being used currently.
- Possible measures to address operating costs include electricity market reform, to ensure that the full advantage of the large increase in low-cost renewable generation can be passed on to consumers, and reform of taxes and levies on electricity compared to fossil fuel alternatives.
- A particular barrier to the electrification of industrial heat will be the availability and cost of electricity connection capacity for increased industrial electrical loads.
- Possible future measures to alleviate this include a review of how electricity connection capacity (MIC) is allocated. Currently MIC is allocated on a fixed 24-hour basis irrespective of the customers pattern of electricity demand. If MIC were allocated on a flexible basis this might free up network capacity for heat electrification and encourage the incorporation of heat storage by industrial users.

7.5.3 Sustainable biomethane supply

GNI estimate that up to 200 AD plants[49] could be required to meet the 5.7 TWh target for biomethane production, but that number is uncertain and depends on the profile of smaller versus larger AD plants that will be developed. Although there are a small number of AD plant already in operation in Ireland, and a central grid injection point for biomethane is also in operation at Cush in Co Kildare, the scale of biomethane injection to date is in the region of 1% of the 2030 target. This presents the challenge of a very large increase in the scale of sustainable biomethane production in a relatively short time period to meet the 2030 target.

Although CAP23 sets a target for biomethane production, it does not set out what support mechanisms will be put in place to help deliver the target. AD technology is mature and well established within the EU, but even once a support mechanism is in place, there will be significant lead in times for financing, planning, development, and construction of a large number of AD plant in Ireland. Therefore, the delivery timeline for biomethane is currently highly uncertain. More clarity is needed on what support mechanism will be put in place, and on the likely timelines for planning and delivery of the large number of AD plant that will be required.

At the time of writing, it is also unclear what share of biomethane will be used in what sectors, and how much will be available to industry. If the full 5.7 TWh biomethane target is achieved and all of that is available for use in industry, it would equate to 45% of industry gas use in 2030, or 20% of total industry energy use in 2030. However, it is possible that a share of biomethane will be used in other sectors, reducing the amount available to industry. It is also possible that significant quantities of biomethane could be purchased by datacentres for use in off-gird electricity generation. Because of the low efficiency of open cycle gas turbines compared to gas boilers, and the fact that grid electricity will be 80% renewable by 2030, any use of biomethane for off-grid electricity generation would be a sub-optimal use of this limited resource.

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[49] GNI, 'Ireland's Climate Action Plan'. [Online]. Accessed from: https://www.gasnetworks.ie/business/renewable-gas/policy/ireland/index.xml

Critical success factors and opportunities

- Where energy crops are used to produce biomethane, specific good practices are required for the cultivation, harvesting, collection and use of these feedstocks. Supply chains that depart from good practice risk causing environmental damage, leading to more greenhouse gas emissions in the land use and agricultural sectors. Resources need to be applied to upskill stakeholders and to promote best practice throughout the supply chain.
- Nationally appropriate sustainability criteria and governance are required to minimise upstream emissions, align with circular and bioeconomy goals, and avoid increasing emissions in non-energy sectors.
- The absence of a support scheme is a key barrier to the development of a biomethane industry at scale in Ireland and needs to be addressed as a priority.
- AD projects require large upfront capital investment and have long payback periods. The market requires clear, strong, and stable policy signals aligned with fiscal supports.
- Due to nascent nature of the industry in Ireland there is a lack of technical expertise in the construction and operation of AD plant.
- The large number of AD plant that will be required represent a major infrastructure development. As with any such development, social acceptance is a critical success factor. Early stakeholder engagement and education is essential for AD development to gain social acceptance.

8 Agriculture

Although the agriculture sector is a large source of greenhouse gas emissions, the vast majority of greenhouse gas emissions from the sector result from livestock and fertiliser use, not from energy use. Energy use and the associated greenhouse gas emissions in agriculture are small in comparison to other sectors. Agriculture accounted for just 2% of energy use and energy related greenhouse gas emissions in 2021. CAP23 does not contain any policy measures directed at reducing energy use in the sector, instead the measures focus on livestock and fertiliser use.

Because of this energy use in agriculture is modelled in less detail than the other major energy using sectors covered above. Our modelling considers decarbonisation options for energy used for heating in the agriculture sector, mostly in the pig and poultry sectors, and also energy used for cooling on dairy farms. Most of the energy use in agriculture is oil used for machinery and we do not currently model low carbon alternatives for this. The WAM-CAP23 scenario shows energy use in the sector increasing by 18% between 2021 and 2030 and the share of oil use remaining at approximately 80%.

For more information on the projected greenhouse gas emissions from the agriculture sector, see the latest EPA Greenhouse Gas Emissions Projections Report[50].

[50] EPA, 'Ireland's Greenhouse Gas Emissions Projections 2022-2040'. 2023. [Online]. Accessed from: https://www.epa.ie/publications/monitoring--assessment/climate-change/air-emissions/irelands-greenhouse-gas-emissions-projections-2022-2040.php

9 Ireland's status against national climate targets

9.1 Key messages:

- The targets set out in the Climate Action Plan aim to further accelerate the transition from fossil fuels to renewable energy sources, but full implementation and delivery of the supporting policies and measures is critical to realise those targets.
- Current projections indicate that if the 2023 Climate Action Plan targets are fully delivered overall emissions will likely still exceed Ireland's national legally binding carbon budget for the first two budget periods.
- Unless greenhouse gas emissions are reduced sharply between now and the end of 2025, it is highly unlikely that we will be able to stay within budget out to 2030.
- Further new measures, combined with an acceleration of planned and existing measures, are now necessary for Ireland to comply with the legally binding carbon budgets.

9.2 Total greenhouse gas emissions

As described in section 2, the Climate Action and Low Carbon Development (Amendment) Act established legally binding carbon budgets that limit total cumulative greenhouse gas emissions in Ireland between 2021 and 2030. The total budget has been apportioned across the main greenhouse gas emitting sectors. Sections 3 to 8 presented data and analysis on greenhouse gas emissions from energy use and industrial process. The remaining sectors are agriculture, LULUCF and other emissions. Because these sectors do not relate to energy use, we do not cover them in detail in this report. For more information on these non-energy sectors, refer to the EPA report Ireland's Greenhouse Gas Emissions Projections 2022-2040[51]. For context, the combined emissions of the non-energy sectors accounted for 45% of the 2018 baseline total, and by 2030 they are projected to make up 51% and 49% of total emissions in the WEM and WAM-CAP23 scenarios, respectively. The rest of this section presents data and analysis for total greenhouse gas emissions from all sectors. In all cases, data on greenhouse gas emissions are taken from the latest EPA greenhouse gas emissions inventory and greenhouse gas emissions projections. [52,53]

The carbon budgets for total greenhouse gas emissions are shown in Table 25. If the indicative trajectory for the carbon budgets was followed every year, then emissions in 2030 would need to be 51% lower than in 2018. However, if this indicative trajectory is exceeded in early years, then to

[51] EPA, 'Ireland's Greenhouse Gas Emissions Projections 2022-2040'. 2023. [Online]. Accessed from: https://www.epa.ie/publications/monitoring--assessment/climate-change/air-emissions/irelands-greenhouse-gas-emissions-projections-2022-2040.php

[52] EPA 'Ireland's Provisional Greenhouse Gas Emissions 1990-2022'. 2023. [Online]. Accessed from: https://www.epa.ie/publications/monitoring--assessment/climate-change/air-emissions/irelands-provisional-greenhouse-gas-emissions-1990-2022.php

[53] EPA 'Ireland's Greenhouse Gas Emissions Projections 2022-2040'.

compensate steeper reductions are required thereafter, leading to a larger reduction required by 2030.

Table 25: Overall national carbon budget obligation and related indicators

Overall carbon budget	
2018 baseline emissions ($MtCO_2eq$)	68
CB1 ceiling 2021-2025 ($MtCO_2eq$)	295
CB2 ceiling 2026-2030 ($MtCO_2eq$)	200
Indicative average annual % reduction required in CB1	-4.6%
Indicative average annual % reduction required in CB2	-9.6%
Initial indicative reduction required by 2030 (relative to 2018; assuming indicative target trajectory met in all years)	-51%

Figure 20 shows the *annual* greenhouse gas emissions projected from all sectors for the first two carbon budget periods for the WEM and WAM-CAP23 scenarios. It also illustrates the indicative annual emissions trajectory required to stay within the carbon budgets from 2021 to 2030. Dashed lines are used to illustrate a revised CB2 trajectory that would be required to meet the CB2 carbon budget if the WEM or WAM-CAP23 scenarios were followed in CB1. The resulting revised average annual reduction rate for CB2 and the revised total reduction by 2030 compared to the 2018 baseline are shown in Table 5.

Figure 20: Annual greenhouse gas emissions from all sectors

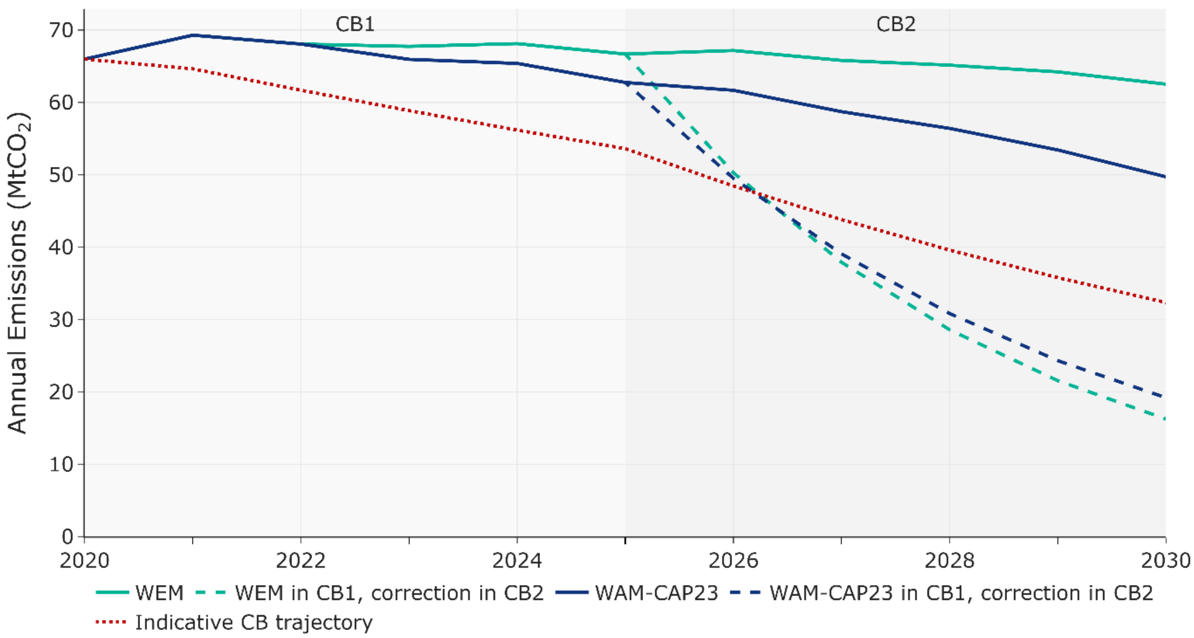


Figure 21 shows the *cumulative* emissions trajectories for all greenhouse gas emissions over the first two carbon budget periods for the WEM and WAM-CAP23 scenario. The black horizontal dashed lines show the sectoral ceilings for the first two budget periods. The chart illustrates the years in which the sectoral ceilings are reached in each scenario, and the cumulative exceedance by the end of the second budget period is noted for each scenario. Both scenarios breach the first carbon budget in 2024, going on to breach the second in 2027. By 2030, total emissions are 34% and 24% over the budget for WEM and WAM-CAP23 respectively.

Figure 21: Cumulative greenhouse gas emissions from all sectors

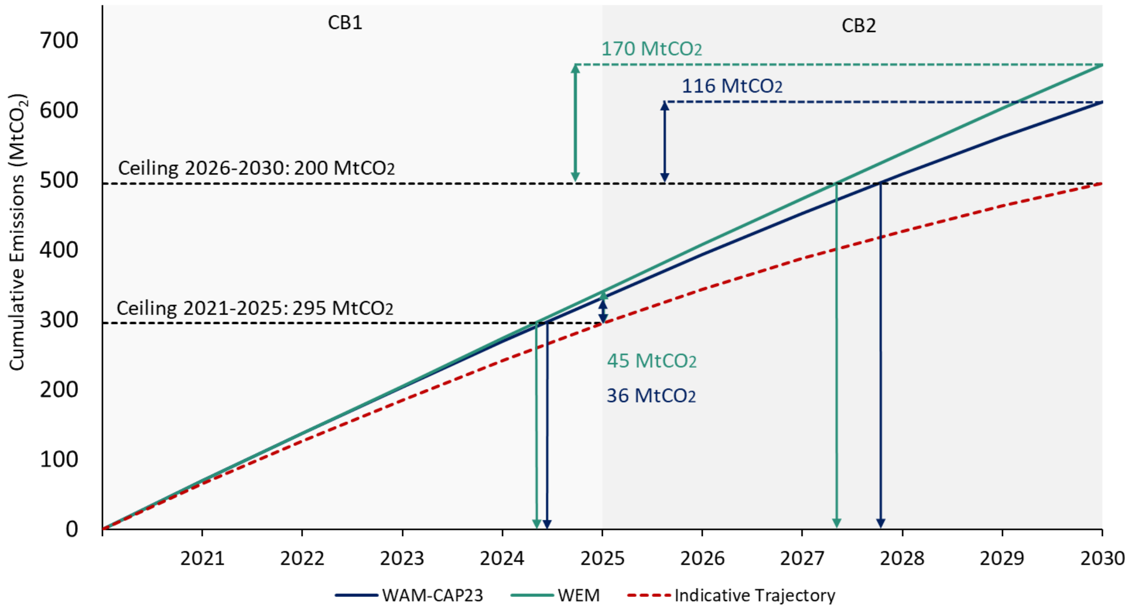


Table 26: Projected exceedance of overall national carbon budget obligation

Industry sector	WEM	WAM-CAP23
Projected CB1 exceedance ($MtCO_2eq$)	44.9	36.5
Projected CB2 exceedance (including CB1 carry over) ($MtCO_2eq$)	169.8	116.5
Projected average annual change in emissions for CB1	-0.3%	-1.5%
Indicative average annual change in emissions required in CB2 to stay within the CB2 budget if named scenario followed in CB1	-24.6%	-21.1%
Revised indicative reduction required by 2030 compared to 2018 to stay within CB2 budget if named scenario followed in CB1[54]	-77% to -90%	-73% to -82%

In the WEM scenario, total greenhouse gas emissions exceed the first carbon budget by 44.9 $MtCO_2eq$ (15%) by 2025. This overshoot means that 22.5% of the CB2 budget is consumed before the CB2 period begins. The second sectoral ceiling is then breached during 2028, with the exceedance reaching 169.8 $MtCO_2eq$ (34%) by 2030.

[54] The final reduction depends on the trajectory taken within CB2. A linear trajectory requires a greater reduction by 2030 than a geometric trajectory, as a geometric trajectory assumes more improvement made in the early years of the period.

The WAM-CAP23 scenario exceeds the CB1 ceiling by 36.5 $MtCO_2eq$ (12%). This overshoot means that 18% of the CB2 budget is consumed before the CB2 period begins. In this scenario the CB2 ceiling is exceeded by 116.5 $MtCO_2eq$ (24%) by 2030.

If the WEM or WAM-CAP23 trajectory is followed until 2025, then total greenhouse gas emissions would need to fall by 77% or 73% respectively by 2030 to keep within the second carbon budget, assuming a geometric reduction trajectory is followed in CB2, as illustrated in Figure 20. But the final reduction required would depend on the trajectory taken within CB2. If the WEM or WAM-CAP23 trajectory were followed until 2025 and emissions were to then follow a linear reduction trajectory in CB2, then total greenhouse gas emissions would need to fall by 90% or 82% respectively by 2030 to keep within the second carbon budget.

These projections present a stark reality. Achieving economy wide emissions reductions of 80% or more by 2030 is simply not feasible. Unless greenhouse gas emissions are reduced sharply before the end of 2025, it is highly unlikely that we will be able to stay within budget out to 2030. Given that the weight of effort in the carbon budgets is loaded on the second carbon budget period to begin with, any exceedance of the first carbon budget will make it extremely difficult to comply with the second carbon budget. The importance of early corrective action is clearly demonstrated; the earlier we can reduce annual emissions, the greater the impact on the growth of cumulative emissions.

10 EU climate and energy targets

10.1 Introduction

In addition to complying with the obligations detailed in the Climate Action and Low Carbon Development Act, Ireland also has an obligation to contribute to EU level targets contained in the EU Climate and Energy Framework. The EU framework is separate from the national carbon budgets process and contains independent obligations to reduce greenhouse gas emissions, increase the share of renewable energy sources and to limit total final energy demand in 2030. The binding targets are set at an EU level and distributed proportionally across member states. If Ireland falls short of its commitments to its EU targets for 2030 (or any interim targets) then, as was the case for the 2020 EU targets, there may be compliance costs in the form of fines or the need to purchase statistical transfers.

As was the case for the 2020 EU climate and energy package, there are three main sets of targets under the 2030 framework[55]:

- Targets to reduce greenhouse gas emissions.
- Targets to increase the share of renewable energy.
- Targets to improve energy efficiency, and cap future total energy demand.

10.2 EU Greenhouse gas emissions reduction targets

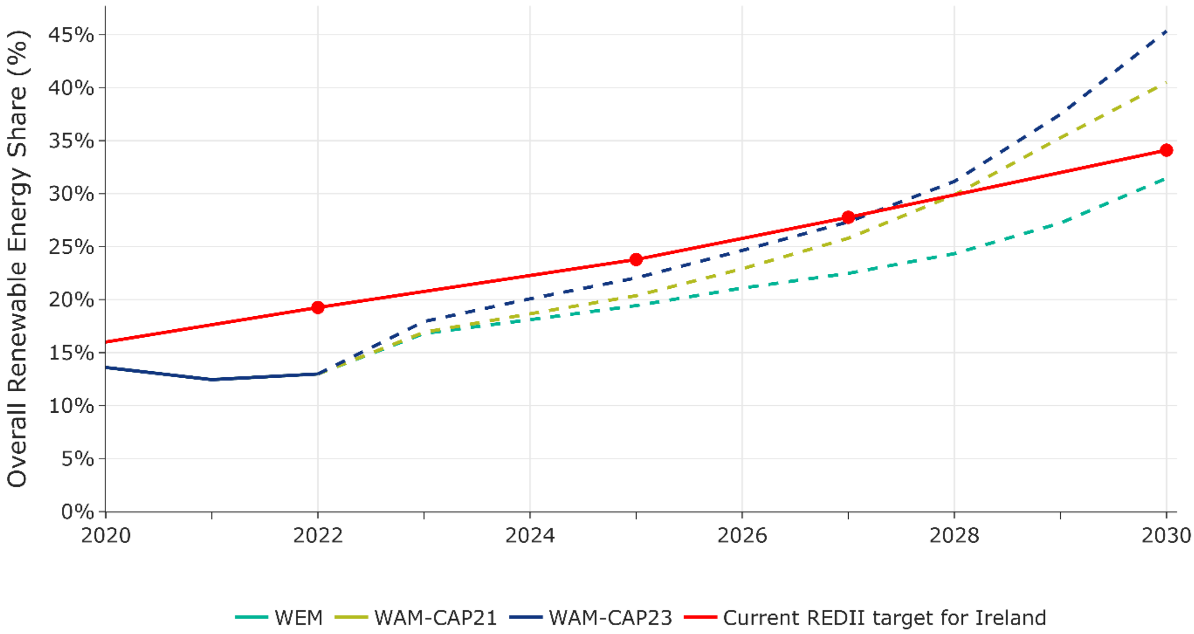
The European Green Deal set a target for the EU to reduce greenhouse gas emission in 2030 by 55% compared to 1990 levels. This target is implemented by the EU Emissions Trading System,[56] the EU Effort Sharing Regulation,[57] and the Land Use, Land Use Change and Forestry Regulation.[58] For more information on Ireland's projected performance against EU greenhouse gas emissions reductions targets, see the latest EPA Greenhouse Gas Emissions Projections Report.[59]

[55] For more information see: https://climate.ec.europa.eu/eu-action/climate-strategies-targets/2030-climate-energy-framework_en
[56] For more information see: https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets_en
[57] For more information see: https://climate.ec.europa.eu/eu-action/effort-sharing-member-states-emission-targets_en
[58] For more information see: https://climate.ec.europa.eu/eu-action/land-use-sector_en
[59] EPA, 'Ireland's Greenhouse Gas Emissions Projections 2022-2040'. 2023. [Online]. Accessed from: https://www.epa.ie/publications/monitoring--assessment/climate-change/air-emissions/irelands-greenhouse-gas-emissions-projections-2022-2040.php

10.3 EU Renewable Energy Directive Target

The EU Renewable Energy Directive (RED) sets out a target for renewable energy share (RES) in gross final energy consumption.[60] The existing EU wide target set in REDII[61] is 32% RES by 2030. The European Parliament and Council have provisionally agreed on increasing this target to a minimum of 42.5% RES by 2030.[62] Irelands current national EU binding target for 2030 RES is 34.1%. There are also interim targets for 2022, 2025 and 2027, as shown in Figure 22 and Table 27. It is likely that Ireland's national target will increase should the provisional increase agreed at EU level happen.

Figure 22: Projected progress towards EU target for Ireland for overall renewable energy share



[60] The revised EU Renewable Energy Directive sets a number of additional targets for different sectors, but for this report we focus on the headline target for overall renewable energy share.
[61] The first Renewable Energy Directive (2009/28/EC) set targets for 2020. This Directive was revised in 2018 (EU/2018/2001) and recast to set targets for 2030. This recast Directive became known as REDII.
[62] Council of the European Union, 'Council and Parliament reach provisional deal on renewable energy directive'. 2023. [Online]. Accessed from: https://www.consilium.europa.eu/en/press/press-releases/2023/03/30/council-and-parliament-reach-provisional-deal-on-renewable-energy-directive/

Table 27: Projected progress towards EU target for Ireland for overall renewable energy share

Current REDII target for overall renewable energy share (RES) for Ireland		WEM	WAM-CAP21	WAM-CAP23
2025	Projected overall RES	19%	20%	22%
	REDII overall RES target for Ireland	24%	24%	24%
	Gap to target	-4%	-3%	-2%
2027	Projected RES	22%	26%	27%
	REDII target	28%	28%	28%
	Gap to target	-5%	-2%	-1%
2030	Projected RES	31%	40%	45%
	REDII target	34%	34%	34%
	Gap to target	-3%	6%	11%

The overall RES in the WAM-CAP23 scenario is three percentage points higher than in the WAM-CAP21 scenario, due mostly to the increase in biomethane and in renewable electricity generation. The WAM-CAP23 scenario shows Ireland exceeding the current 2030 EU target for overall RES by eleven percentage points. In contrast, the WEM scenario shows Ireland achieving just 31% overall RES, falling three percentage points short of the current 2030 target.[63]

In the interim target years of 2025 and 2027 the WAM-CAP23 scenario shows us falling short of the interim overall RES targets. This is due to the revised profile of renewable generation capacity additions which now assumes that more of the planned capacity will arrive later in the decade, particularly for biomethane. If Ireland's target is revised upwards in line with the increased EU level ambition, it would result in a greater gap to target in the interim years.

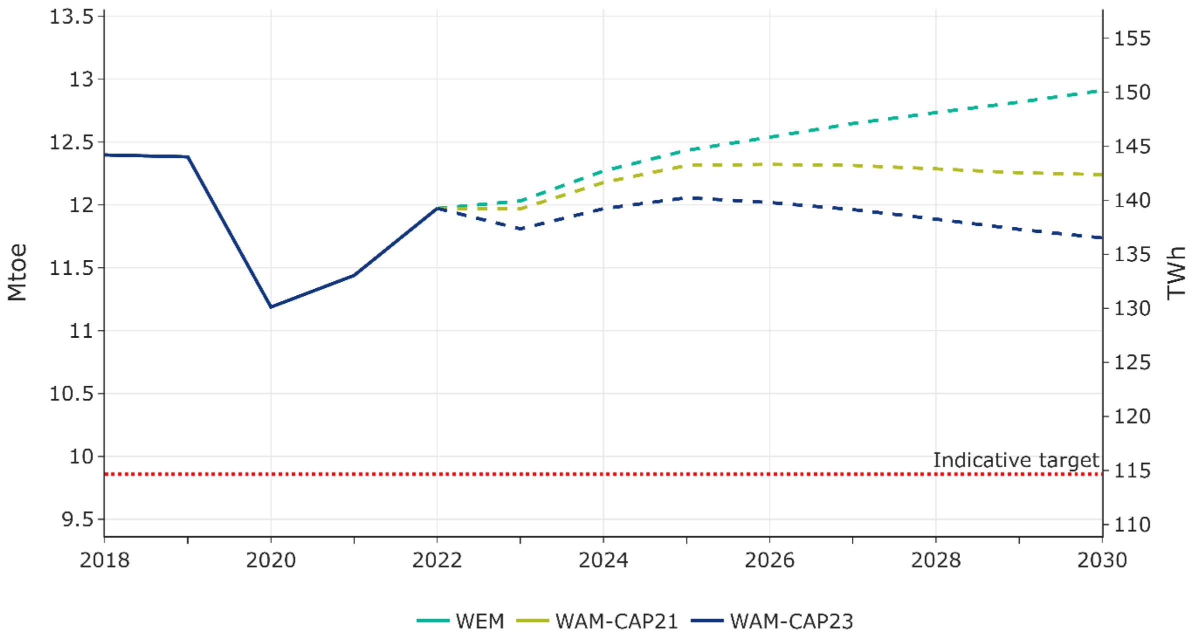
[63] Here we have assumed that all projected biomass energy use will qualify to count towards the overall RES target. In order to be counted towards the REDII targets, biomass used in facilities over a certain size needs to have its sustainability certified and verified. The system of verification is currently being put in place in Ireland, but is not yet operational. Therefore, currently a share of the biomass being used in Ireland cannot be counted towards REDII targets. This is an evolving situation, and we will update our assumptions on the share of biomass that can be counted as more information becomes available.

10.4 EU Energy Efficiency Directive target

The amended European Energy Efficiency Directive (EED) was formally agreed in July 2023. This amendment sets a target to limit final energy consumption at EU level in 2030 to 763 Mtoe. [64,65] The final energy caps for each member state have not yet been set and are expected to be finalised in early 2024. While Ireland's EED target has not yet been finalised, the indicative target is for Ireland's 2030 final energy demand to not exceed 9.858 Mtoe (114.65 TWh). This is approximately 18% below the 2022 level.

The EED target for 2030 differs fundamentally from the 2020 EED target. For 2020 the target was to demonstrate improvements in energy efficiency. These energy efficiency improvements were estimated compared to counterfactual scenarios where no efficiency measures were carried out. By this approach, it was possible to demonstrate the required energy efficiency savings while at the same time increasing total final energy use in the country. This is no longer the case. For 2030 the target is for an absolute reduction in final energy use. This means that achieving energy savings from energy efficiency measures will not suffice if they are outweighed by increases in final energy demand driven by socio-economic growth. Figure 23 and Table 28 below show the target and projections for final energy consumption.

Figure 23: Projected progress towards EU Energy Efficiency Directive



[64] The EU's target for the reduction of energy consumption by 2030 will be 11.7%, compared to projected consumption in the 2020 Reference Scenario. The primary energy consumption target is indicative, while the final energy consumption target is binding. The result of this is that the EU's final energy consumption in 2030 will not amount to more than 763 Mtoe.

[65] Under the Directive, final energy consumption does not include the ambient energy used by heat-pumps but does include international aviation.

Table 28: Projected progress towards EU Energy Efficiency Directive

2030 Energy Efficiency Directive final energy target (ktoe)	2022 Actual (ktoe)	2030 Projected (ktoe)		
		WEM	WAM-CAP21	WAM-CAP23
EED Final energy*	11,973	12,911	12,241	11,738
Indicative final energy target		9,858	9,858	9,858
Gap to indicative target		3,053	2,383	1,880

*Under the EED definition, final energy consumption includes international aviation and excludes ambient energy.

The indicative EED final energy cap for Ireland is exceeded in all scenarios. In the WEM scenario it is exceeded by 3,053 ktoe (31%) and in the WAM-CAP23 scenario it is exceeded by 1,880 ktoe (19%). These projections indicate that it will be extremely challenging for Ireland to meet the indicative final energy limit.

Glossary

Term	Description
CAP / CAP21 / CAP23	Climate Action Plan / Climate Action Plan 2021 / Climate Action Plan 2023
CB1 / CB2 / CB3	Carbon Budget period 1 (2021-2025) / period 2 (2026-2030) / period 3 (2031-2035)
CCAC	Climate Change Advisory Council
EED	EU Energy Efficiency Directive
EPA	Environmental Protection Agency
ESRI	Economic and Social Research Institute
EV	Electric Vehicle
GW	Gigawatt; a unit of power
HGV	Heavy Goods Vehicle
ICE	Internal Combustion Engine
ktoe	kilotonne of oil equivalent; a unit of energy
LGV	Light Goods Vehicle
MtCO2eq	Megatonne of carbon dioxide equivalent
NEMF	National Energy Modelling Framework
NTA	National Transport Authority
OECD	Organization for Economic Cooperation and Development
ORESS	Offshore Renewable Support Scheme
RED / REDII	EU Renewable Energy Directive / Recast EU Renewable Energy Directive
RES	Renewable Energy Share
RES-E	Renewable Energy Share of Electricity
RESS	Renewable Energy Support Scheme
SEAI	Sustainable Energy Authority of Ireland
TWh	Terawatt-hour; a unit of energy
WAM	With Additional Measures scenario
WAM-CAP21	With Additional Measures - Climate Action Plan 2021 scenario
WAM-CAP23	With Additional Measures - Climate Action Plan 2023 scenario
WEM	With Existing Measures scenario

Appendix 1:

1.1 Ireland's National Energy Modelling Framework (NEMF)

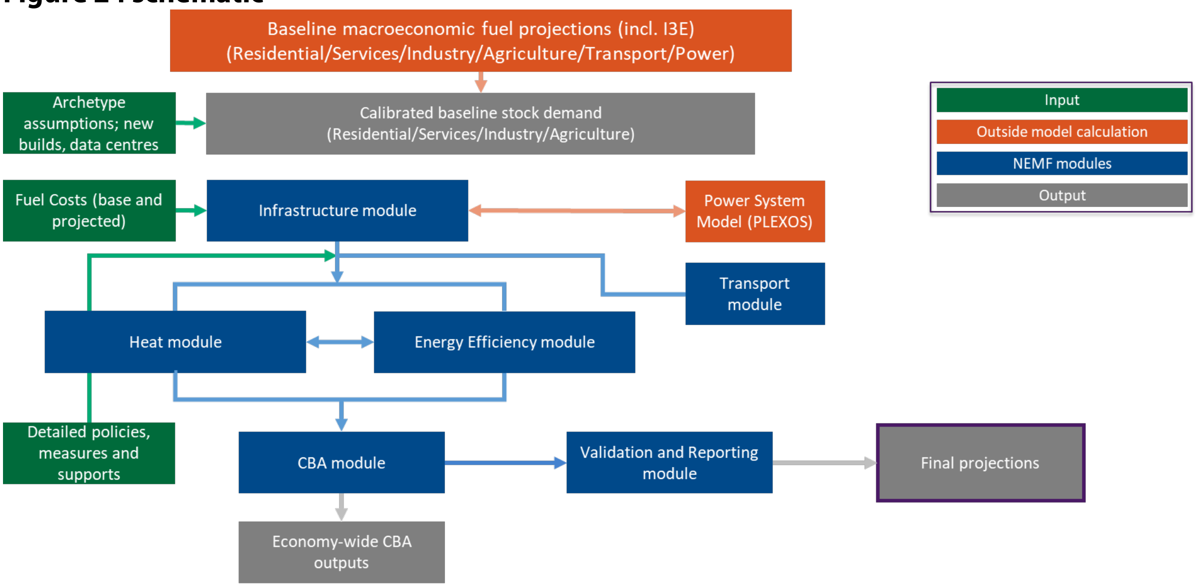
The National Energy Modelling Framework (NEMF), developed and maintained by SEAI, is a full national energy-economy model that is used to assesses the impacts of packages of energy policies and measures on future energy supply and demand. It combines several SEAI sectoral models with data from the Economic and Social Research Institute (ESRI)'s Ireland Environment, Energy and Economy (I3E) macroeconomic model to produce policy-rich outlooks for the whole energy system.

The archetype model within the NEMF contains data on 680 individual heat demand archetypes, representing a combination of physical and consumer attributes, which in turn provide a detailed description of demand in residential, services and industry sectors, as well as agricultural energy use. The NEMF can also be used to examine variation in technology readiness, technical suitability, cost data, and performance data to assess various scenarios (including potential decarbonisation paths) in Ireland.

Technology suitability and performance are mapped to each archetype and the model contains representations of bioenergy and hydrogen resources and fuel supply chains as well as an infrastructure module that calculates the costs of infrastructure deployment linked to technology uptake. The model uses this techno-economic data to generate payback and lifetime cost estimates for the various technology options available, accounting for policy incentives, taxes, and regulations. This payback and lifetime cost information is used with other data on consumer decision-making behaviour to simulate how much uptake may result in various scenarios and in response to policy measures and what impact a given set of policy measures can have on the energy system. Where technology deployment is based on centralised decisions, these are accounted for outside of the consumer decision-making framework: district heating and industrial Carbon Capture, Utilisation and Storage (CCUS) are dealt with in this way.

A high-level outline of NEMF is shown below.

Figure 24 schematic



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