Scotland's Net Zero Roadmap: D1.1.3 Final Report on Emissions Baselines

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About Scotland's Net Zero Roadmap and Partners

Scotland's Net Zero Roadmap (SNZR) is Innovate UK funded project number 75206. The aim of the project is to develop a roadmap that sets out how Scottish industry can move towards Net Zero by 2045, based on exploring a number of decarbonisation scenarios. The project focuses on a cluster of industrial activity on the East Coast of Scotland which covers many of the largest industrial sites across a range of sectors and 80% of Scotland's industrial CO_2 emissions.

SNZR is led by NECCUS and other project partners are Aker Solutions Limited, Costain Limited, Altrad Babcock Limited, Energy System Catapult Limited, Halliburton Manufacturing and Services Limited, Net Zero Technology Centre, Optimat Limited, Pale Blue Dot Energy Limited, The University of Edinburgh, The University of Strathclyde, and Wood Limited.

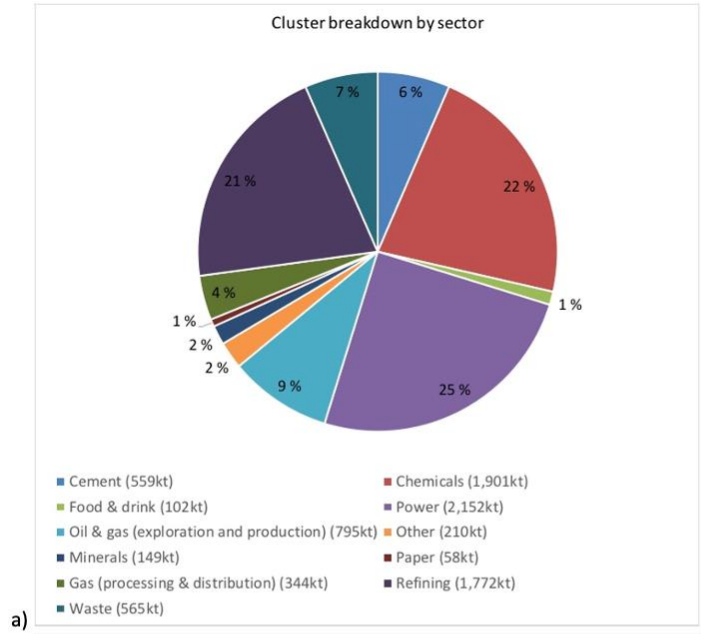
Executive Summary

The Scotland's Net Zero Roadmap (SNZR) project is one of six roadmap projects aimed at producing detailed plans to reduce carbon emissions from major industrial areas across the UK. Funded by the Industrial Strategy Challenge Fund (ISCF) as part of the UK Government Industrial Decarbonisation Challenge (IDC), the SNZR project brings together 11 partner organisations from industry and academia to map out industry's role in achieving Scotland's target of Net Zero by 2045.

This final report summarises the findings of Work Package 1 Task 1.1, which was focused on conducting a baseline analysis of the most recent (2019) industrial CO_2 emissions data and on developing illustrative future baseline emissions scenarios out to 2045, for the sites within the SNZR cluster boundary. This final iteration incorporates the results of a second review, conducted between July and November 2022, that was focused solely on any new and/or significant developments within the cluster boundary, either announced or projected to take place in the intervening years between the baseline start year of 2019 and the target year for net zero, 2045.

The revised scenarios fed directly into the final iteration of the energy systems modelling outputs within Work Package 5, and were based on the BEIS Energy and Emissions Projections 2019 (BEIS EEP) dataset and assume no deep decarbonisation measures are implemented in the UK, and therefore provide a baseline against which potential decarbonisation pathways to 2045 could be assessed. The BEIS EEP are based on '*central estimates of economic growth and fossil fuel prices*' and '*contains all agreed policies where decisions on policy design are sufficiently advanced to allow robust estimates of impact'.* Within the context of the SNZR project, this study is focused on the collection and presentation of publicly available data that is relevant to understanding the current and future emissions profiles in the cluster under business-as-usual (BAU) scenarios.

Figure 1 presents a high-level overview of how the cluster looks now (as per 2019 data) and how it could look in 2045. This includes the current baseline, with sectoral breakdown, and the changes projected by the illustrative future baseline scenarios. According to the projections, an emissions gap of 6.1MtCO_2 remains by 2045, while the analysis overall points to an important role for the Chemicals, Power, Refining and Waste sectors for the SNZR project, and by extension Scotland's journey towards Net Zero.



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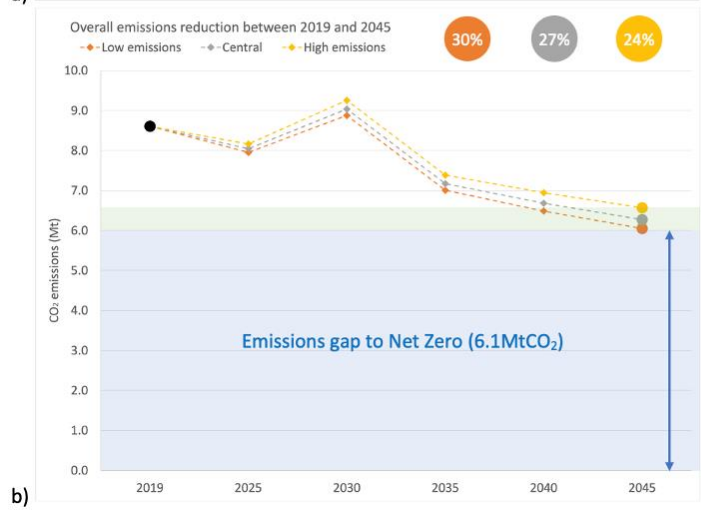

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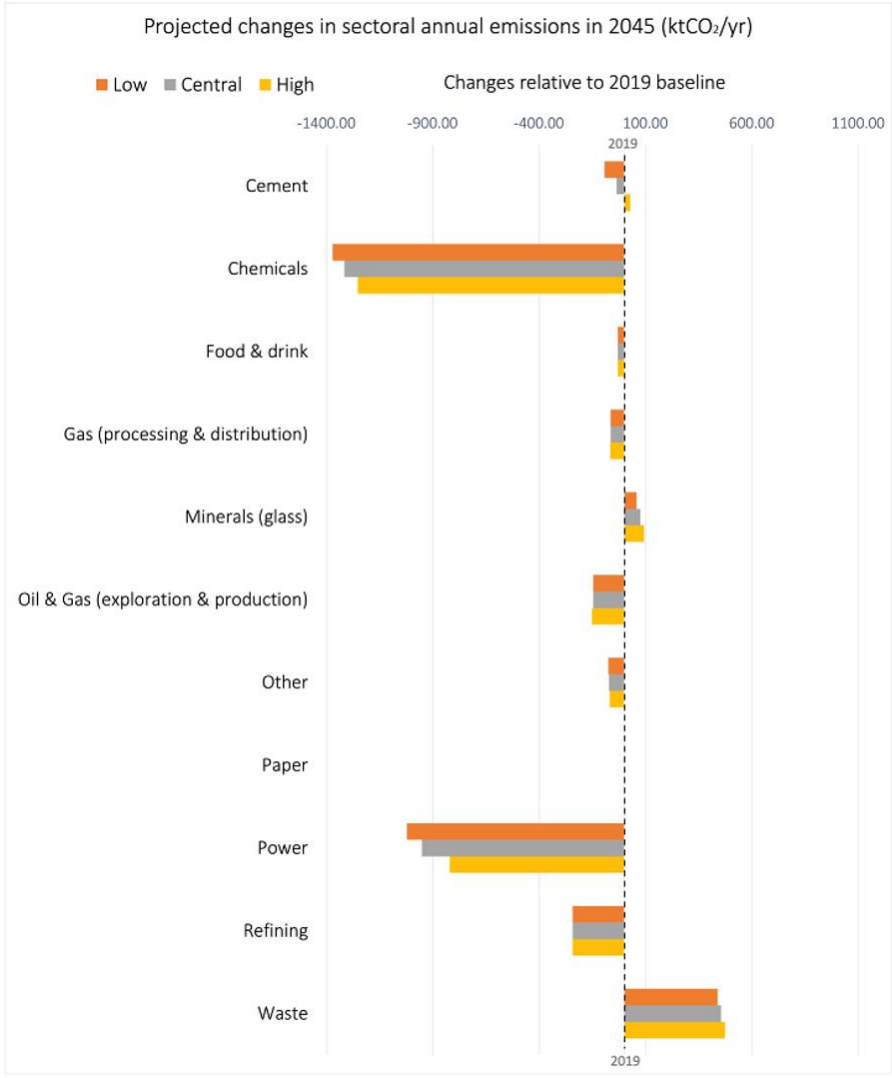

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Figure 1: Overview of current baseline and projected BAU future baseline scenarios for SNZR cluster (2019-2045) - a) current (2019) baseline broken down by sector: 8.6MtCO$_2$; b) future baseline projections (2019-2045); c) projected sectoral changes (2019-2045)

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1 Introduction

1.1 Background

The Scotland's Net Zero Roadmap (SNZR) project is one of six roadmap projects aimed at producing detailed plans to reduce carbon emissions[1] from major industrial areas across the UK[2]. Funded by the Industrial Strategy Challenge Fund (ISCF) as part of the UK Government Industrial Decarbonisation Challenge (IDC), the SNZR project brings together 11 partner organisations from industry and academia to map out industry's role in achieving Scotland's target of Net Zero by 2045[3].

The roadmap will consider multiple carbon reducing options such as electrification, the integration of renewable energy, fuel switching to clean sources (such as hydrogen), capture of carbon emissions from energy generation and industrial processes, and negative emissions opportunities (such as capturing carbon from biogenic energy sources). The project will create an energy system model covering key industrial sites along the Scottish East Coast, from the Lothians in the South to Aberdeenshire in the North. In total, 28 industrial sites will be assessed which collectively emit around 80%[4] of Scotland's industrial carbon dioxide (CO_2) emissions. It is therefore anticipated that any net zero solutions developed by the project can provide infrastructure plans and blueprints for the whole of Scotland. All of the data presented in this study is from publicly available sources.

1.2 This report

This final report summarises the results of Work Package 1 Task 1.1, which was focused on conducting a baseline analysis of the most recent (2019) industrial CO_2 emissions data and on developing illustrative future baseline emissions scenarios out to 2045, for the sites within the SNZR cluster boundary. Within the context of the SNZR project, this study is focused on the collection and presentation of publicly available data that is relevant to understanding the current and future emissions profiles in the cluster under business-as-usual (BAU) scenarios.

This report presents an overview of the SNZR cluster for the baseline start year of 2019, and incorporates the results of a second review of the status and impact of new and/or significant developments within the cluster boundary, either announced or projected to take place in the years between 2019 and the target year for net zero, 2045. These revised, final BAU baseline scenarios fed directly into the final iteration of the energy systems modelling outputs within Work Package 5.

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[1] These projects are focused on carbon dioxide (CO_2) emissions only. Reference to 'carbon', 'carbon emissions' or 'emissions' herein should be interpreted as meaning carbon dioxide (CO_2) or CO_2 emissions.

[2] BEIS (2021). Press Release. See: https://www.gov.uk/government/news/green-boost-for-regions-to-cut-industry-carbon-emissions

[3] Scottish Government (2019). Press Release. See: https://www.gov.scot/news/scotland-to-become-a-net-zero-society/

[4] SEPA (2020). SPRI dataset for 2019. See: https://www.sepa.org.uk/environment/environmental-data/spri/

This report is structured into two main sections. Section 2 gives the unchanged overview of the start year baseline for the cluster, including the cluster boundary, and covers the geographic, and current (2019) industrial and emissions scope of the cluster. Section 3 presents the revised, final set of three projected BAU future baseline scenarios to illustrate how the cluster might look in 2045, incorporating any announced and/or projected significant developments during the period 2019-2045 and assuming no deep decarbonisation measures are otherwise implemented. Conclusions and next steps are given in section 4.

1.3 Study aims and approach

This study seeks to do two things. Firstly, to quantify and provide analysis of the current industrial and emissions scope of the cluster, and secondly, to develop BAU future baseline scenarios covering the sites within the cluster boundary. These future scenarios are intended to illustrate how the emissions profile of the cluster is likely to have changed by Scotland's target year for Net Zero, 2045, incorporating any announced and/or projected significant developments during the period 2019-2045 and assuming no deep decarbonisation measures are otherwise implemented in the intervening years. The two key tasks comprising this study are outlined below in Figure 2.

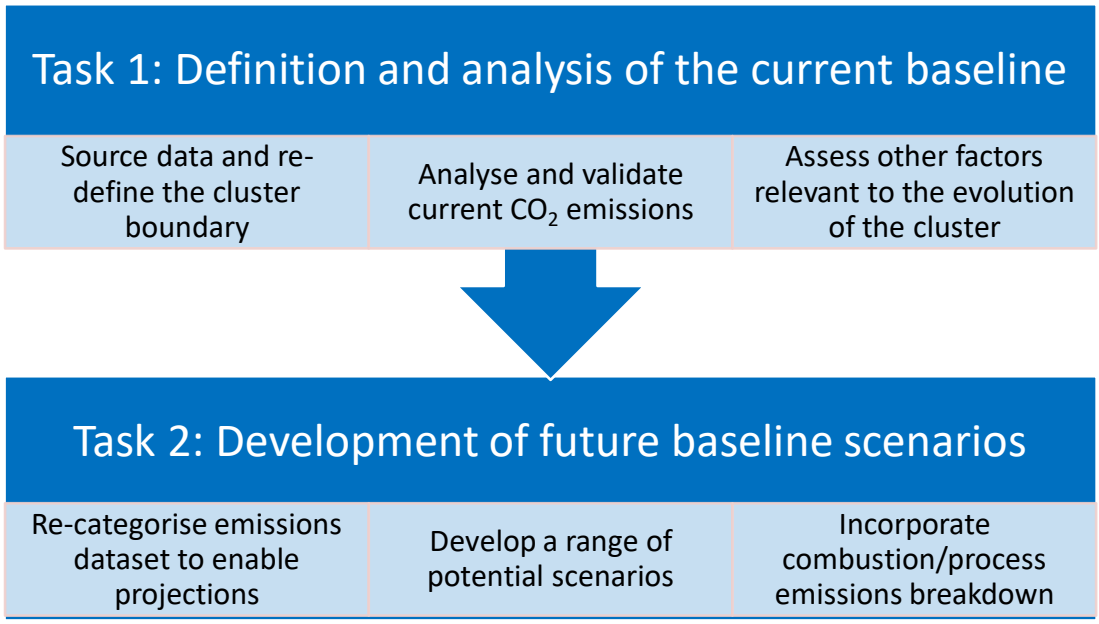

Figure 2: Task 1 and Task 2 overview

1.3.1 Task 1: Definition and analysis of the current baseline

- Site-level direct (Scope 1[5]) emissions data was retrieved from the Scottish Pollutant Release Inventory (SPRI) dataset[6] for 2019, as compiled by the Scottish Environment Protection Agency (SEPA). This was incorporated, together with near-future policy/regulatory requirements, to update and re-define the cluster boundary that was proposed in phase 1.
- Data for the sites within scope was analysed according to various criteria, including year-on-year change, industrial sector, proximity to existing gas transport infrastructure already identified as having potential for CO_2/hydrogen reuse, size of emissions and historical emissions trajectory, and validated by cross-referencing with site-level data from the European Pollutant Release and Transfer Register (E-PRTR)[7].
- The sector category classifications used by the SPRI dataset were mapped onto those used by the BEIS National Atmospheric Emissions Inventory (NAEI)[8], to allow for better alignment with the IPCC sector category classifications assigned in the future baseline scenarios in Task 2.

1.3.2 Task 2: Development of future baseline scenarios

- Baseline emissions for the 28 sites within scope, with a start year of 2019, were defined in Task 1.
- The sector category classifications assigned in Task 1 were then cross-referenced with IPCC guidance[9], to ensure that the sector categories in the most recent BEIS energy and emissions projections (EEP) dataset[10] could be assigned accurately.
- A Compound Annual Growth Rate (CAGR)[11][12] was then established for each IPCC sector category, and applied to the emissions data for each site within scope. The BEIS EEP 2019 dataset only makes projections up to 2040; emissions projections for the period 2040-2045 were calculated using a CAGR based on the projections for 2035-2040 and combined to give an overall CAGR for each category for the full 26-year period 2019-2045 – see Appendix B. The BEIS EEP are based on '*central estimates of economic growth and fossil fuel prices*' and '*contains all agreed policies where decisions on policy design are sufficiently advanced to allow robust estimates of impact*'.

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[5] Scope 1 emissions refers to all direct emissions from the activities of an organisation or under their control. See: https://compareyourfootprint.com/difference-scope-1-2-3-emissions/

[6] SEPA (2020). SPRI dataset for 2019. See: https://www.sepa.org.uk/environment/environmental-data/spri/

[7] European Environment Agency (2021). See: https://industry.eea.europa.eu

[8] National Atmospheric Emissions Inventory (2021). See: https://naei.beis.gov.uk/data/map-large-source

[9] IPCC (2006). Guidelines for National Greenhouse Gas Inventories. Chapter 8: Reporting Guidance and Tables. See: https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_8_Ch8_Reporting_Guidance.pdf

[10] BEIS (2020). Updated energy and emissions projections, Appendix C: Carbon dioxide emissions by IPCC category. See: https://www.gov.uk/government/publications/updated-energy-and-emissions-projections-2019

[11] As per industry precedent in Element Energy (2020). HIDR Baseline Local Emissions Assessment. See: https://www.humberlep.org/project/humber-industrial-decarbonisation-roadmap-hidr-phase-1/

[12] Investopedia (2021). Compound Annual Growth rate (CAGR). See: https://www.investopedia.com/terms/c/cagr.asp

- Four ‘sets’ (each containing a low, central and high emissions scenario) of BAU scenarios were then developed to illustrate possible futures where no deep decarbonisation measures are implemented within the cluster. These scenarios differed in the degree of granularity at which IPCC sector categories were assigned, e.g. sub-sub-sector, sub-sector or sector category.
- The most granular of these scenario ‘sets’ was selected and combined with the sectoral combustion/process emissions breakdown. This scenario is presented herein as the preferred option to provide a baseline against which potential decarbonisation pathways to 2045 could be assessed.
- The status and impact of new and/or significant developments within the cluster boundary, either announced or projected to take place in the years between 2019 and the target year for net zero, 2045, were assessed. Developments deemed to be certain to come online, because of one or a combination of the following: Final Investment Decision (FID) reached, already under construction, fully consented, aligned with Scottish Government incineration capacity review (2022)[13], were included in the projections.

NB: It should be noted that the emissions projection scenario proposals were very sensitive to the IPCC sector categories assigned. In general terms, assigning higher level ‘sector’ and/or ‘sub-sector’ categories, or combinations thereof, gave an overall lower emissions reduction projection. The preferred option presented here has assigned categories at the most granular level possible, in line with IPCC guidance and industry precedent. The fact that they are almost perfectly aligned with the NAEI dataset classifications suggests that this is the right approach.

[13] Scottish Government (2022). Stop, Sort, Burn, Bury - incineration in the waste hierarchy: independent review. See: https://www.gov.scot/publications/stop-sort-burn-bury-independent-review-role-incineration-waste-hierarchy-scotland/

2 The SNZR cluster boundary - geographical, industrial and emissions scope

This section presents the geographical, industrial and emissions scope for the SNZR project at cluster and sector levels, and outlines the methodology employed to define the cluster. The cluster covers 28 sites spread across 11 different industrial sectors[14], and 14 local authority areas[15]. These 28 sites include most of the top 25 largest emitters in the country, and collectively, they accounted for 76%, or 8.6Mt, of Scotland's industrial CO_2 emissions in 2019.

2.1 Methodology to define the cluster

The cluster presented here is an update on that which was proposed for the SNZR phase 1 project, and is reflective of the then most recent emissions data (for 2019) and upcoming changes for some of the sectors represented. The overall aims in attempting to define the cluster boundary were to cover as wide a geographical area as possible while capturing the highest percentage of emissions from across as many sectors as possible; and to align that with existing and/or potential gas transport and infrastructure options identified as the most likely near-term solutions. The cluster was proposed based on the following 6 criteria, and in this order of priority:

1. Size of emissions (largest emitters to maximise reach and impact)
2. Proximity to/availability of gas (CO_2 & hydrogen) transport infrastructure – pipelines
3. Proximity to/availability of other transport options - shipping, rail, road
4. Proximity to other large emitters (to maximise potential for sharing of infrastructure)
5. Potential to act as a local CO_2 takeaway 'hub' for smaller, otherwise remote sites
6. Potential to feed into a local CO_2 takeaway 'hub' (applicable to smaller, otherwise remote sites)
7. Application of any upcoming important sectoral changes (e.g. policy, regulatory)[16]

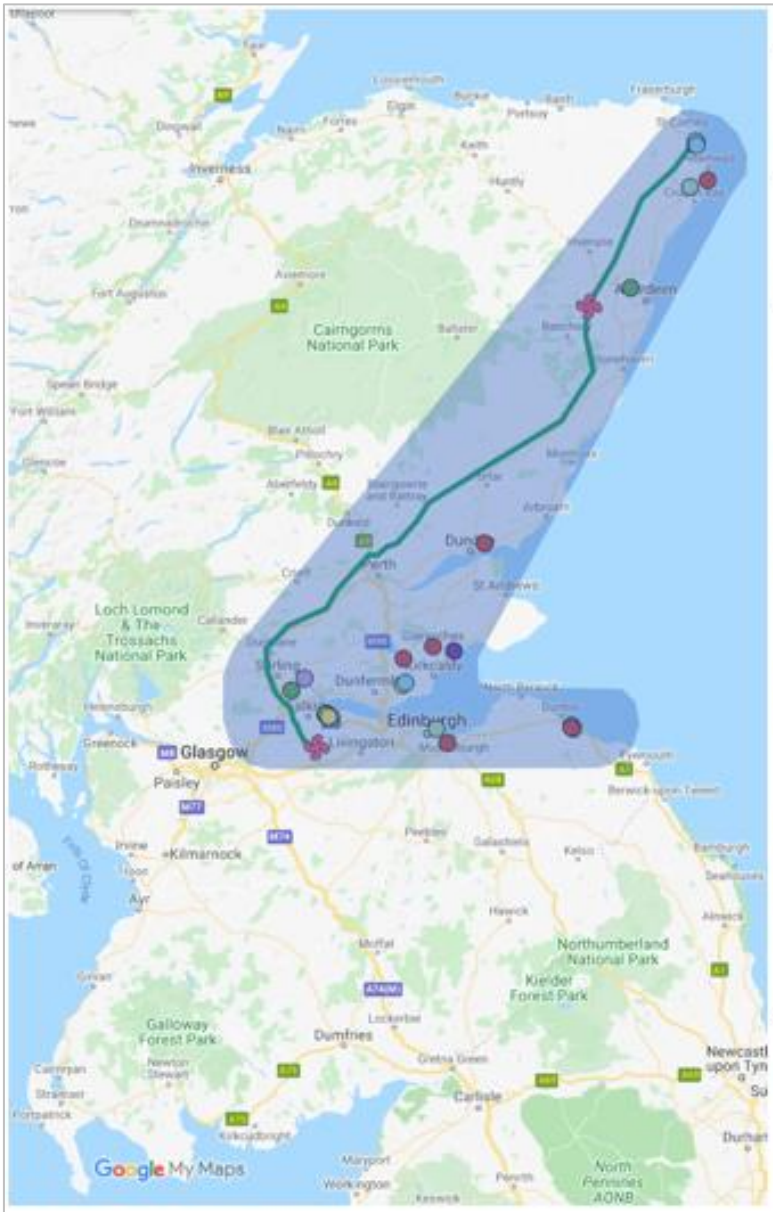
2.2 Cluster level

The geographical, industrial and emissions scope of the cluster is summarised in Figure 3 below. See Appendix A for a summary of the 28 sites within scope.

[14] Applying NAEI sector categories. See: https://naei.beis.gov.uk/data/map-large-source

[15] There are 14 local authorities in the cluster: emitters are spread across 12 local authorities; Angus and Perth & Kinross are included as the NTS Feeder 10 pipeline traverses those areas.

[16] The Scottish Government's near-ban on waste being sent to landfill by 2025 influenced the decision to remove 4 landfill sites that would have qualified for inclusion based on all other criteria. The upcoming landfill ban coincides with an increase in the number of operational Energy-from-Waste (EfW) plants. With more EfW plants either under construction or in planning, these were prioritised for inclusion over soon-to-be-phased-out landfill sites. See: https://www.gov.scot/policies/managing-waste/



No. of sites	28
Total emissions in scope (%)	76%
Total emissions in scope (Mt)	8.6Mt
Sectors	11

- Cement
- Chemicals
- Food & drink
- Gas (processing & distribution)
- Minerals
- Oil & Gas (exploration & production)
- Paper
- Power
- Refining
- Waste & waste-water
- Other

Local authorities 14

- Aberdeen City
- Aberdeenshire
- Angus
- City of Edinburgh
- Clackmannanshire
- Dundee City
- East Lothian
- Falkirk
- Fife
- Midlothian
- North Lanarkshire
- Perth & Kinross
- Stirling
- West Lothian

Figure 3: Geographical, industrial and emissions scope of the SNZR cluster overview (cluster level)

2.3 Sector level

2.3.1 Sector mapping

The SPRI dataset assigns each site into one of six high-level sectors. To allow for a more granular analysis of the data, and to better align with the IPCC sector category classifications assigned in the BEIS EEP (Energy and Emissions Projections) dataset, the SPRI sectors were mapped onto the corresponding NAEI sectors[17] in terms of both site activity and emissions source (combustion/process). Table 1 below outlines how the SPRI sectors were mapped onto the NAEI sectors, and the number of corresponding sites. See Appendix A for a more detailed summary of the sector mapping process.

SPRI		NAEI	
Sector name	**No. of sites**	**Sector (short) name**	**No. of sites**
Animal and vegetable products	2	Food & drink	2
Chemical Industry	1	Chemicals	1
Energy	14	Chemicals	3
		Power	1
		Oil & gas (exploration and production)	4
		Gas (processing & distribution) Refining	6
Mineral industry	2	Cement	1
		Minerals	1
Paper and wood production and processing	2	Other	1
		Paper	1
Waste and waste-water management	7	Power	2
		Waste	5
6	**28**	**11**	**28**

Table 1: Sector mapping overview (SPRI-NAEI)

[17] National Atmospheric Emissions Inventory (2021). See: https://naei.beis.gov.uk/data/map-large-source

2.3.2 Cluster breakdown by sector

Both the absolute and percentage share of emissions for each sector are summarised in Figure 4 below. The cluster is visibly dominated by three sectors, which, combined, account for over two-thirds of emissions in 2019: Power has the largest emissions profile (25% or 2.2MtCO_2), and is closely followed by Chemicals (22% or 1.9MtCO_2) and Refining (21% or 1.7MtCO_2 respectively. The three sectors with the next largest emissions are Oil & gas (9% or 0.8 MtCO_2), Waste (7% or 0.6MtCO_2) and Cement (6% or 0.6MtCO_2).

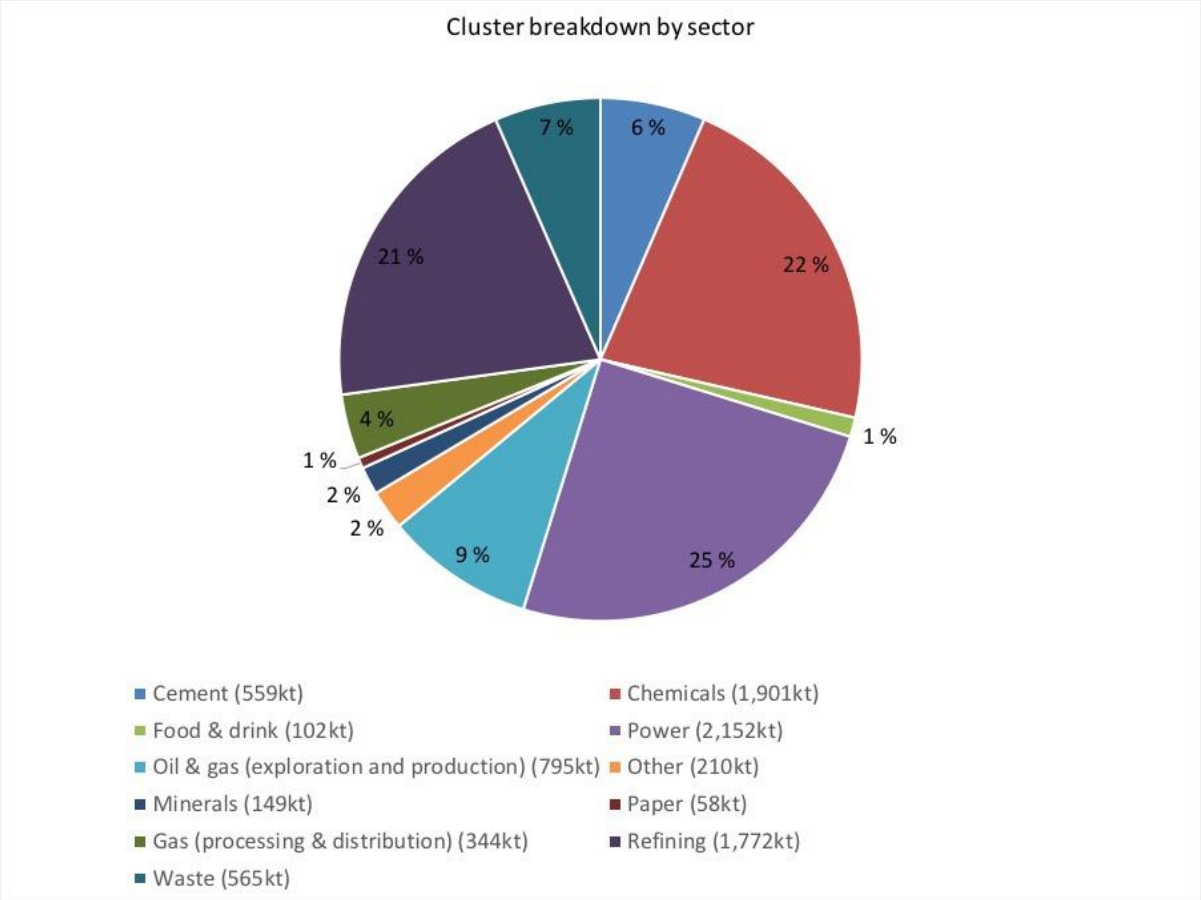


Figure 4: Cluster breakdown by sector

2.3.3 Sector breakdown by emissions source

In order to be able to attribute sectoral emissions to the most relevant sector category for the purpose of projecting future baseline scenarios, it is important to understand the source of emissions. At the highest level, it is possible to distinguish between emissions arising from combustion activities to supply energy for power generation and industrial processes- 'combustion emissions' – and those arising from the industrial processes themselves and/or the chemical reactions therein – 'process emissions'. This is an important distinction to make as process emissions can only be decarbonised via CCS, or a fundamental change to the process itself, rather than by fuel switching to lower carbon alternatives. Figure 5 below summarises this breakdown for the eleven sectors within the cluster.

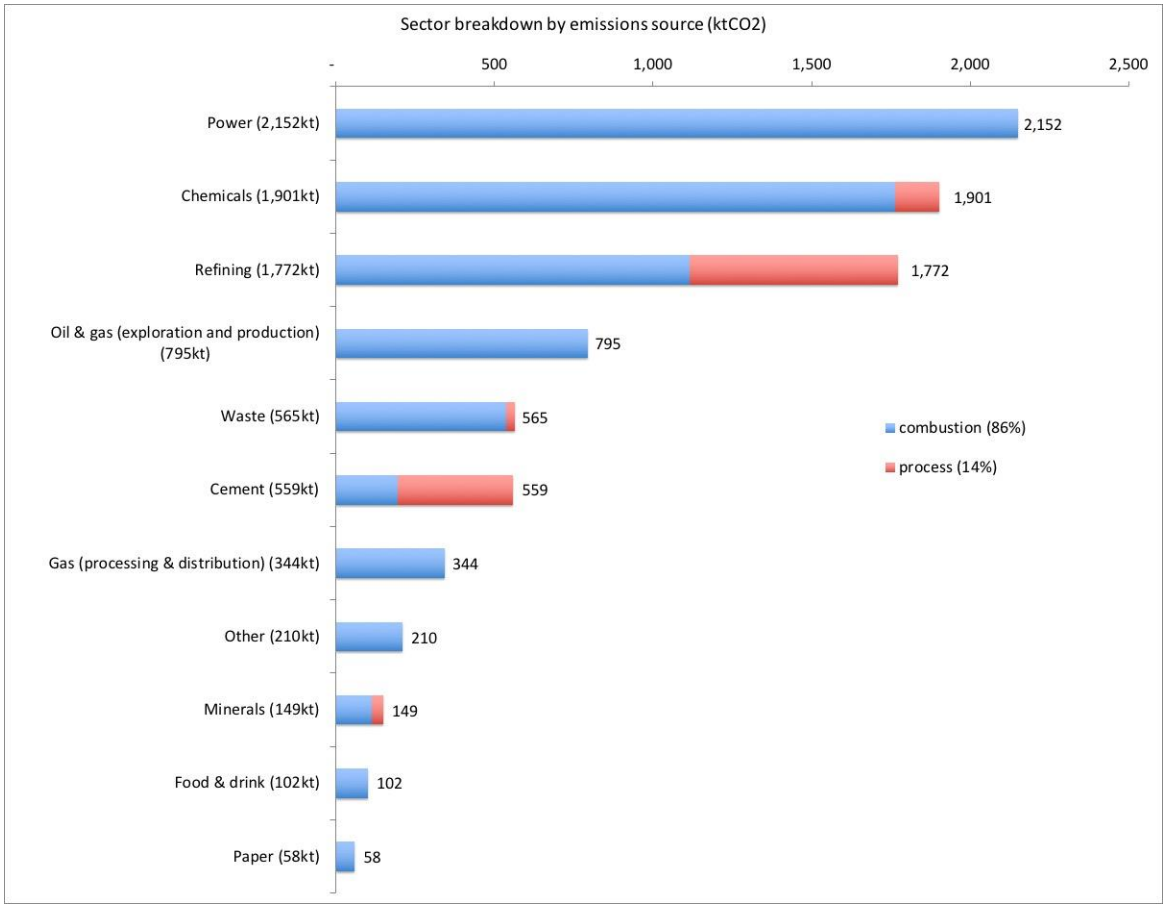


Figure 5: Sector breakdown by emissions source

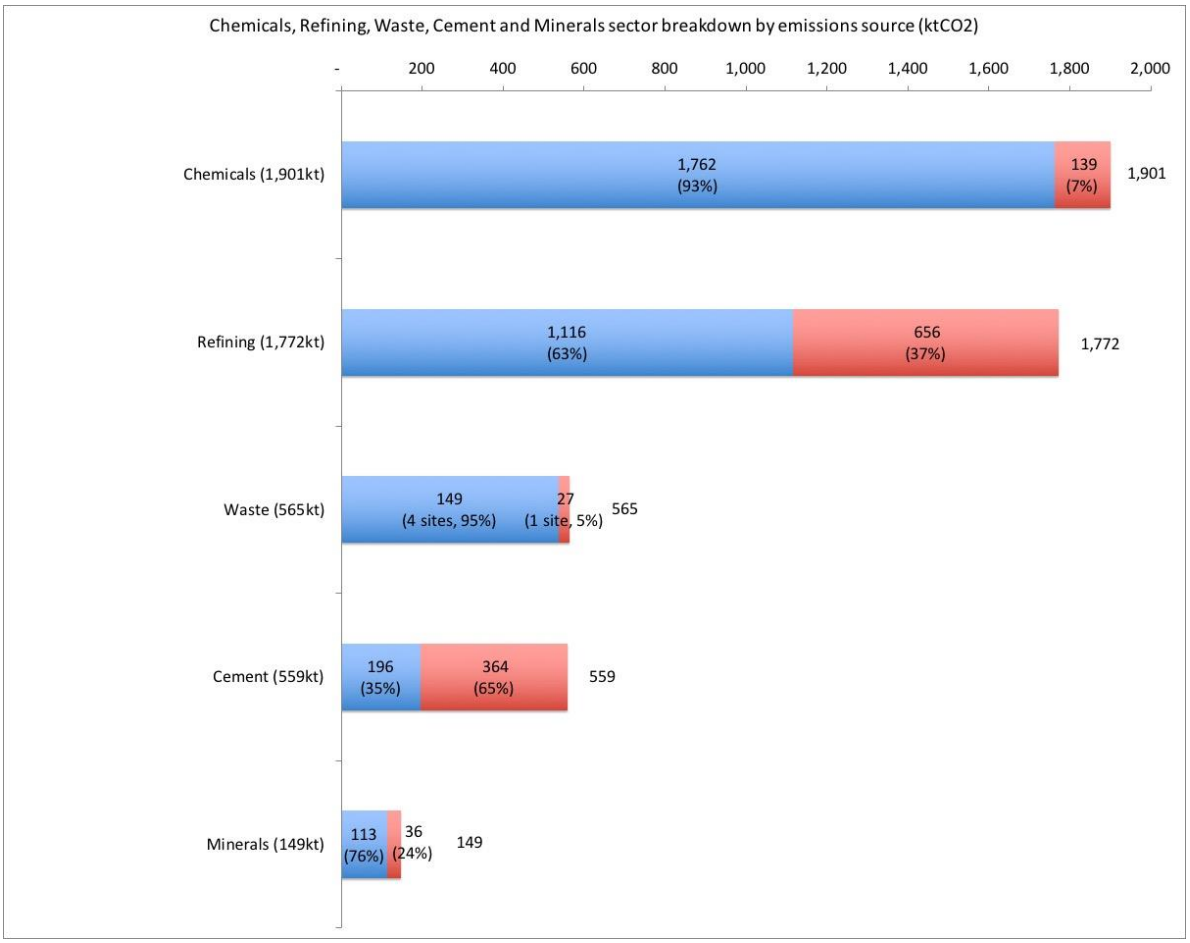
Total emissions across the cluster are comprised of 86% combustion emissions and 14% process emissions. The five sectors with a combustion/process emissions breakdown - Chemicals, Refining, Waste, Cement and Minerals – are presented in more detail in Figure 6 below.

The sectors were broken down into combustion/process emissions using one of two methods. Firstly, sectoral breakdown percentages from a combination of UK Government and energy and industry body sectoral reports were used. This method was used for Chemicals (89%/11%)[18], Refining (63%/37%)[19],

[18] DECC (2015). Industrial Decarbonisation & Energy Efficiency Roadmaps to 2050: Chemicals. See: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/416669/Chemicals_Report.pdf

[19] DECC (2015). Industrial Decarbonisation & Energy Efficiency Roadmaps to 2050: Oil Refining. See: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/416671/Oil_Refining_Report.pdf

Cement (35%/65%)[20] and Minerals (76%/24%)[21], which in the case of SNZR covers glass manufacturing. Secondly, Waste was broken down according to the IPCC guidance on sector category classification. Of the five sites classified under Waste, four (3 x EfW plant and 1 x biogas facility) were assigned combustion categories; the other (a waste-water processing facility), was assigned a process emissions category. See Appendix A.



NB: Chemicals is shown with a 93%/7% split, not the sectoral breakdown of 89%/11% that was used for calculations. This is because one site (Grangemouth CHP) is classified under Chemicals but has only combustion emissions, thereby skewing the final sectoral weighting slightly.

Figure 6: Chemicals, Refining, Waste, Cement and Minerals sector breakdown by emissions source

[20] IEA (2018). Technology Roadmap: Low-carbon transition in the cement industry. See: https://iea.blob.core.windows.net/assets/cbaa3da1-fd61-4c2a-8719-31538f59b54f/TechnologyRoadmapLowCarbonTransitionintheCementIndustry.pdf

[21] British Glass (2014). A Clear Future: UK glass manufacturing sector decarbonisation roadmap to 2050. See: https://www.britglass.org.uk/sites/default/files/A%20clear%20future%20-%20UK%20glass%20manufacturing%20sector%20decarbonisation%20roadmap%20to%202050_summary.pdf

2.4 Site level

The 28 sites within the cluster are summarised in Figure 7 below in order of overall quantity of emissions (largest-smallest). They have also been given a ranking (in parentheses) that reflects their position in the full SPRI 2019 dataset of 84 emitters, highlighting that almost all of the sites are within the top-50 largest emitters, including most of the top 25. The emissions profiles range from 1.6MtCO_2 for Peterhead Power Station down to 26ktCO_2 for the National Grid North Sea Gas Terminal.

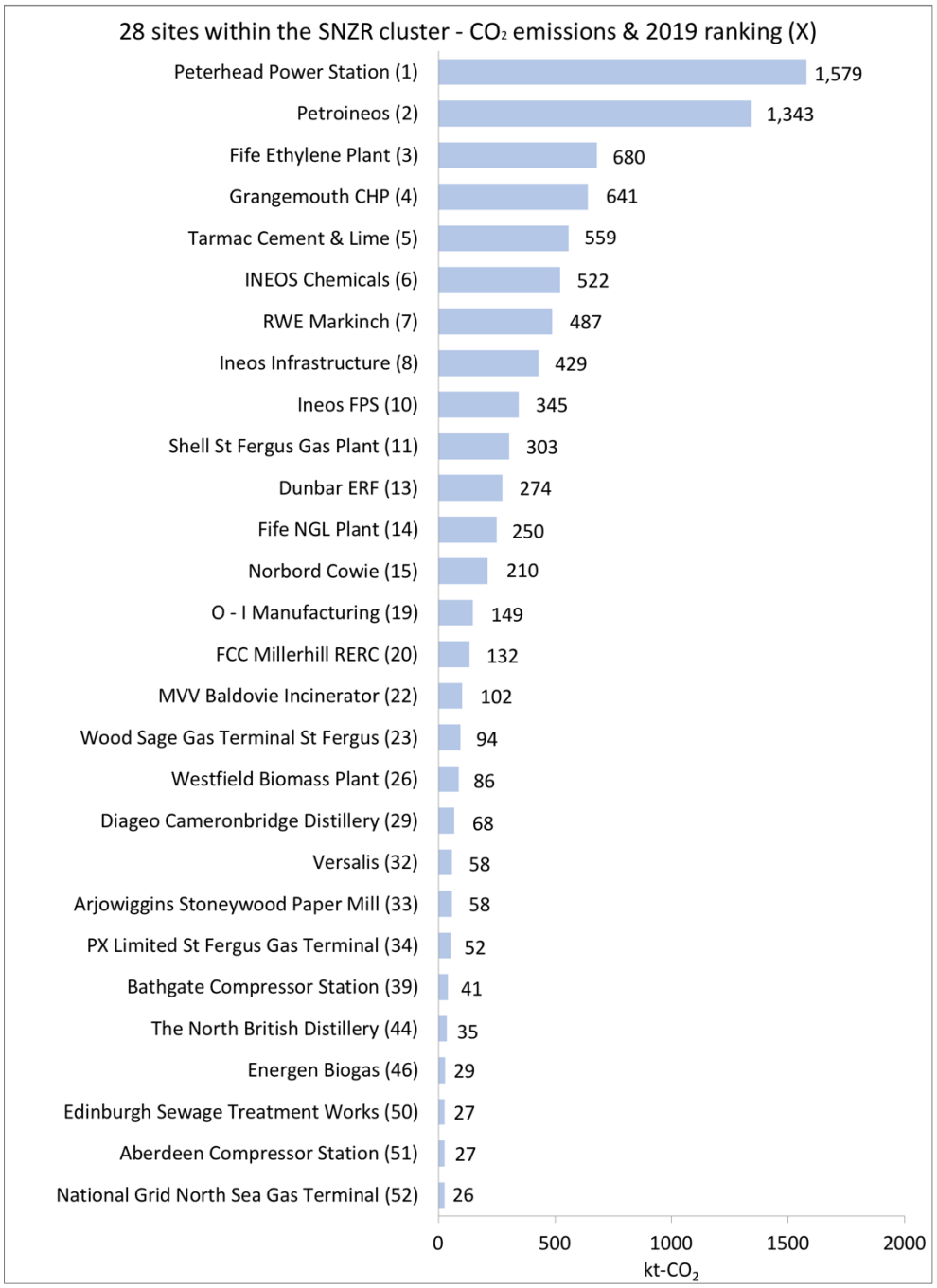


Figure 7: 28 sites within the SNZR cluster with 2019 ranking

3 Business-as-usual future baseline scenarios

This section presents the results of the final revision of the second key task within this study, which was to develop illustrative future baseline emissions scenarios out to 2045, for the sites within the SNZR cluster boundary. These scenarios incorporate newly operational, announced and/or projected significant developments that have either come online or are deemed as certain to do so during the period 2019-2045, and assume no deep decarbonisation measures are otherwise implemented within the cluster across those same intervening years. These scenarios therefore provide a baseline against which potential decarbonisation pathways to 2045 could be assessed. The projections are summarised at both the cluster and sector level.

3.1 Three scenarios assuming no deep decarbonisation

In order to cover a range of potential futures, a set of three BAU scenarios were developed: 'High emissions', 'Central' and 'Low emissions' - see Table 2 below. These scenarios represent hypothetical futures - they are not pathways or forecasts - and they are intended to assist energy system modelling activities within the project to plot potential emissions pathways for the cluster.

These scenarios represent the most granular level of sector category classification considered from four different sets of scenario proposals, and employ a combination of sector, sub-sector and sub-sub-sector growth assumptions aligned with a BAU future. They are based on the BEIS EEP 'High Growth', 'Reference' and 'Low Growth" scenarios, all of which are aligned with "*…all agreed policies where decisions on policy design are sufficiently advanced to allow robust estimates of impact (i.e. including "planned" policies).*".[22]

The scenarios were projected by applying a compound annual growth rate (CAGR) to each IPCC sector category assigned to a site. The CAGR rates were calculated based on the BEIS EEP dataset. This dataset only extends to 2040 so an additional CAGR was employed to extrapolate the projections out to 2045 (see Appendix B).

NB: Given the large degree of uncertainty, these scenarios do not account for the impact of the COVID-19 pandemic. The 2019 SPRI dataset was retained as the baseline start year as it was deemed to more accurately reflect a BAU approach.

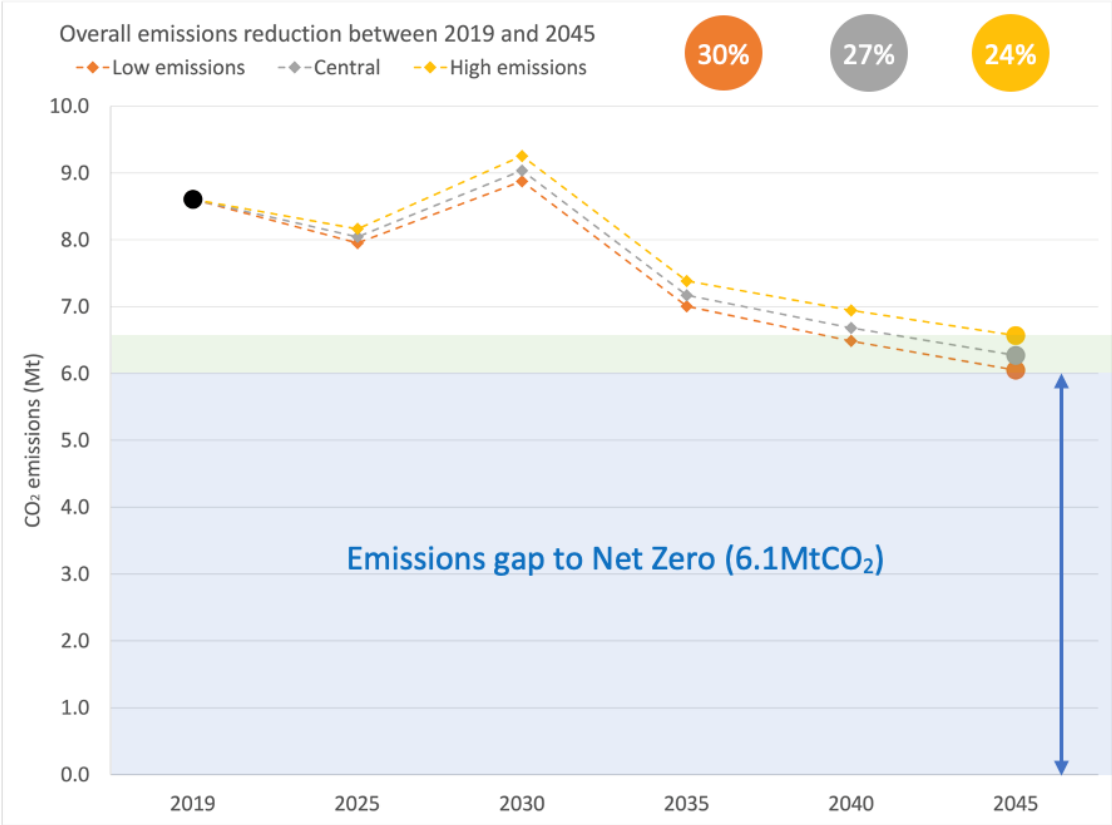
BAU scenario	High emissions	Central	Low emissions
Equivalent BEIS scenario	High Growth	Reference	Low Growth

Table 2: 'High emissions', 'Central' and 'Low emissions' scenarios

[22] BEIS (2020). Updated energy and emissions projections, Appendix C: Carbon dioxide emissions by IPCC category https://www.gov.uk/government/publications/updated-energy-and-emissions-projections-2019

3.2 Emissions projections (2019-2045) - cluster level

Overall emissions are projected to reduce by 2.0-2.6MtCO_2 by 2045, compared to 2019 levels. This represents a reduction in relative terms of between 24-30%, depending on the scenario – see Figure 8 below. Even under the 'Low emissions' scenario, there remains an emissions gap to net zero for the cluster of 6.1MtCO_2.



NB: Intervening years are marked for reference only, and dotted lines have been added to indicate interpolation between these points.

Figure 8: Cluster level projected annual CO_2 emissions 2019-2045 under BAU scenarios, and emissions gap to net zero in 2045

3.3 New, significant developments affecting the SNZR cluster between 2019-2045

A total of 10 new and/or significant[23] developments were identified within the cluster boundary. These developments were all identified from publicly available sources and cover projects and/or changes that have either already taken place or were deemed to be certain to come take place, because of one or a combination of the following: FID reached, already under construction, fully consented, aligned

[23] Developments with an annual total release of 26ktCO_2/yr or above were deemed as 'significant', 26kt/yr being the annual total release for the smallest of the SNZR 28 sites, the National Grid North Sea Gas Terminal at Peterhead. In practice, the smallest development that was incorporated had an annual total release of 90ktCO_2.

with Scottish Government incineration capacity review (2022)[24]. These developments included 7 new projects across the Power and Waste sectors, and significant changes to 3 existing SNZR cluster sites across the Power, Waste and Refining sectors. Together, these developments account for a modelled net increase of 500ktCO_2 (from 5.6Mt to 6.1Mt) in the emissions gap to net zero in 2045 when compared to the preliminary results presented in the first iteration of his study. The baseline projections for all other sites, and sectors, within the SNZR cluster boundary remain unchanged.

3.3.1 Developments in the Power sector

There are 2 major developments in the Power sector that will have a significant impact on the CO_2 emissions profile of the cluster, and they pertain to a single site/emitter: Peterhead Power Station. According to current plans, the existing plant, operated by SSE Thermal, is scheduled to be retired in 2030 and to be replaced by a separate, new plant on the same site: the Peterhead Carbon Capture Power Station, a joint venture between SSE Thermal and Equinor, which is scheduled to come online in the mid-2020s with a CO_2 emissions profile of around 1.5Mt/yr. Both plants are expected to run in parallel until 2030[25]. The new plant is a key plank of the Scottish Cluster project[26] and, once complete, could tie into the Acorn CCS project infrastructure[27]. A Section 36 planning application was submitted for the new plant in March 2022[28]. These developments are summarised in Table 3 below.

Site/Project name	Local Authority	Type & Status	Start year (if later than 2019)	End year (if earlier than 2045)	Total annual release ($ktCO_2$)
Peterhead Power Station	Aberdeenshire	Closure Planned	-	2030*	1,579
Peterhead Carbon Capture Power Station	Aberdeenshire	New plant Planned	2026*	-	1,450*

Table 3: New and/or significant developments in the Power sector (* *modelled*)

[24] Scottish Government (2022). Stop, Sort, Burn, Bury - incineration in the waste hierarchy: independent review. See: https://www.gov.scot/publications/stop-sort-burn-bury-independent-review-role-incineration-waste-hierarchy-scotland/

[25] Element Energy (2021). CCUS Economics Impacts Study Delivering a roadmap for growth and emissions reductions for Scotland. See: https://www.scottish-enterprise.com/media/4319/ccus-economic-impact-assessment-report.pdf

[26] The Scottish Cluster (2022). See: https://www.thescottishcluster.co.uk

[27] The Acorn Project (2022). See: https://theacornproject.uk

[28] SSE (2022). Press Release. See: https://www.sse.com/news-and-views/2022/03/peterhead-takes-major-step-towards-low-carbon-power-as-planning-application-submitted/

3.3.2 Developments in the Waste sector

The Waste sector sees the largest number of new, significant developments of any sector, with 6 new Energy-from-Waste (EfW) plants projected to be operational by the mid-2020s and 1 existing plant scheduled to come offline towards the end of the decade. Of the 6 new plants, 2 are already operational and 4 are currently under construction. These developments cover 6 of the 14 local authorities within the SNZR cluster boundary. They are summarised in Table 4 below.

Site/Project name	Local Authority	Type & Status	Start year (if later than 2019)	End year (if earlier than 2045)	Total annual release ($ktCO_2$)[29]
MVV Baldovie EfW CHP (old)	Dundee City	Closure Planned	-	2030*	102
MVV Baldovie EfW CHP (new)	Dundee City	New plant Operational	2022	-	99*
Levenseat Renewable Energy EfW ACT (CHP) Plant – Phase 1	West Lothian	New plant Operational	2020	-	90*
Earls Gate Energy Centre	Falkirk	New plant Construction	2023*	-	194*
Westfield Energy Recovery Facility	Fife	New plant Construction	2025*	-	216*
NESS Energy Project.	Aberdeen City	New plant Construction	2023*	-	135*
Drumgray ERC	North Lanarkshire	New plant Construction	2026*	-	270*

Table 4: New and/or significant developments in the Waste sector (* *modelled*)

[29] Modelled total annual release figures were calculated by applying a ratio of 0.9tCO_2 produced for every 1t waste processed (0.9:1) to plant capacity figures from publicly available sources comprising project websites, industry and government reports and analyses, local authority planning portals, and industry and mainstream media outlets. In line with Scottish Government (2021). Call for Evidence: Review of the Role of Incineration in the Waste Hierarchy. See: https://bit.ly/3sobVuO, year 1 of operation was modelled using a capacity load factor of 50%, with 95% assumed for each year thereafter over the lifetime of the plant.

3.3.3 Developments in the Refining sector

There is 1 significant change in the Refining sector. The CO_2 emissions profile for the Petroineos refinery has been revised in line with temporary and permanent plant shutdowns that took place in 2019 and 2020 respectively, leading to a reduction in emissions of around 30% of its 2018 level[303132]. These changes reduce the CO_2 emissions profile from 2020 for this site by around 250kt (from its 2019 level) to 1.1Mt/yr. This change is summarised in Table 5 below, where the current (2019) baseline data (*italicised*) is presented for comparison only.

Site/Project name	Local Authority	Type & Status	Start year (if later than 2019)	End year (if earlier than 2045)	Total annual release ($ktCO_2$)
Petroineos	Falkirk	*Current (2019) baseline*	*2019*	-	*1,343*
		Change Reduced capacity	2020	-	1,100*

Table 5: New and/or significant developments in the Refining sector (* *modelled*)

3.4 Emissions projections (2019-2045) - sector level

There is substantial variation between sectors in terms of how they contribute to the overall reduction in emissions for the cluster. The largest reductions come from Chemicals (1.3-1.4Mt), Power (0.8-1Mt) and Refining (240kt) and Oil & gas (152kt), which represent the 1st, 2nd, 3rd and 4th largest sector reductions respectively.

From a total of thirty-three BAU scenarios, seven result in an increase in emissions by 2045: Waste and Minerals (low, central and high scenarios), and Cement (high scenario). Waste and Minerals are the

[30] Element Energy (2021). CCUS Economics Impacts Study Delivering a roadmap for growth and emissions reductions for Scotland. See: https://www.scottish-enterprise.com/media/4319/ccus-economic-impact-assessment-report.pdf

[31] Herald Scotland (2020). See: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiLpe6d9-P1AhXSh1wKHWGUDa8QFnoECAYQAQ&url=https%3A%2F%2Fwww.heraldscotland.com%2Fnews%2F18860799.devastating---scots-refinery-part-owned-ineos-axe-200-jobs-mothballs-plants%2F&usg=AOvVaw1afP-gSOZc0xvW1_TTa9S0

[32] Argus Media (2021). See: https://www.argusmedia.com/en/news/2273399-uks-grangemouth-refinery-shuts-hydrocracker-unit

only two sectors to see an increase in emissions across all three scenarios (low, central and high): 439-474kt (a difference of 35kt or a 8% increase on the low scenario value) for Waste; 58-94kt (a difference of 36kt or a 62% increase on the low scenario value) for Minerals.

3.4.1 Projections for individual sectors

Each sector is summarised below in terms of its projected annual CO_2 emissions (shown in 5-year intervals) and projected absolute emissions reduction in 2045, compared to a 2019 baseline. The sectors are presented in order of size of emissions reduction contribution (largest to smallest). Sites are listed in tables to show (i) the sites assigned to each sector, (ii) the total annual release figures in 2019 ($ktCO_2$*) for each site and the sector as a whole, and (iii) notes on any new, significant developments. Figure 20 presents an overview of projected changes in sectoral annual emissions in 2045 within the cluster.

** Figures may not add up exactly due to rounding*

3.4.1.1 Chemicals

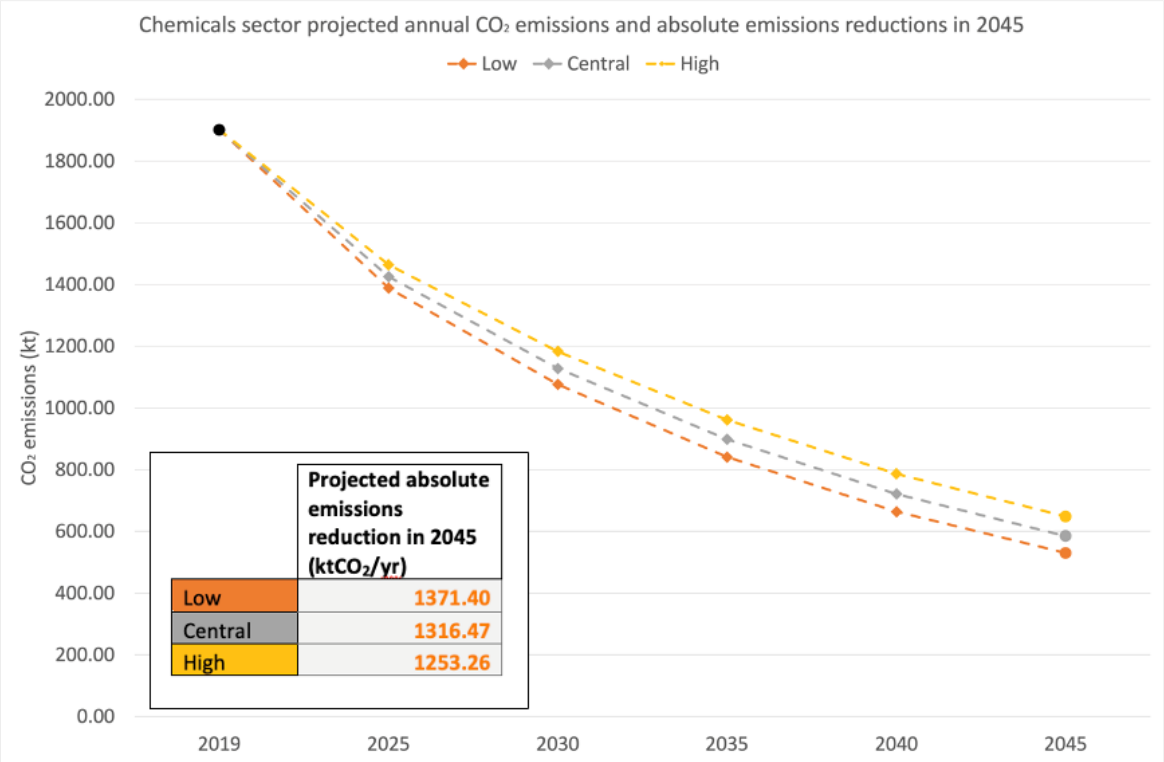


Figure 9: Chemicals sector projected annual CO_2 emissions and projected absolute emissions reduction under BAU (low, central & high) scenarios 2019-2045

Chemicals sees the largest projected absolute reduction in annual emissions in 2045 of all the sectors, and across all three scenarios, ranging from 1,253-1,371kt (1.3 - 1.4Mt). This is due to the fact that it is one of the largest sectors, in terms of absolute emissions, and has the lowest assumed growth rate of all the sectors across future scenarios (approx.-5%).

Site (2019 ranking)	2019 total annual release ($ktCO_2$)
Fife Ethylene Plant (3)	680
Grangemouth CHP (4)	641
INEOS Chemicals (6)	522
Versalis (32)	58
	1,901

Table 6: Sites within the Chemicals sector

3.4.1.2 Power

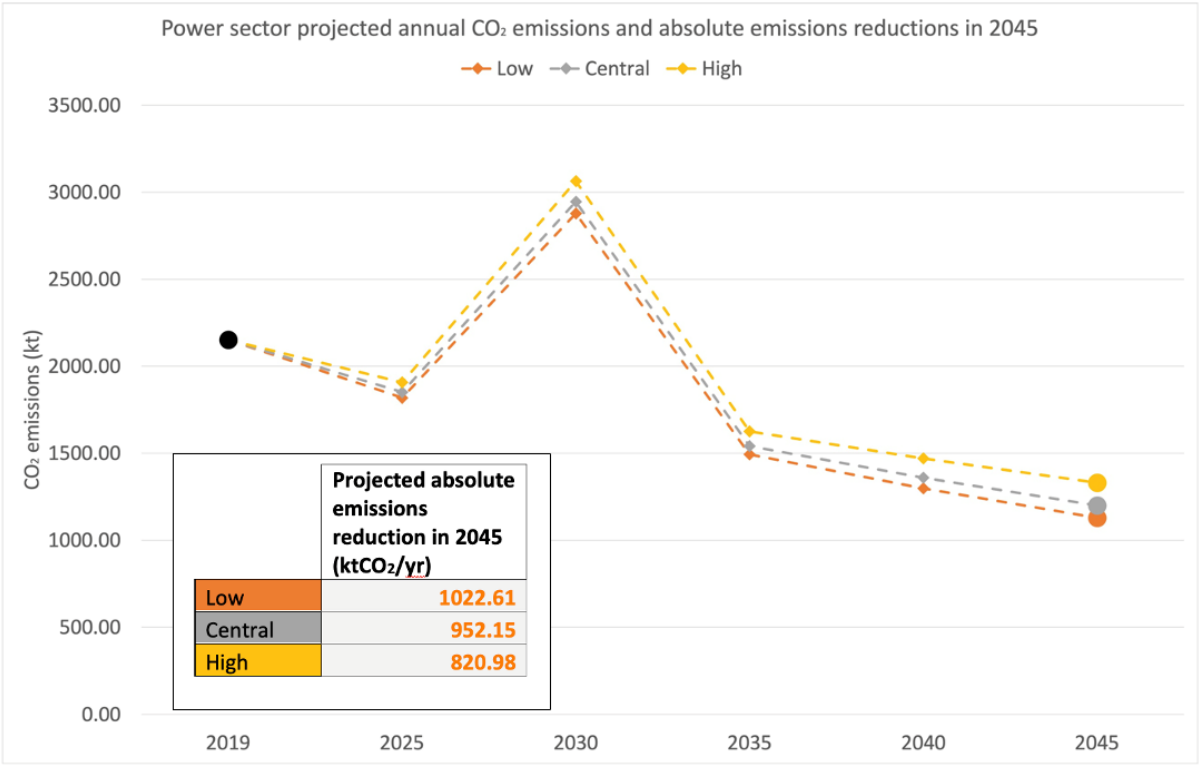


Figure 10: Power sector projected annual CO_2 emissions and projected absolute emissions reduction under BAU (low, central & high) scenarios 2019-2045

Power sees the 2nd largest projected absolute reduction in annual emissions in 2045 across all three scenarios, ranging from 820-1,022kt (0.8 - 1Mt). This is due to the fact that it is the largest sector in terms of absolute emissions and has a relatively low assumed growth rate across future scenarios (approx. -2.5%). While the 4-year period where the new and existing plants are projected to operate in parallel has very little bearing on the final emissions profile in 2045, importantly, this results in a near-doubling of projected cumulative annual emissions between 2026-2030, as discussed in section 3.3.3 above.

Site (2019 ranking)	2019 total annual release ($ktCO_2$)	Notes
Peterhead Power Station (1)	1,579	Existing plant modelled with an end year of 2030
RWE Markinch (7)	487	
Westfield Biomass Plant (26)	86	
Peterhead Carbon Capture Power Station	-	New plant with a modelled operational start year of 2026 and a modelled total annual release of 1,450$ktCO_2$
	2,152	

Table 7: Sites within the Power sector

3.4.1.3 Refining

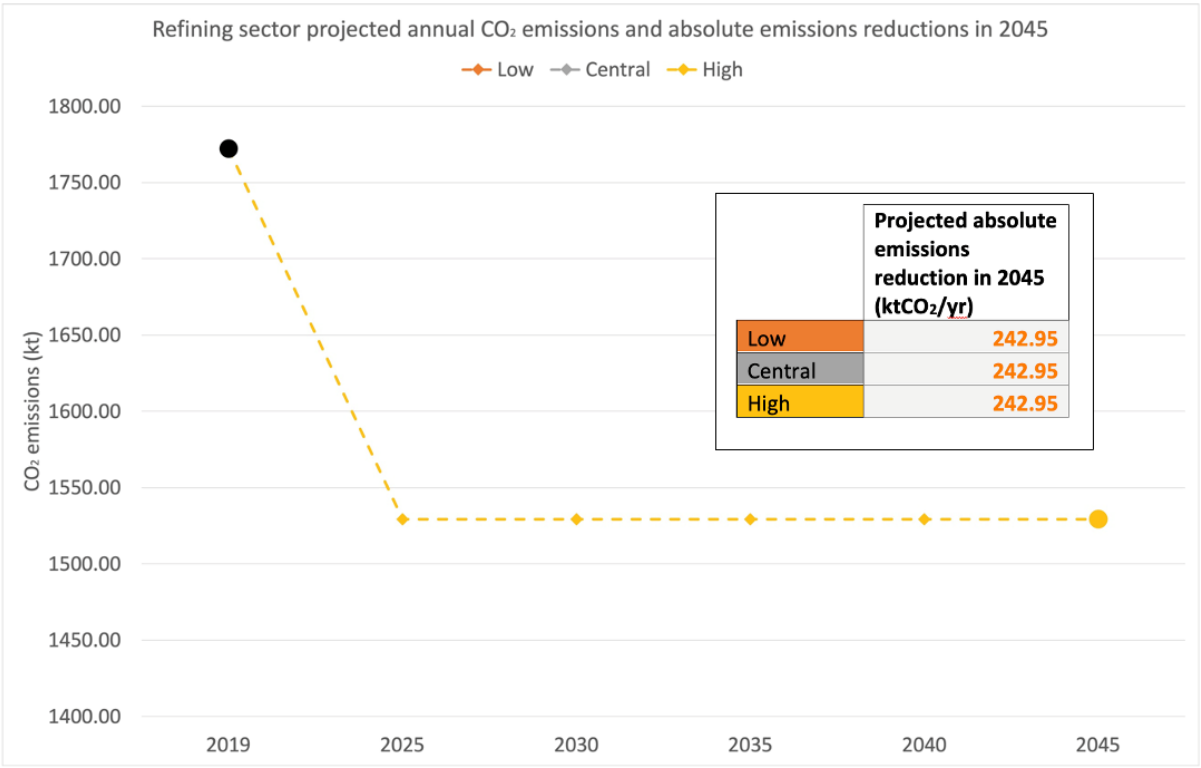


Figure 11: Refining sector projected annual CO_2 emissions and projected absolute emissions reduction under BAU (low, central & high) scenarios 2019-2045

Refining sees the 3rd largest projected absolute reduction in annual emissions in 2045 across all three scenarios of 243kt. This is entirely due to the plant shutdowns discussed in section 3.3.3 above. Refining sees no change between 2020 and 2045. Despite being the 3rd largest in terms of emissions, Refining has an assumed growth rate of 0% for both combustion and process emissions.

Site (2019 ranking)	2019 total annual release ($ktCO_2$)	Notes
Petroineos (2)	1,343	Remodelled total annual release of 1,100$ktCO_2$ from 2020 onwards, due to reduced capacity following plant shutdowns
Ineos Infrastructure (8)	429	
	1,772	

Table 8: Sites within the Refining sector

3.4.1.4 Oil & Gas (exploration & production)

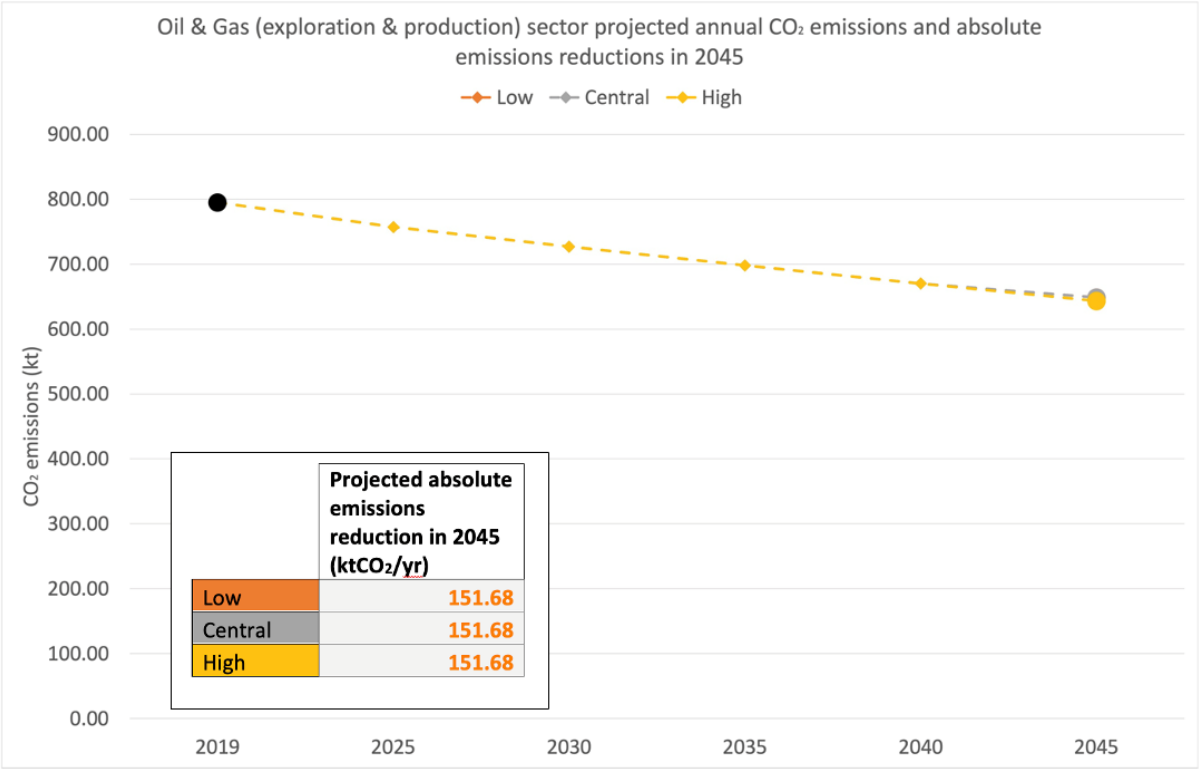


Figure 12: Oil & gas (exploration & production) sector projected annual CO_2 emissions and projected absolute emissions reduction under BAU (low, central & high) scenarios 2019-2045

Oil & gas (exploration & production) sees the 4th largest projected absolute reduction in annual emissions in 2045 across all three scenarios of 152kt. This is due to the fact that Oil & gas is the 4th largest sector in terms of absolute emissions and has only a moderate assumed growth rate (approx. -1%).

Site (2019 ranking)	2019 total annual release ($ktCO_2$)
Ineos FPS (10)	345
Shell St Fergus Gas Plant (11)	303
Wood Sage Gas Terminal St Fergus (23)	94
PX Limited St Fergus Gas Terminal (34)	52
	795

Table 9: Sites within the Oil & gas (exploration & production) sector

3.4.1.5 Other

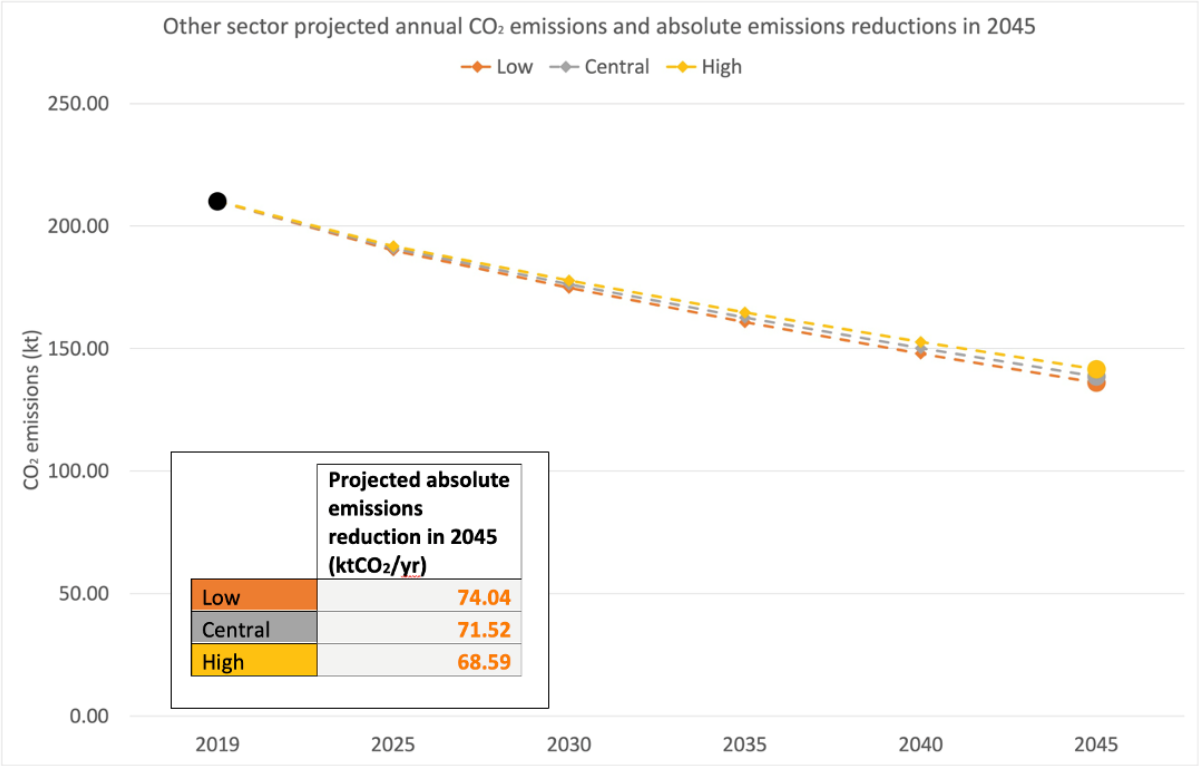


Figure 13: Other sector projected annual CO_2 emissions and projected absolute emissions reduction under BAU (low, central & high) scenarios 2019-2045

'Other' sees the 5th largest projected absolute reduction in annual emissions in 2045 across all three scenarios ranging, from 69-74kt. This is due the fact that, despite being one of the smaller sectors in terms of absolute emissions reduction, Other has only a relatively low assumed growth rate (approx. 1.6%).

Site (2019 ranking)	2019 total annual release ($ktCO_2$)
Norbord Cowie (15)	210
	210

Table 10: Sites within the Other sector

3.4.1.6 Gas (processing & distribution)

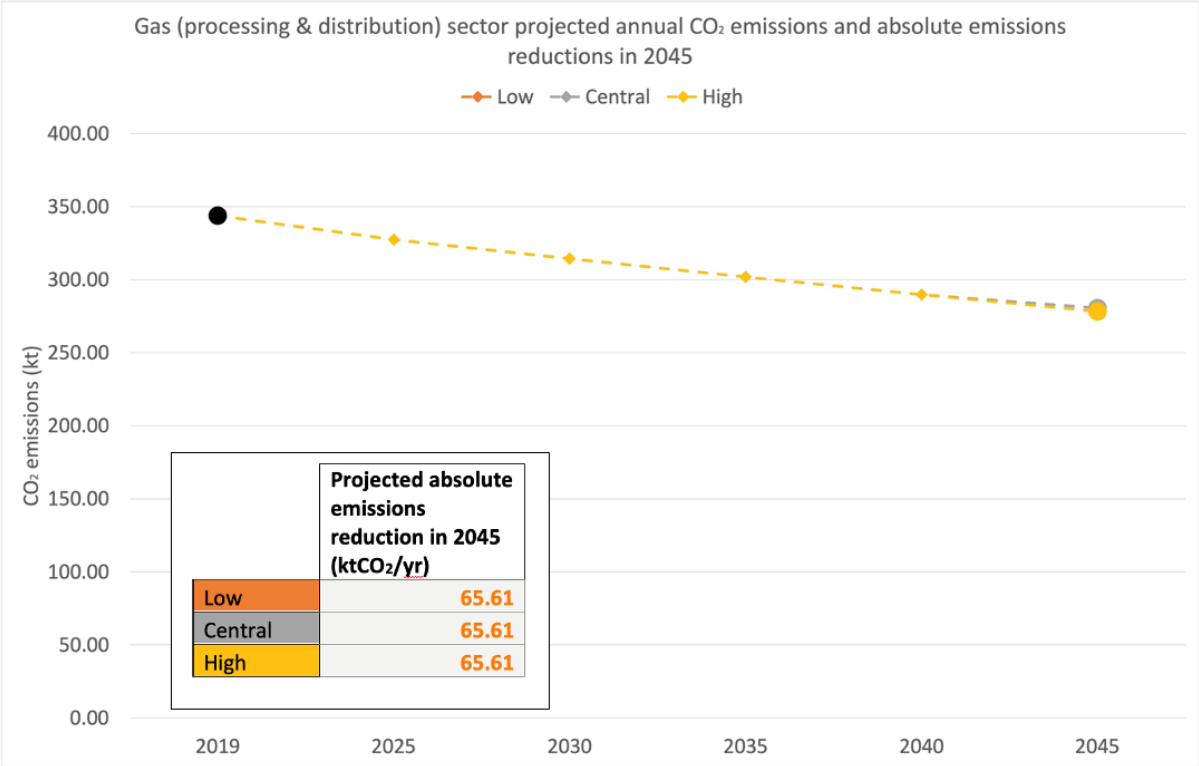


Figure 14: Gas (processing & distribution) sector projected annual CO_2 emissions and projected absolute emissions reduction under BAU (low, central & high) scenarios 2019-2045

Gas (processing & distribution) sees the 6th largest projected absolute reduction in annual emissions in 2045 across all three scenarios of 66kt. This is due primarily to only a moderately low assumed growth rate (approx. -1%).

Site (2019 ranking)	2019 total annual release ($ktCO_2$)
Fife NGL Plant (14)	250
Bathgate Compressor Station (39)	41
Aberdeen Compressor Station (51)	27
National Grid North Sea Gas Terminal (52)	26
	344

Table 11: Sites within the Gas (processing & distribution) sector

3.4.1.7 Cement

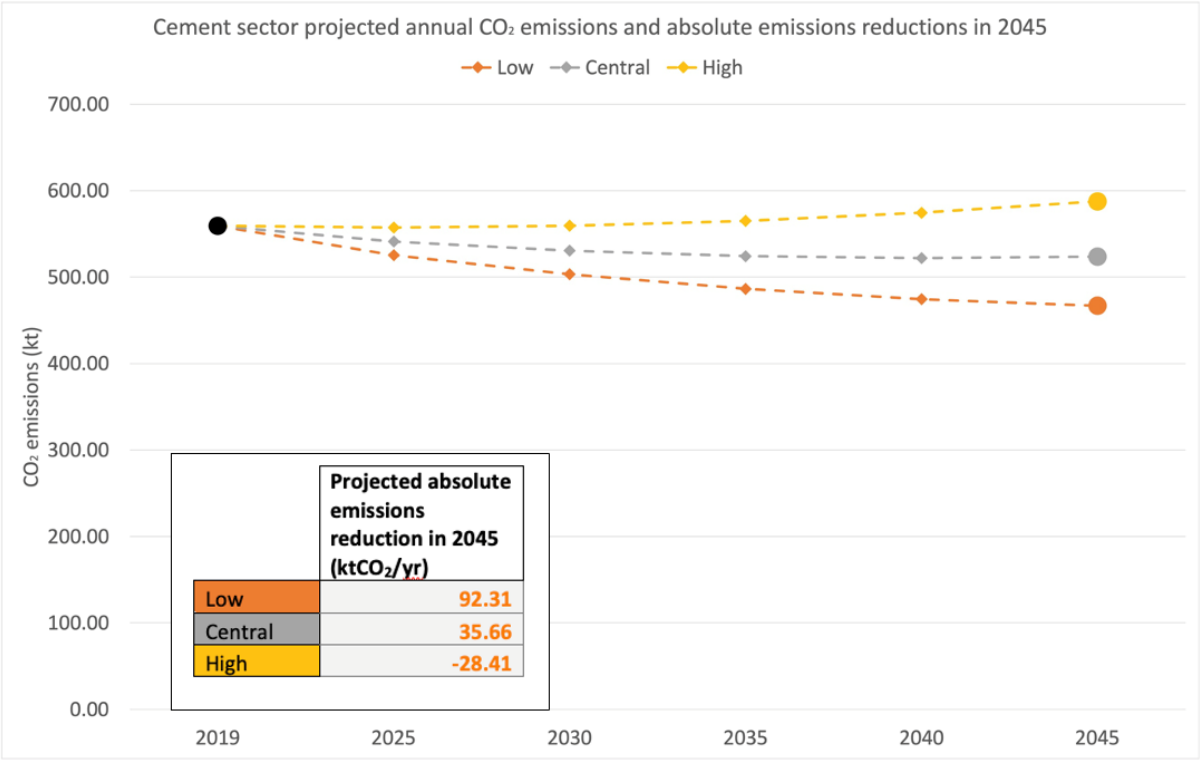


Figure 15: Cement sector projected annual CO_2 emissions and projected absolute emissions reduction under BAU (low, central & high) scenarios 2019-2045

Cement sees the 7th largest absolute projected reduction in annual emissions in 2045 across all three scenarios ranging, from a reduction of 92kt in the low scenario to an **increase** of 28kt in the high scenario. Cement shows the greatest variation between the low and high scenarios of all sectors. These contrasting outcomes are due to the fact that Cement has a relatively low growth rate (approx. -2%) for process emissions – covering 65% of its emissions – and a relatively high positive assumed growth rate for combustion emissions (approx. +1.6%).

Site (2019 ranking)	2019 total annual release ($ktCO_2$)
Tarmac Cement & Lime (5)	559
	559

Table 12: Sites within the Cement sector

3.4.1.8 Food & drink

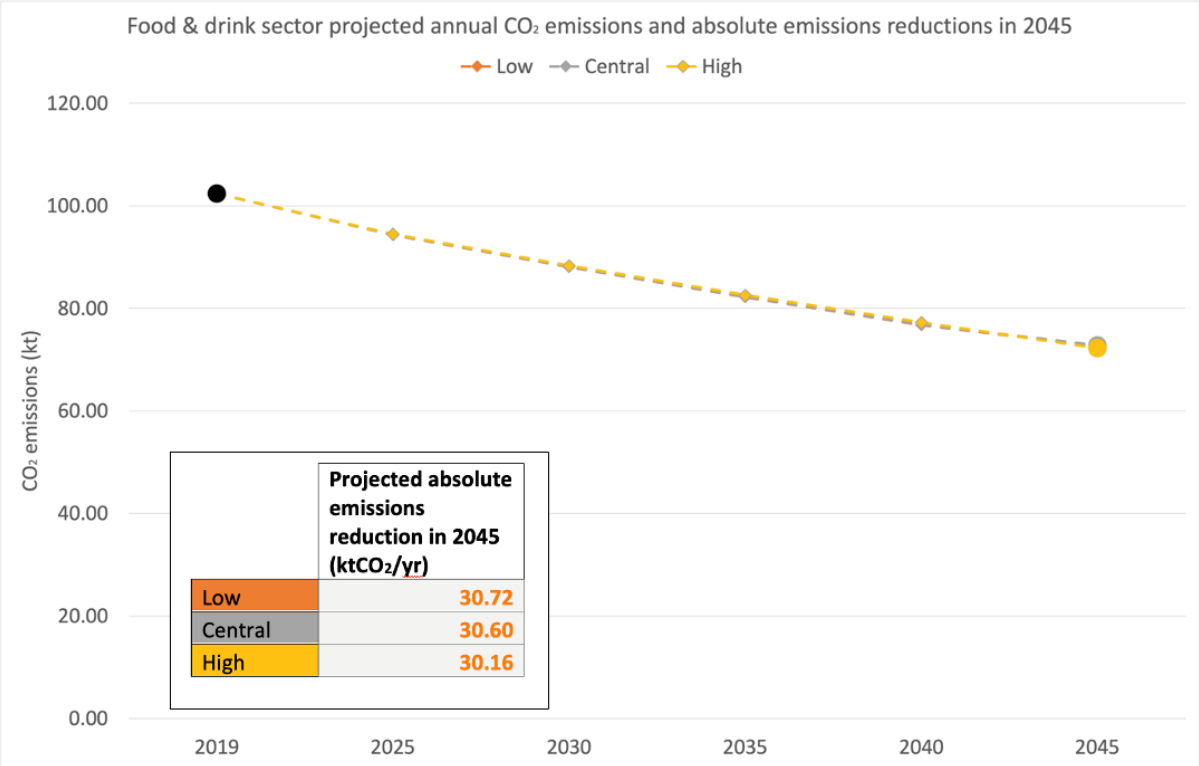


Figure 16: Food & drink sector projected annual CO_2 emissions and projected absolute emissions reduction under BAU (low, central & high) scenarios 2019-2045

Food & drink sees the 8th largest projected absolute reduction in annual emissions in 2045 across all three scenarios of 30-31kt. This is due primarily to a relatively low assumed growth rate (approx. -1.4%).

Site (2019 ranking)	2019 total annual release ($ktCO_2$)
Diageo Cameronbridge Distillery (29)	68
The North British Distillery (44)	35
	102

Table 13: Sites within the Food & drink sector

3.4.1.9 Paper

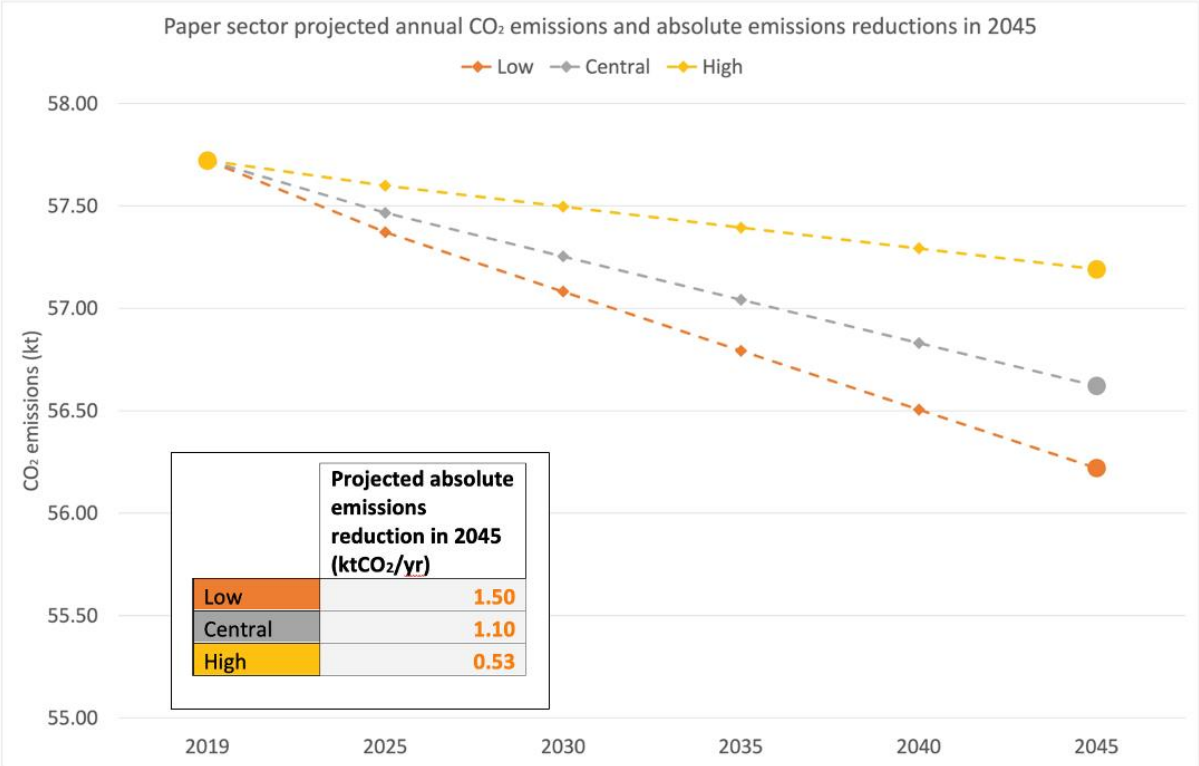


Figure 17: Paper sector projected annual CO_2 emissions and projected absolute emissions reduction under BAU (low, central & high) scenarios 2019-2045

Of the sectors that see a projected absolute reduction in annual emissions in 2045 across all three scenarios, paper is the smallest, ranging from 0.5-1.5kt. This is due to the fact the paper is a very small sector and has a negligible assumed growth rate (approx. -0.1%).

Site (2019 ranking)	2019 total annual release ($ktCO_2$)
Arjowiggins Stoneywood Paper Mill (33)[33]	58
	58

Table 14: Sites within the Paper sector

[33] The Arjowiggins mill went into administration in Oct 2022. It is retained in this analysis because (i) it continued trading on a restricted basis and (ii) it was therefore possible that a buyer could be found to continue operations, and (iii) it is a small emitter with negligible impact on overall cluster CO_2 emissions. See: https://www.arjowiggins.com/news/arjowiggins-uk-group-placed-into-administration/

3.4.1.10 Minerals

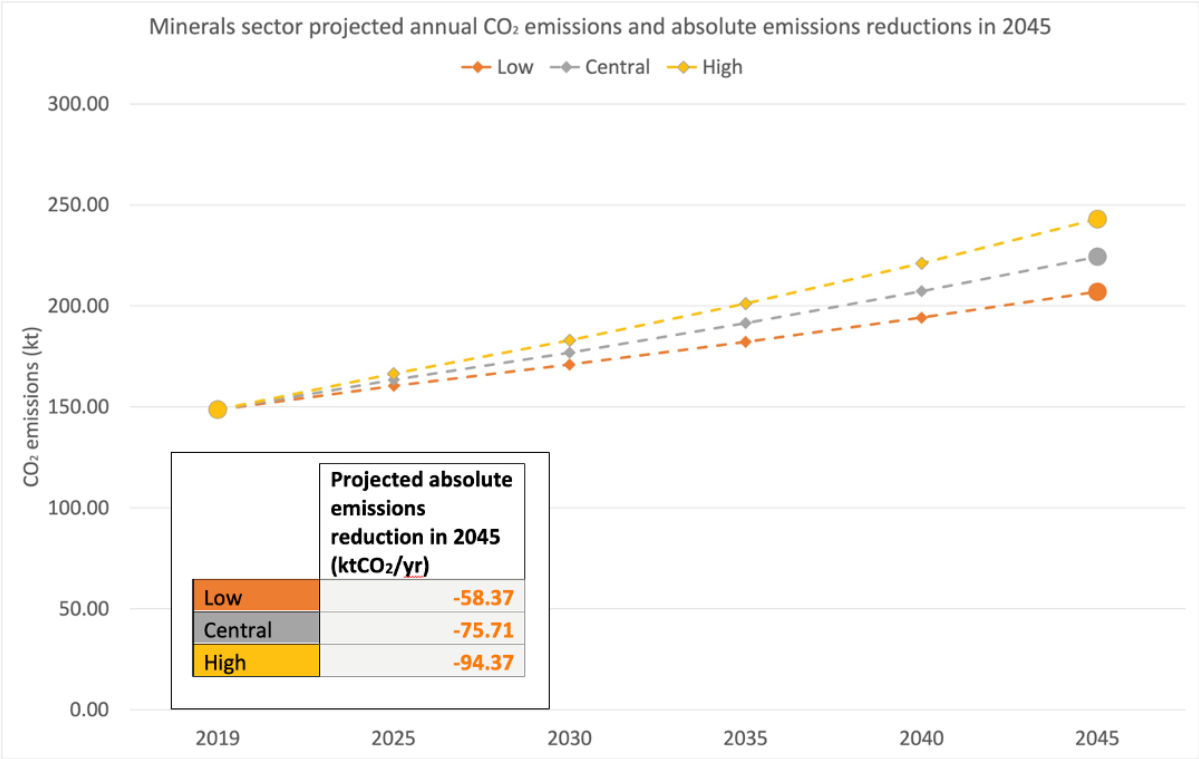


Figure 18: Minerals sector projected annual CO_2 emissions and projected absolute emissions reduction under BAU (low, central & high) scenarios 2019-2045

Minerals is one of two sectors to see a projected **increase** in annual emissions in 2045 across all three scenarios, ranging from 58-94kt. This is due primarily to a high positive assumed growth rate (approx. +3%), as the sector itself is comprised of only 1 site.

Site (2019 ranking)	2019 total annual release ($ktCO_2$)
O - I Manufacturing (19)	149
	149

Table 15: Sites within the Minerals sector

3.4.1.11 Waste

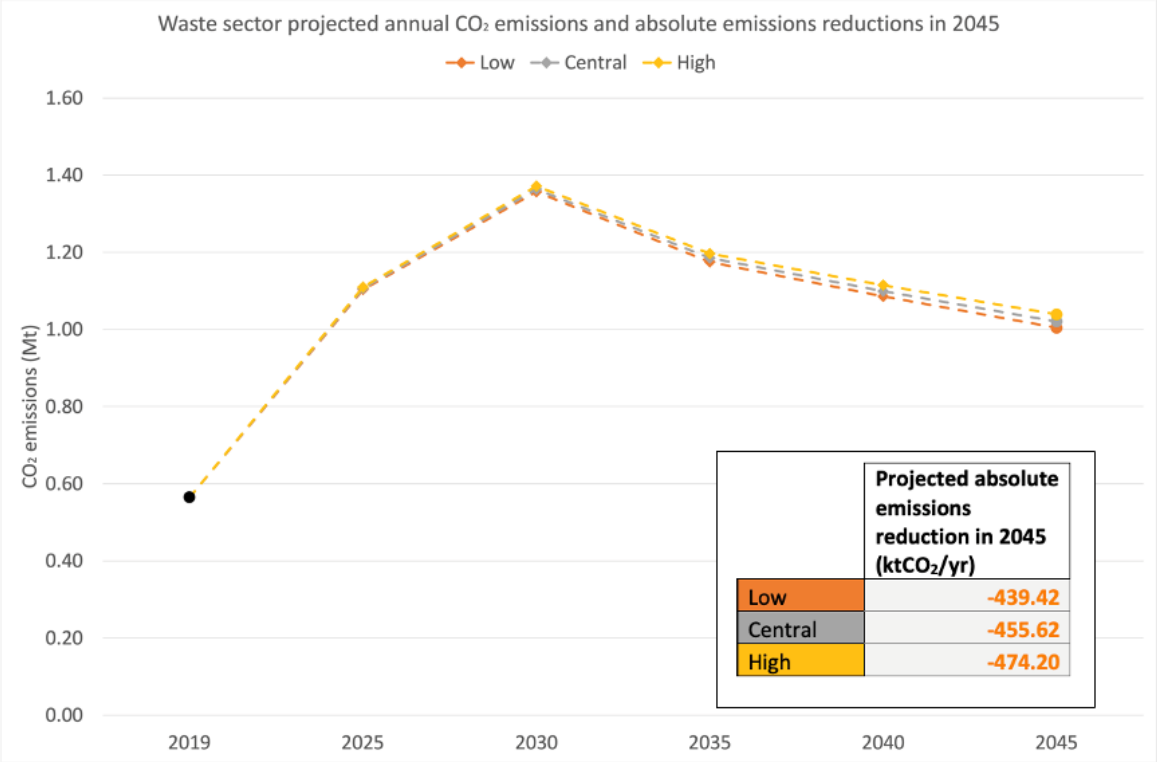


Figure 19: Waste sector projected annual CO_2 emissions and projected absolute emissions reduction under BAU (low, central & high) scenarios 2019-2045

Waste is the other sector to see a projected **increase** in annual emissions in 2045 across all three scenarios, ranging from 439-474kt (0.44-0.47Mt). This is due to the fact that it is a comparatively large sector in terms of absolute emissions with 4 new plants projected to come online in the mid-2020s, as discussed in section 3.3.3 above, and has a relatively low assumed growth rate across future scenarios (approx. -2%).

Site (2019 ranking)	2019 total annual release ($ktCO_2$)	Notes
Dunbar ERF (13)	274	
FCC Millerhill RERC (20)	132	
MVV Baldovie Incinerator (22)	102	Existing plant with a modelled end year of 2030
Energen Biogas (46)	29	
Edinburgh Sewage Treatment Works (50)	27	
MVV Baldovie EfW CHP (new)	-	New plant that became operational in 2022, with a modelled total annual release of 99$ktCO_2$
Levenseat Renewable Energy EfW ACT (CHP) Plant - Phase 1	-	New plant that became operational in 2020, with a modelled total annual release of 90$ktCO_2$
Earls Gate Energy Centre	-	New plant with a modelled operational start year of 2023 and a modelled total annual release of 194$ktCO_2$
Westfield Energy Recovery Facility	-	New plant with a modelled operational start year of 2025 and a modelled total annual release of 216$ktCO_2$
NESS Energy Project.	-	New plant with a modelled operational start year of 2023 and a modelled total annual release of 135$ktCO_2$
Drumgray ERC	-	New plant with a modelled operational start year of 2026 and a modelled total annual release of 270$ktCO_2$
	565	

Table 16: Sites within the Waste sector

3.4.2 Changes in sectoral emissions – overview

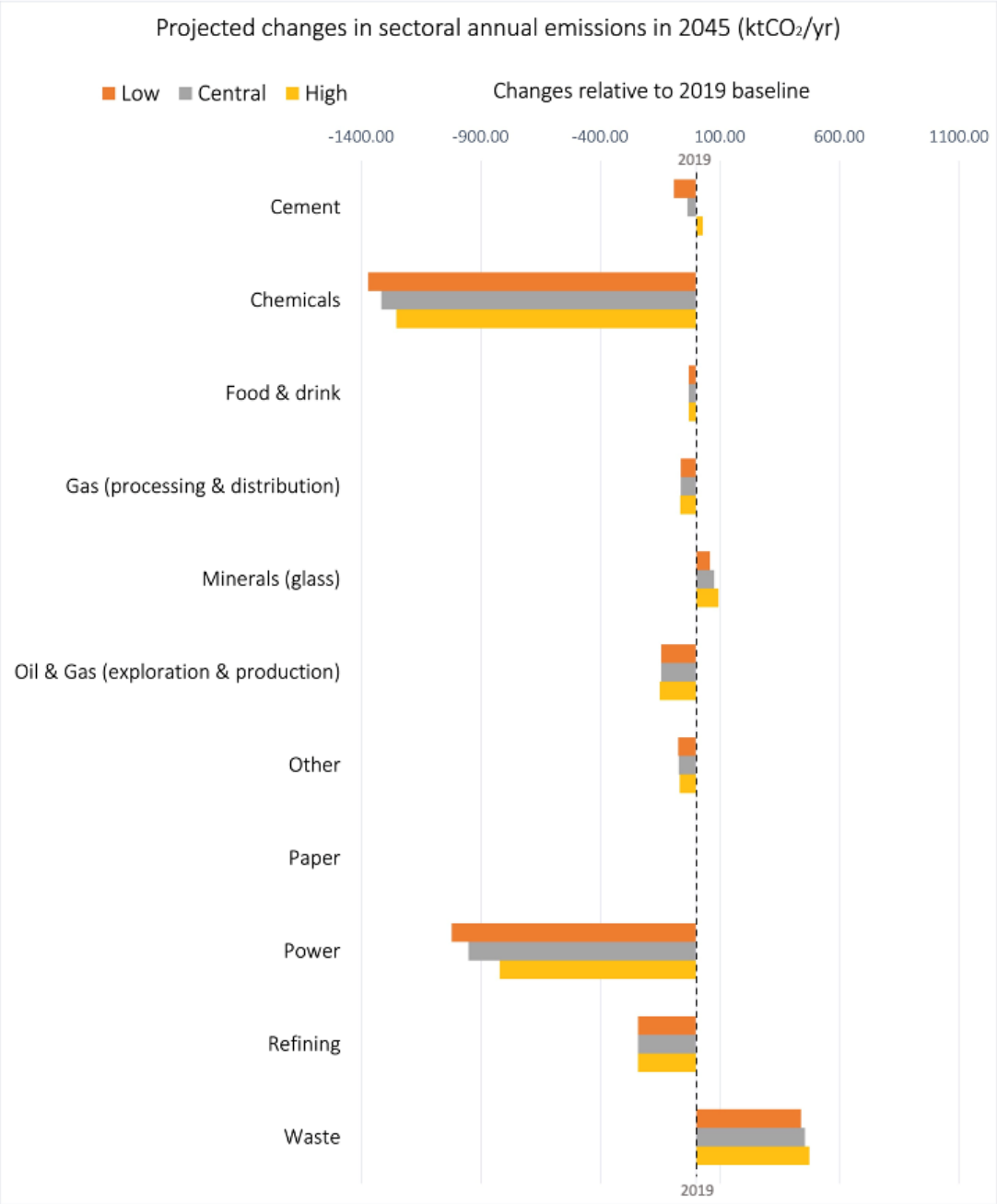


Figure 20: Projected changes in sectoral annual emissions in 2045, compared to 2019 baseline

There is considerable variation between sectors in how these projections assume they will evolve. In 2045, most of the sectors indicate a modest contribution to reducing annual emissions, while Minerals is projected to increase slightly, and Waste to increase moderately by around 0.5Mt (from a 565ktCO_2/yr 2019 baseline). Chemicals, Power and Refining combined represent the largest absolute emissions reduction potential of between 2.3-2.6MtCO_2 (from a 5.8Mt/yr 2019 baseline). This is negated, however, by the projected growth in the Waste sector, which reduces the total reduction potential for the cluster to between 2-2.6MtCO_2. This suggests that the Chemicals, Power, Refining and Waste sectors at least will have an important role to play in reaching net zero.

4 Conclusions and next steps

This report summarises the final results of Work Package 1 Task 1.1, which was focused on conducting a baseline analysis of the most recent (2019) industrial CO_2 emissions data and on developing illustrative future baseline emissions scenarios out to 2045, for the sites within the SNZR cluster boundary. Within the context of the SNZR project, this study is focused on the collection and presentation of publicly available data that is relevant to understanding the current and future emissions profiles in the cluster under business-as-usual (BAU) scenarios.

This report presents an overview of the SNZR cluster for the baseline start year of 2019, and incorporates the results of a second review of the status and impact of new and/or significant developments within the cluster boundary, either announced or projected to take place in the years between 2019 and the target year for net zero, 2045. These revised, final BAU baseline scenarios fed directly into the final iteration of the energy systems modelling outputs within Work Package 5.

The current baseline for the cluster, based on the most recent SPRI 2019 dataset, remains unchanged (from D1.1.1 Interim Report on Emissions Baselines) and can be summarised in the following key points.

- Scotland's total emissions within scope (%): **76%**
- Scotland's total emissions within scope (CO_2): **8.6Mt**
- Sites within scope: **28** (including most of top-25 largest emitters)
- Sectors within scope: **11**
- Local authority areas within scope: **14**
- 3 largest emitting sectors (CO_2): **Power** (25%, 2.2Mt), **Chemicals** (22%, 1.9Mt) and **Refining** (21%, 1.7Mt)
- Combustion / process emissions breakdown (%): combustion **86%** / process **14%**

The final illustrative future baseline scenario projections developed for the cluster, based on the BEIS EEP (Energy and Emissions Projections) 2019, can be summarised in the following key points.

- 3 illustrative - 'high', 'central' and 'low' - future baseline emissions scenarios to 2045
- Most granular classification from four different sets of scenario proposals
- Incorporate new, significant developments within the cluster between **2019**-**2045**
- Assume no deep decarbonisation otherwise within the cluster between **2019**-**2045**
- Provide a baseline against which potential decarbonisation pathways to 2045 could be assessed
- Projected total cluster emissions reductions relative to 2019: **2.0-2.6MtCO_2 (24-30%)**
- Substantial variation between sectors in terms of how they contribute to the projected total cluster emissions reduction across the 3 scenarios in 2045, relative to 2019
    - Largest emissions reduction: **Chemicals** (1.3-1.4Mt), contributing between 74-61% of the projected total cluster emission reduction in 2045
    - 2nd largest emissions reduction: **Power** (0.8-1Mt), contributing between 48-46% of the projected total cluster emission reduction in 2045
    - 3rd largest emissions reduction: **Refining** (243kt), contributing between 14-11% of the projected total cluster emission reduction in 2045
    - 4th largest emissions reduction: **Oil & gas** (152kt), contributing between 9-7% of the projected total cluster emission reduction in 2045
    - Largest emissions ***increase***: **Waste** (439-474kt), contributing between -23 and -17% of the projected total cluster emission reduction in 2045

- **Chemicals**, **Power** and **Refining** combined represent an absolute emissions reduction potential of **2.3-2.6MtCO$_2$ (27-31%)**, relative to 2019
- Projected ***growth*** in the **Waste** sector, however, ***reduces*** the projected total emissions reduction potential for the cluster by around 0.5Mt (17-23%) to between **2.0-2.6MtCO$_2$**.
- 'Low emissions' scenario still leaves an emissions gap to net zero for the cluster of **6.1MtCO$_2$ (70%)**, relative to 2019

This analysis overall points to an important role for the Chemicals, Power, Refining and Waste sectors within the SNZR project, and by extension Scotland's journey towards Net Zero.

5 Appendix

5.1 Appendix A: SNZR 28 sites and sector mapping

Table 17 summarises the 28 sites within the SNZR cluster boundary in terms of total emissions, local authority and the sector mapping exercise.

	Company/Site	Total release ($ktCO_2$)	Local Authority	SPRI sector classification	NAEI sector classification	IPCC sector category classification
1	SSE Generation Limited (Peterhead)	1,579	Aberdeenshire	Energy	Major power producers	1A1a: Public Electricity and Heat Production
2	Petroineos Manufacturing Scotland Limited	1,343	Falkirk	Energy	Processing & distribution of petroleum products	1A1b: Petroleum Refining
3	ExxonMobil Chemical Ltd	680	Fife	Energy	Chemical industry	1A2c: Chemicals 2B: Chemical Industry
4	Grangemouth CHP Ltd	641	Falkirk	Energy	Chemical industry	1A2c: Chemicals
5	Tarmac Cement & Lime Limited	559	East Lothian	Mineral industry	Cement	1A2f: Non-metallic minerals 2A1: Cement Production

	Company/Site	Total release ($ktCO_2$)	Local Authority	SPRI sector classification	NAEI sector classification	IPCC sector category classification
6	INEOS Chemicals Grangemouth Limited	522	Falkirk	Chemical industry	1A2c: Chemicals	Chemical industry 2B: Chemical Industry
7	RWE Markinch Limited	487	Fife	Waste and waste-water management	Major power producers	1A1a: Public Electricity and Heat Production
8	Ineos Infrastructure (Grangemouth) Limited	429	Falkirk	Energy	Processing & distribution of petroleum products	1A1b: Petroleum Refining
9	Ineos FPS Limited (Kinneil Terminal)	345	Falkirk	Energy	Oil & gas exploration and production	1A1c: Manufacture of Solid Fuels and Other Energy Industries
10	Shell UK Limited (St Fergus)	303	Aberdeenshire	Energy	Oil & gas exploration and production	1A1c: Manufacture of Solid Fuels and Other Energy Industries
11	Viridor Waste Management Ltd. Dunbar ERF	274	East Lothian	Waste and waste-water management	Waste collection, treatment & disposal	1A2g: Other
12	Shell UK Limited. Fife NGL Plant Cowdenbeath	250	Fife	Energy	Processing & distribution of natural gas	1A1c: Manufacture of Solid Fuels and Other Energy Industries

	Company/Site	Total release ($ktCO_2$)	Local Authority	SPRI sector classification	NAEI sector classification	IPCC sector category classification
13	Norbord Europe Limited (Cowie)	210	Stirling	Paper and wood production and processing	Other industries	1A2g: Other
14	O - I Manufacturing UK Ltd	149	Clackmannanshire	Mineral industry	Other mineral industries	1A2f: Non-metallic minerals 2A3: Glass Production
15	FCC Waste Services (UK) Limited. Millerhill RERC	132	Midlothian	Waste and waste-water management	Waste collection, treatment & disposal	1A2g: Other
16	MVV Environmental Baldovie Ltd	102	Dundee City	Waste and waste-water management	Waste collection, treatment & disposal	1A2g: Other
17	Wood Group UK Limited. Sage Gas Terminal	94	Aberdeenshire	Energy	Oil & gas exploration and production	1A1c: Manufacture of Solid Fuels and Other Energy Industries
18	EPR Scotland Limited. Westfield Biomass Plant Fife	86	Fife	Waste and waste-water management	Major power producers	1A1a: Public Electricity and Heat Production

	Company/Site	Total release ($ktCO_2$)	Local Authority	SPRI sector classification	NAEI sector classification	IPCC sector category classification
19	Diageo Distilling Limited. Cameronbridge Distillery	68	Fife	Animal and vegetable products	Food, drink & tobacco industry	1A2e: Food Processing, Beverages and Tobacco
20	Versalis UK Limited	58	Falkirk	Chemical Industry	Chemical industry	1A2c: Chemicals 2B: Chemical Industry
21	Arjowiggins Scotland Limited	58	Aberdeen City	Paper and wood production and processing	Paper, printing & publishing industries	1A2d: Pulp, Paper and Print
22	PX Limited. St Fergus Gas Terminal	52	Aberdeenshire	Energy	Oil & gas exploration and production	1A1c: Manufacture of Solid Fuels and Other Energy Industries
23	National Grid Gas Plc. Bathgate Compressor Station (Site 2)	41	West Lothian	Energy	Processing & distribution of natural gas	1A1c: Manufacture of Solid Fuels and Other Energy Industries
24	The North British Distillery Company Limited	35	City of Edinburgh	Animal and vegetable products	Food, drink & tobacco industry	1A2e: Food Processing, Beverages and Tobacco
25	Energen Biogas Limited	29	North Lanarkshire	Waste and waste-water management	Waste collection, treatment & disposal	1A4a: Commercial/Institutional

	Company/Site	Total release ($ktCO_2$)	Local Authority	SPRI sector classification	NAEI sector classification	IPCC sector category classification
26	Veolia Water Outsourcing Limited. Edinburgh Sewage Treatment Works	27	City of Edinburgh	Waste and waste-water management	Water & sewerage	5D: Wastewater treatment and discharge
27	National Grid Gas Plc. Aberdeen Compressor Station	27	Aberdeenshire	Energy	Processing & distribution of natural gas	1A1c: Manufacture of Solid Fuels and Other Energy Industries
28	National Grid Gas Plc. North Sea Gas Terminal	26	Aberdeenshire	Energy	Processing & distribution of natural gas	1A1c: Manufacture of Solid Fuels and Other Energy Industries

Table 17: Summary of the 28 sites within the SNZR cluster boundary including sector mapping overview by site

5.2 Appendix B: CAGRs applied to IPCC sector categories

Table 18 summarises the Compound Annual Growth Rates (CAGR) that were established for each IPCC sector category, based on a start year of 2019 and end year of 2040. The BEIS EEP 2019 dataset only makes projections up to 2040; emissions projections for the period 2040-2045 were calculated using a CAGR based on the projections for 2035-2040 and combined to give an overall CAGR for each category for the full 26-year period 2019-2045.

BEIS IPCC category	Sub-sector short name	'Low emissions'	'Central'	'High emissions'
1A1a: Public Electricity and Heat Production	Power	-2.8%	-2.5%	-2.0%
1A1b: Petroleum Refining	Refining	0.0%	0.0%	0.0%
1A1c: Manufacture of Solid Fuels and Other Energy Industries	Other energy industries	-0.8%	-0.8%	-0.8%
1A2c: Chemicals	Chemicals	-5.5%	-5.1%	-4.6%
1A2d: Pulp, Paper and Print	Pulp and paper	-0.1%	-0.1%	0.0%
1A2e: Food Processing, Beverages and Tobacco	Food and drink	-1.4%	-1.4%	-1.3%
1A2f: Non-metallic minerals	Minerals	1.3%	1.6%	2.0%
1A2g: Other	Other	-1.7%	-1.6%	-1.5%
1A4a: Commercial/Institutional	Other energy	0.3%	0.5%	0.7%
2A1: Cement Production	Cement	-2.4%	-1.8%	-1.2%
5D: Wastewater treatment and discharge	Wastewater	0.0%	0.0%	0.0%
1A1: Energy Industries	Energy Industries	-1.7%	-1.5%	-1.3%
1A2: Manufacturing Industries and Construction	Manufacturing	-1.0%	-0.9%	-0.8%
1A4: Other Sectors	Other Sectors	0.7%	0.7%	0.7%

2: Industrial Processes	Industrial Processes	-1.0%	-0.8%	-0.5%
2A: Mineral Industry	Minerals	-1.8%	-1.3%	-0.7%
2A3: Glass Production	Glass	1.1%	1.4%	1.7%
2B: Chemical Industry	Chemicals	-0.3%	-0.2%	-0.1%
5: Waste management	Waste	0.0%	0.0%	0.0%
1B2a: Oil	Refining	0.0%	0.0%	0.0%

Table 18: CAGRs applied to each IPCC sector category used

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