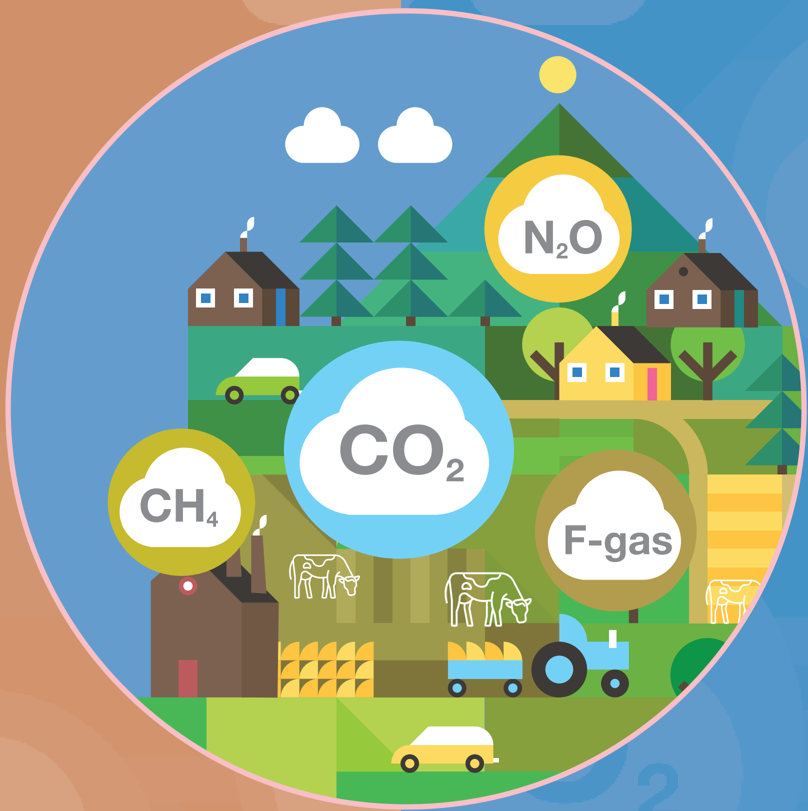
Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

Quarterly Greenhouse Gas Emissions Indicator Report

2024 Quarter 2

December 2024



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An Ghníomhaireacht um Chaomhnú Comhshaoil

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1 Key Findings

Please note that all quoted figures in Key Findings are comparing emissions the end of Quarter 2 2024 with emissions at the end of Quarter 2 2023 unless otherwise indicated.

Quarterly figures are more susceptible to volatility and seasonality, particularly in the case of comparison to the previous quarter. In addition, these data have been seasonally adjusted to provide a clearer picture of underlying trends by eliminating the noise caused by seasonal fluctuations.

An increase or decrease in quarterly emissions does not indicate an overall yearly change in the same direction.

- In Quarter 2 2024 overall greenhouse gas emissions decreased by -4.1% (-582.6 kt CO_2 eq) compared to Quarter 2 2023.
- The largest sectoral decreases in emissions were observed in the Electricity (-19.1%, -375.3 kt CO_2 eq) and Agriculture (-4.6%, 243.9 kt CO_2 eq) sectors.
- Significant decreases were also observed in the Industry sector with emissions falling by -9.4% (-148.7 kt CO_2 eq) and the Transport sector (-2.9%, -84.7 kt CO_2 eq).
- The largest increase in emissions this quarter was observed in the Residential Buildings sub sector at +16.7% (+278.3 kt CO_2 eq). There were 14% more heating degree days (HDD: days below 15.5 degrees Celsius where heating would be needed) in Q2 2024 compared to Q2 2023.

Table 1: Key Findings

Sector	Key Finding
GHG Emissions Q2 2023 to Q2 2024	Overall emissions decreased by -4.1% (-583 kt CO_2 eq), driven mainly by reductions in emissions from electricity generation (-19.1%), agriculture (-4.6%) and industrial processes (-9.4%).
Agriculture	Emissions were reduced by -4.6% driven by reductions in the national herd (-1.9%), milk production (-4.4%), and inorganic nitrogen fertiliser and limestone sales (-13.6% and -23.0% respectively).
Transport	The key driver for the -2.9% decrease in transport emissions was decreased sales of diesel (-4.6%) compared to the same quarter last year and an increase in the fraction by volume of biofuel in petrol from 7.1% to 9.1% underpinned by changes to European legislation and national policy.
Electricity	Electricity generation emissions decreased by -19.1% (-376 kt CO_2 eq) due to the amount of net imported electricity in increasing from 10.9% to 18.1% of electricity supply, in combination with reductions in coal and gas use, and increases in renewables.
Buildings	**(Commercial and Public)** Emissions were relatively flat at -0.5% (-2 kt CO_2 eq) due to little change in the heating demand from commercial and public buildings.
	(Residential) Emissions were up +16.7% (+278 kt CO_2 eq) due to increased energy demand for home heating due to 14.5% more heating degree days in combination with a drop in gas prices of 12.9% compared to the same quarter last year.

Sector	Key Finding
Industry	Industry emissions were down -9.4% (-149 kt CO_2 eq), driven mainly by reductions in both process and combustion emissions from cement production.
Other	Emissions from Other sectors decreased by -1.7% (-6.5 kt CO_2 eq) with increases in emissions from landfilled waste (+18.8%, +27 kt CO_2 eq) offset by decreases from gas and liquid fuel combustion in Petroleum Refining (-43.1%, -33 kt CO_2 eq).
GHG Emissions Q1 2024 to Q2 2024	Overall greenhouse gas emissions increased by +0.5% (+62 kt CO_2 eq) driven mainly by increases in the Agriculture sector impacted by adverse weather conditions.
GHG Emissions H1 2023 to H1 2024	Comparing the first half of 2024 with 2023, emissions have decreased by 3.4% (964 kt CO_2 eq) largely due to reductions in the electricity (-16.6%, -634 kt CO_2 eq) and Agriculture (-4.6%, -503.4 kt CO_2 eq) sectors.

Table 2 summarises the year-on-year changes for 2024 Quarter 2 compared to 2023 Quarter 2, and also the quarter-on-quarter changes for 2024 Quarter 2 compared to 2024 Quarter 1.

Table 2: Key Findings

Sector	Emissions Q2 2024 (kt CO_2 eq)	Comparisons with Q2 2023 (%)	Comparison with Q1 2024 (%)
Overall	**13,557.2**	**-4.1**	**0.5**
Agriculture	5,041.6	-4.6	5.2
Buildings (Commercial and Public)	342.7	-0.5	-6.1
Buildings (Residential)	1,943.5	16.7	-0.8
Electricity	1,588.7	-19.1	-1.3
Industry	1,429.2	-9.4	1.3
Other	368.7	-1.7	-4.7
Transport	2,842.9	-2.9	-4.4

2 2024 Quarter 2 Summary

This section presents the key high-level emissions estimates for Quarter 2 2024, followed by further sectoral analysis in Section 3.

Figure 1: Overall quarterly movement in greenhouse gas emissions for all sectors from Q1 2018 to Q2 2024

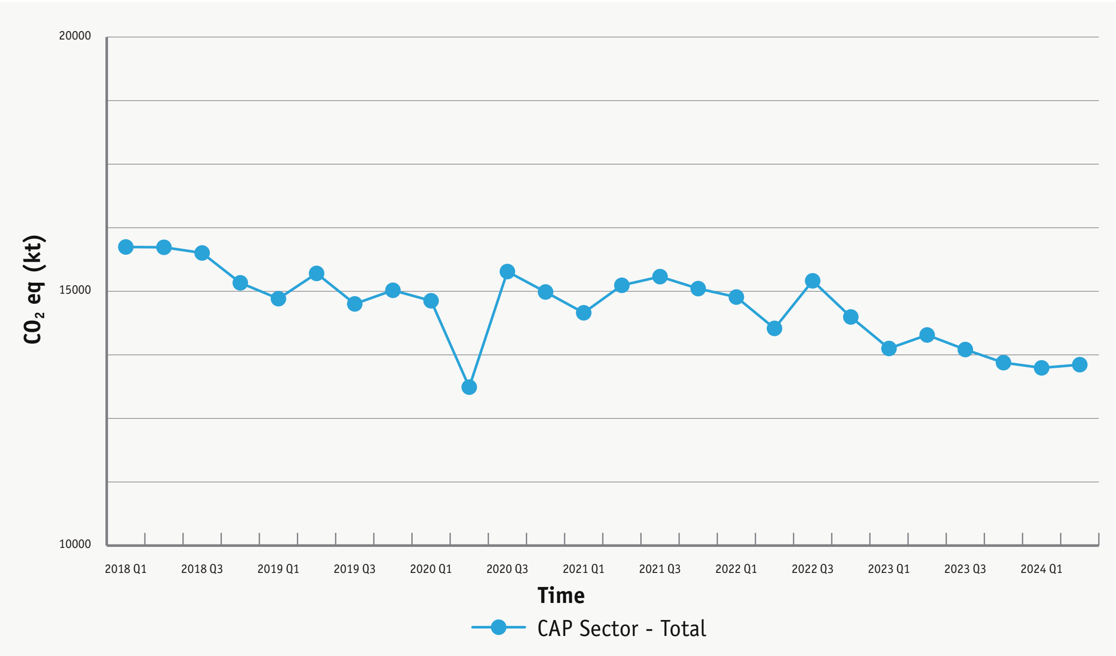
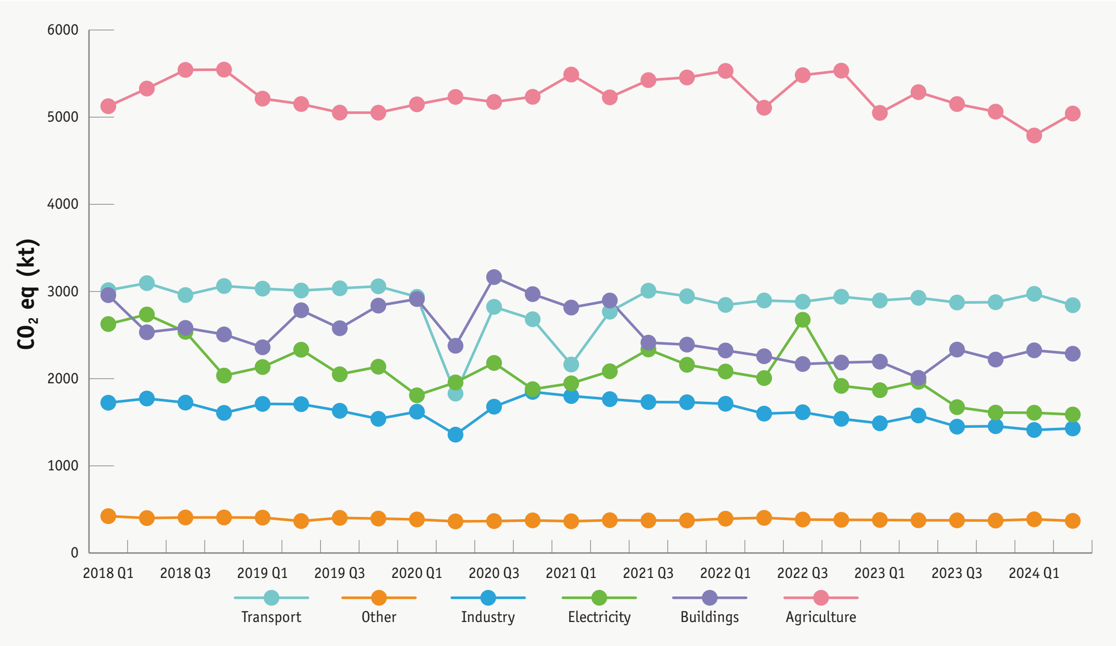


Figure 1 shows that from a high in Q2 2018 overall emissions are on a downward trend with marked drop in emissions during the Covid-19 pandemic lockdown in Q2 2020.

Similarly, Figure 2 summarises emissions per Climate Action Plan-aligned sector. Since 2018, the broadly consistent trend in emissions reductions can be seen in the Buildings and Electricity sectors. The only major change was in Q2 2020 and Q2 2021 during the Covid-19 pandemic lock downs, with marked reductions in transport emissions. Agriculture remains the largest source of emissions throughout this period and the 'Other' sector (waste, petroleum refining and fluorinated gases) the smallest source.

Figure 2: Overall quarterly movement in greenhouse gas emissions for all Sectors from Q1 2018 to Q2 2024



2.1 Year-on-Year Change

In this section we look at the emissions for Quarter 2 2024 and compare them to Quarter 2 2023. We will also provide cumulative emissions for the first half of 2024 (Quarters 1 and 2) in comparison to the first half of 2023.

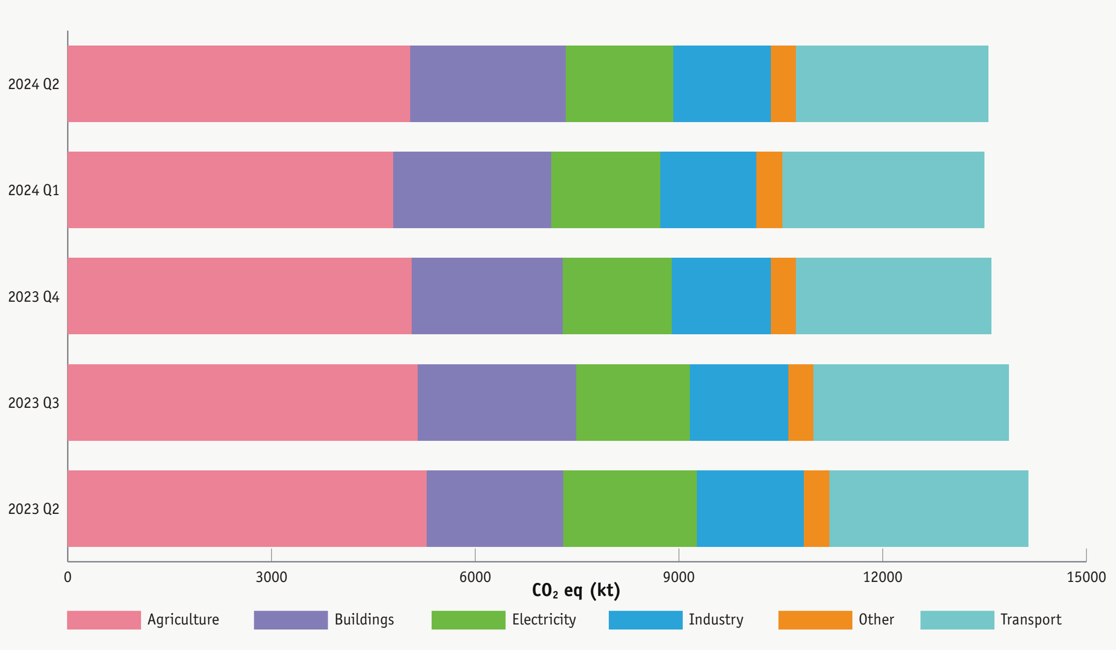
Looking at Quarter 2 2024 compared to Quarter 2 2023:

- Overall greenhouse gas emissions decreased by -4.1% (-582.6 kt CO_2 eq).
- The largest sectoral decreases in emissions were observed in the Electricity (-19.1%, -375.5 kt CO_2 eq) and Industry (-9.4%, -148.7 kt CO_2 eq) sectors.
- Significant decreases were also observed in the Agriculture sector with emissions falling by -4.6% (-243.9 kt CO_2 eq) and the Transport sector (-2.9%, -84.7 kt CO_2 eq).
- The largest increase in emissions this quarter was observed in the Residential Buildings sub sector at +16.7% (+278.3 kt CO_2 eq).

Table 3: Summary Q2 2024 compared to Q2 2023

Sector	Emissions Q2 2024 (kt CO_2 eq)	Comparisons with Q2 2023 (kt CO_2 eq)	Comparisons with Q2 2023 (%)
Overall	**13,557.2**	**-582.6**	**-4.1**
Agriculture	5,041.6	-243.9	-4.6
Buildings (Commercial and Public)	342.7	-1.6	-0.5
Buildings (Residential)	1,943.5	278.3	16.7
Electricity	1,588.7	-375.5	-19.1
Industry	1,429.2	-148.7	-9.4
Other	368.7	-6.5	-1.7
Transport	2,842.9	-84.7	-2.9

Figure 3: Overall quarterly movement in greenhouse gas emissions for all Sectors from Q2 2023 to Q2 2024



2.2 Year-to-Date Change

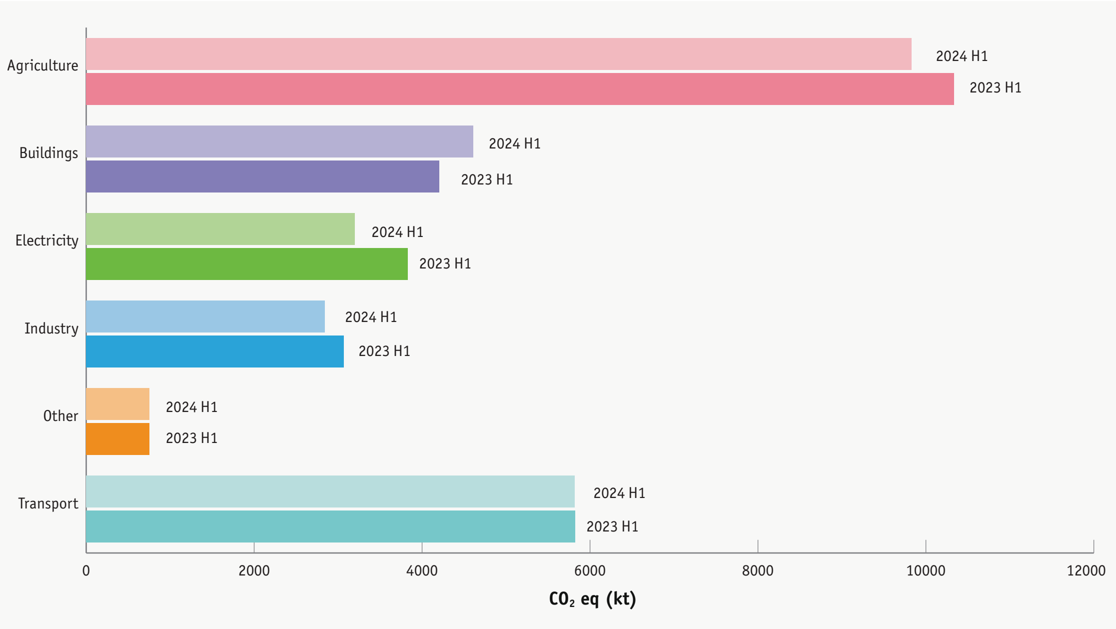
Comparing emissions in the first half of 2024 with the first half of 2023:

- Overall greenhouse gas emissions decreased by -3.5% (-987.2 kt CO_2 eq).
- The largest sectoral decrease in emissions was observed in the Electricity (-16.6%, -634.2 kt CO_2 eq) and Agriculture (-4.6%, -503.4 kt CO_2 eq).
- The largest increase in emissions this half was observed in the Residential Buildings sub sector at +11.2% (+394.2 kt CO_2 eq).

Table 4: Summary H1 2024 compared to H1 2023

Sector	Emissions H1 2024 (kt CO_2 eq)	Comparisons with H1 2023 (kt CO_2 eq)	Comparisons with H1 2023 (%)
Overall	**27,052.5**	**-964.0**	**-3.4**
Agriculture	9,831.9	-503.4	-4.6
Buildings (Commercial and Public)	707.7	12.6	1.8
Buildings (Residential)	3,903.6	394.2	11.2
Electricity	3,197.6	-634.2	-16.6
Industry	2,840.4	-225.3	-7.3
Other	755.5	1.0	0.1
Transport	5,815.8	-8.8	-0.2

Figure 4: Comparing H1 2024 to H1 2023 by sector



2.3 Quarter-on-Quarter Change

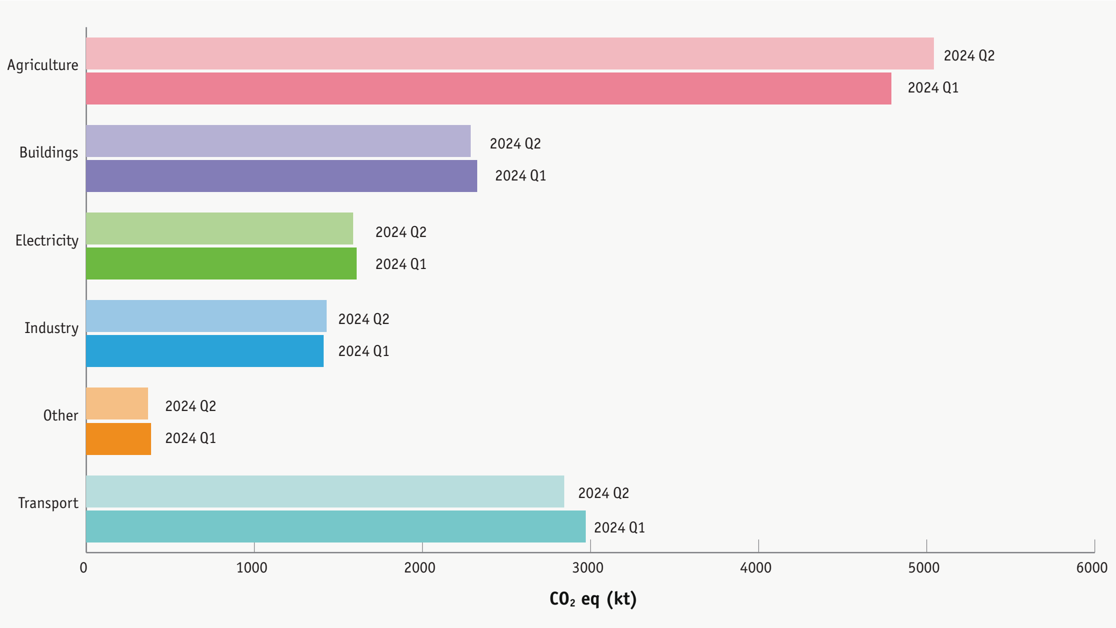
Looking at Quarter 2 2024 compared to Quarter 1 2024:

- The overall greenhouse gas emissions increased by +0.5% (+62.0 kt CO_2 eq).
- The largest sectoral increase in emissions was observed in the Agriculture (+5.2%, +230.0 kt CO_2 eq). This was largely due to adverse weather and ground conditions in the first quarter resulting in delayed fertiliser application.
- Significant decreases were observed in the Transport (-4.4%, -129.9 kt CO_2 eq) and Buildings (Commercial and Public) (-6.1%, -22.4 kt CO_2 eq) sectors.

Table 5: Summary Q2 2024 compared to Q1 2024

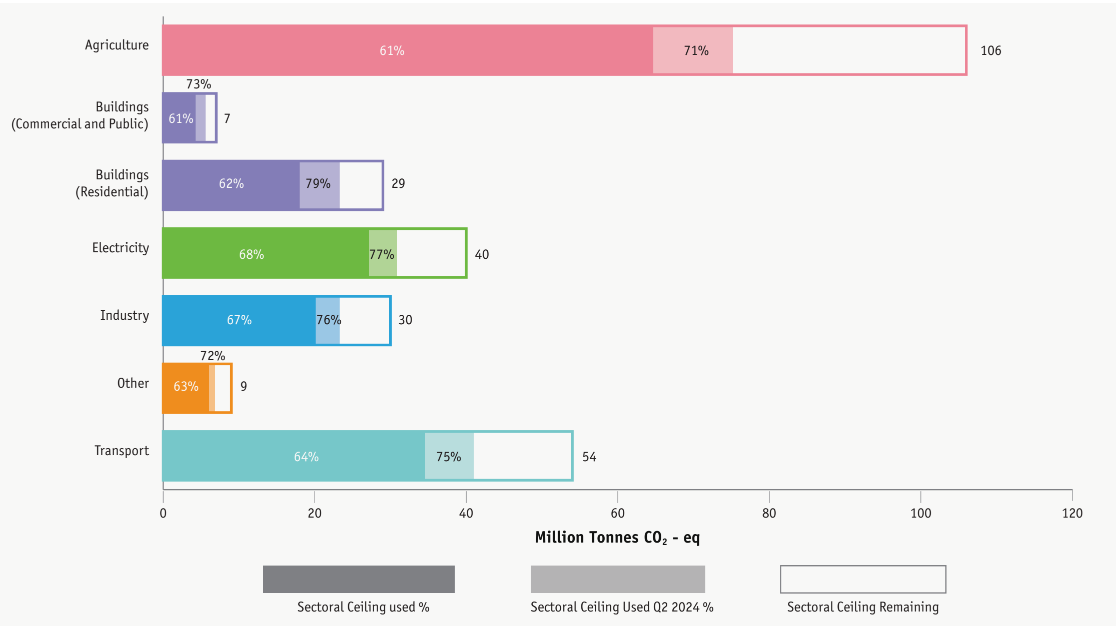
Sector	Emissions Q2 2024 (kt CO_2 eq)	Comparisons with Q1 2024 (kt CO_2 eq)	Comparisons with Q1 2024 (%)
Overall	**13,557.2**	**62.0**	**0.5**
Agriculture	5,041.6	251.3	5.2
Buildings (Commercial and Public)	342.7	-22.4	-6.1
Buildings (Residential)	1,943.5	-16.5	-0.8
Electricity	1,588.7	-20.3	-1.3
Industry	1,429.2	17.9	1.3
Other	368.7	-18.1	-4.7
Transport	2,842.9	-129.9	-4.4

Figure 5: Comparing Q2 2024 to Q1 2024 by sector



With regards to Sectoral Emissions Ceilings, looking specifically at the first Carbon Budget period of 2021-2025, Figure 6 shows the emissions used and the remaining CAP emissions until the ceiling is reached. The amount of sectoral budget used ranges from 71% in the Agriculture Sector to 79% in the buildings (residential) sector. The largest percentage increase of emissions of 17% was within Residential buildings; it should be noted that two of the six months in this half are meteorological winter, and the first half of 2024 had 7% more days below 15.5 degrees Celsius (Heating Degree Days) than 2023.

Figure 6: Summary of Sectoral Ceiling Emissions Used across 2021, 2022 and 2023 (darker colours), Emissions Used in up to Q2 2024 (tinted colours) and the Sectoral Ceiling Emissions Remaining (outline)



3 Sectoral Summaries

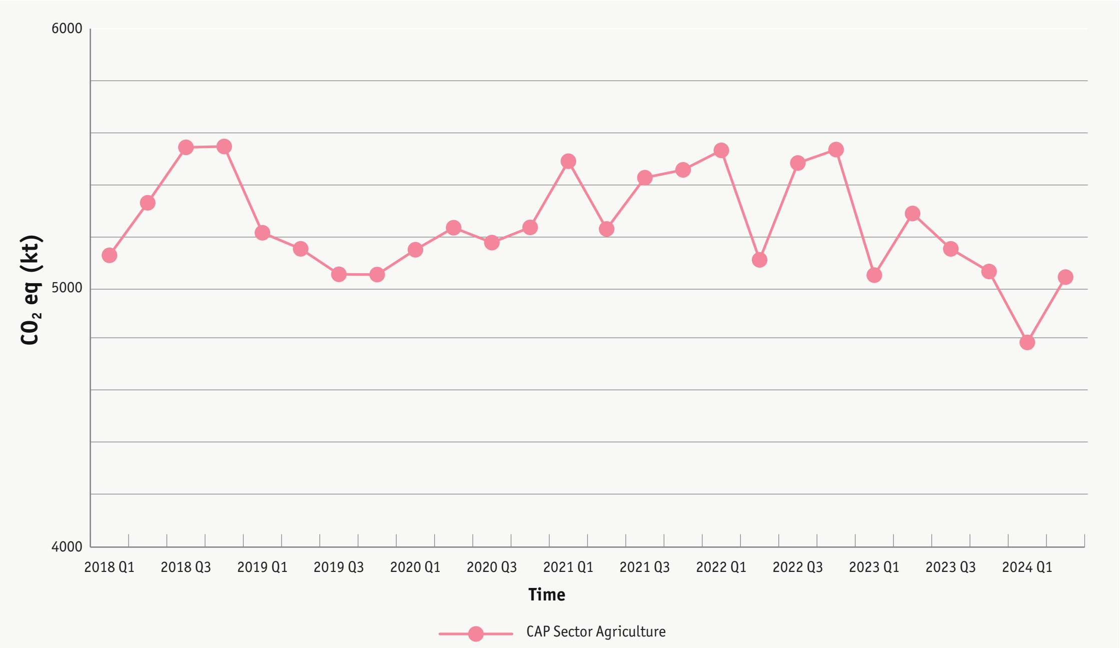
3.1 Agriculture

Subsectors: Agricultural soils, Agriculture/Forestry fuel combustion, Enteric fermentation, Fishing fuel combustion, Liming, Manure management, Urea application

Number of indicator Categories: 18

Estimated total coverage of quarterly indicator categories compared to original annual National Inventory Report: 97.0%

Figure 7: Changes in emissions in the Agriculture Sector from Q1 2018 to Q2 2024, based on seasonally adjusted data



3.1.1 Agriculture Year-on-Year Change

Key finding:

- The most significant drivers for the -4.6% decrease in emissions this quarter were a 1.9% reduction in the national herd (-1.2% dairy cows, -2.1% other cattle) and reduced inorganic Nitrogen fertiliser use (-13.6%) compared to the Quarter 2 2023.

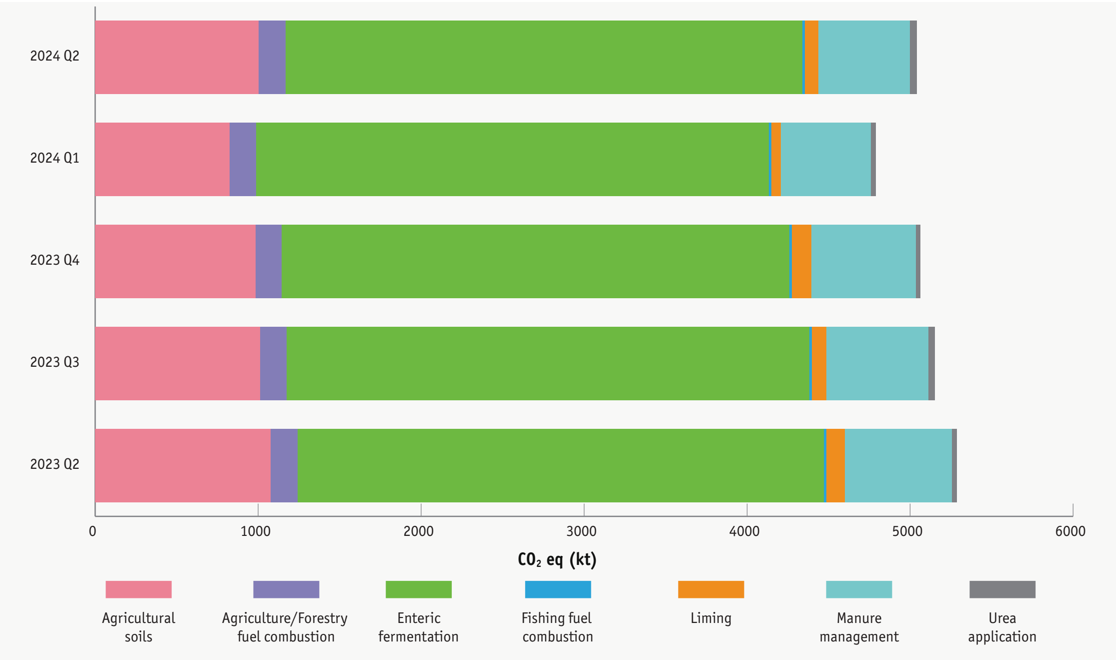
Looking at Quarter 2 2024 compared to Quarter 2 2023

- Agriculture greenhouse gas emissions decreased by -4.6% (-243.9 kt CO_2 eq) compared to the same quarter last year.
- The largest sectoral decreases in emissions were observed in Manure Management (-14.1%, -92.2 kt CO_2 eq), Agricultural soils (-6.8%, -73.3 kt CO_2 eq), and Enteric fermentation (-1.9%, 60.7 kt CO_2 eq).
- Reductions in emissions were driven by decreased cattle numbers (-1.9%), inorganic Nitrogen fertiliser use (-13.6%), milk production (-4.4%), and limestone sales (-23.0%).

Table 6: Summary Q2 2024 compared to Q2 2023 - Agriculture

Sector	Greenhouse Gas	Emissions Q2 2024 (kt CO_2 eq)	Comparisons with Q2 2023 (kt CO_2 eq)	Comparisons with Q2 2023 (%)
Agriculture	**CH_4, CO_2, N_2O**	**5,041.6**	**-243.9**	**-4.6**
Agricultural soils	N_2O	1,002.9	-73.3	-6.8
Agriculture/Forestry fuel combustion	CO_2	165.0	0.5	0.3
Enteric fermentation	CH_4	3,170.3	-60.7	-1.9
Fishing fuel combustion	CO_2	15.1	0.1	0.4
Liming	CO_2	82.6	-29.4	-26.2
Manure management	CH_4, N_2O	562.2	-92.2	-14.1
Urea application	CO_2	43.4	11.1	34.5

Figure 8: Comparison of sub-sectoral breakdown in emissions for this quarter vs last four quarters, based on seasonally adjusted data



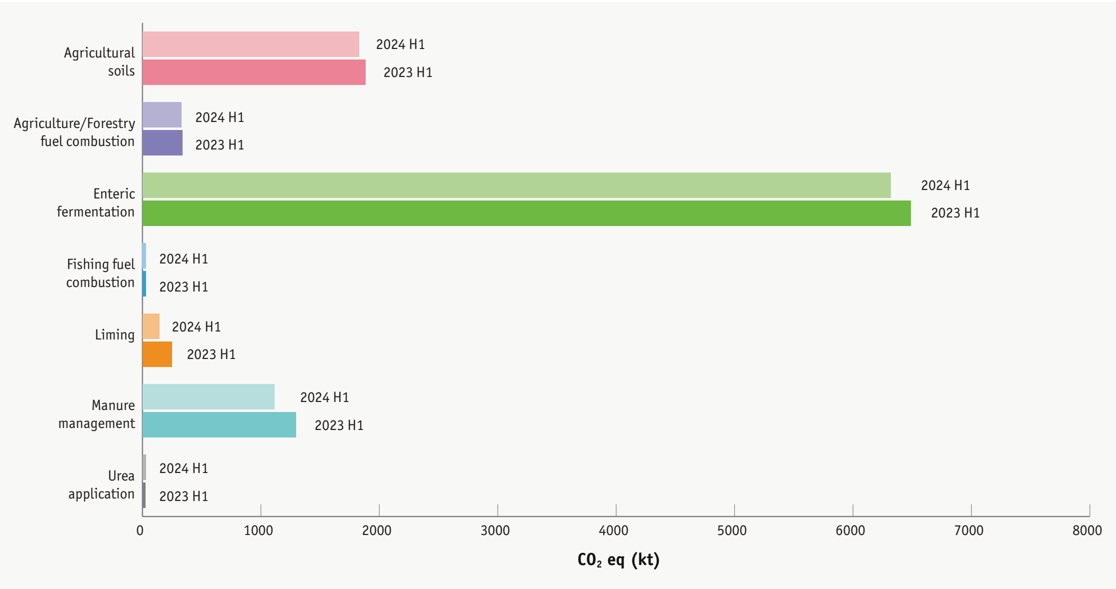
Looking at the first half of 2024 compared to the first half of 2023:

- Overall agriculture greenhouse gas emissions decreased by -4.9% (-503.4 kt CO_2 eq).
- The largest sub-sectoral decrease in agriculture emissions was observed in manure management (-14.0%, -181.8 kt CO_2 eq).
- There were also decreases in emissions from Enteric Fermentation (-2.6%, -169.9 kt CO_2 eq) and liming (-42.6%, -104.9 kt CO_2 eq).

Table 7: Summary H1 2024 compared to H1 2023 - Agriculture

Sector	Emissions H1 2024 (kt CO_2 eq)	Comparisons with H1 2023 (kt CO_2 eq)	Comparisons with H1 2023 (%)
Agriculture	**9,831.9**	**-503.4**	**-4.9**
Agricultural soils	1,826.4	-56.9	-3.0
Agriculture/Forestry fuel combustion	327.6	-9.4	-2.8
Enteric fermentation	6,317.3	-169.9	-2.6
Fishing fuel combustion	30.3	0.9	2.9
Liming	141.5	-104.9	-42.6
Manure management	1,112.5	-181.8	-14.0
Urea application	76.1	18.7	32.6

Figure 9: Emissions in Agricultural subsectors in H1 2024 and H1 2023



3.1.2 Agriculture Quarter-on-Quarter Change

Key finding:

- The most significant driver for the +5.2% increase in emissions this quarter was increased fertiliser use (+106%) to agricultural soils. Quarter 1 was affected by adverse weather and ground conditions which may have resulted in delays to the application of fertiliser until the second quarter.

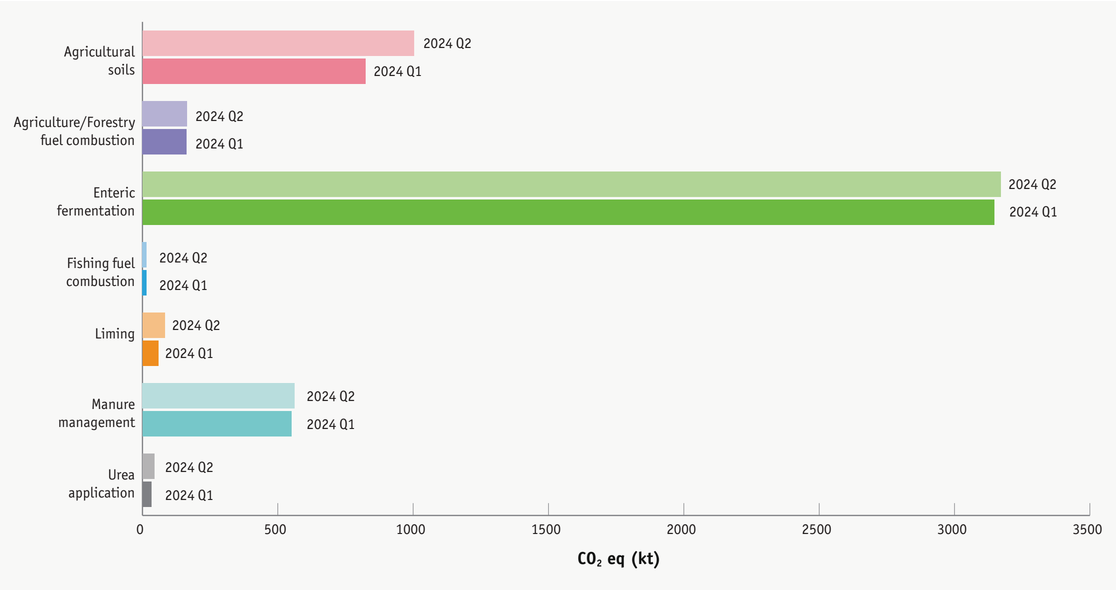
Looking at Quarter 2 2024 compared to Quarter 1 2024

- Agriculture greenhouse gas emissions increased by +5.2% (+251.3 kt CO_2 eq) compared to the previous quarter (2024 Quarter 1) on a seasonally-adjusted basis.
- The increase was mainly driven by increased inorganic nitrogen fertiliser sales (+106%) following the unseasonably poor weather and ground conditions in the first quarter of the year which may have delayed application. However, emissions were still down year over year.

Table 8: Table 8 Summary Q2 2024 compared to Q1 2024 - Agriculture

Sector	Greenhouse Gas	Emissions Q2 2024 (kt CO_2 eq)	Comparisons with Q1 2024 (kt CO_2 eq)	Comparisons with Q1 2024 (%)
Agriculture	**CH_4, CO_2, N_2O**	**5,041.6**	**251.3**	**5.2**
Agricultural soils	N_2O	1,002.9	179.4	21.8
Agriculture/Forestry fuel combustion	CO_2	165.0	2.3	1.4
Enteric fermentation	CH_4	3,170.3	23.3	0.7
Fishing fuel combustion	CO_2	15.1	-0.1	-1.0
Liming	CO_2	82.6	23.6	40.1
Manure management	CH_4, N_2O	562.2	11.9	2.2
Urea application	CO_2	43.4	10.7	32.8

Figure 10: Changes in emissions in the Agriculture Subsectors from Q1 2024 to Q2 2024, based on seasonally adjusted data



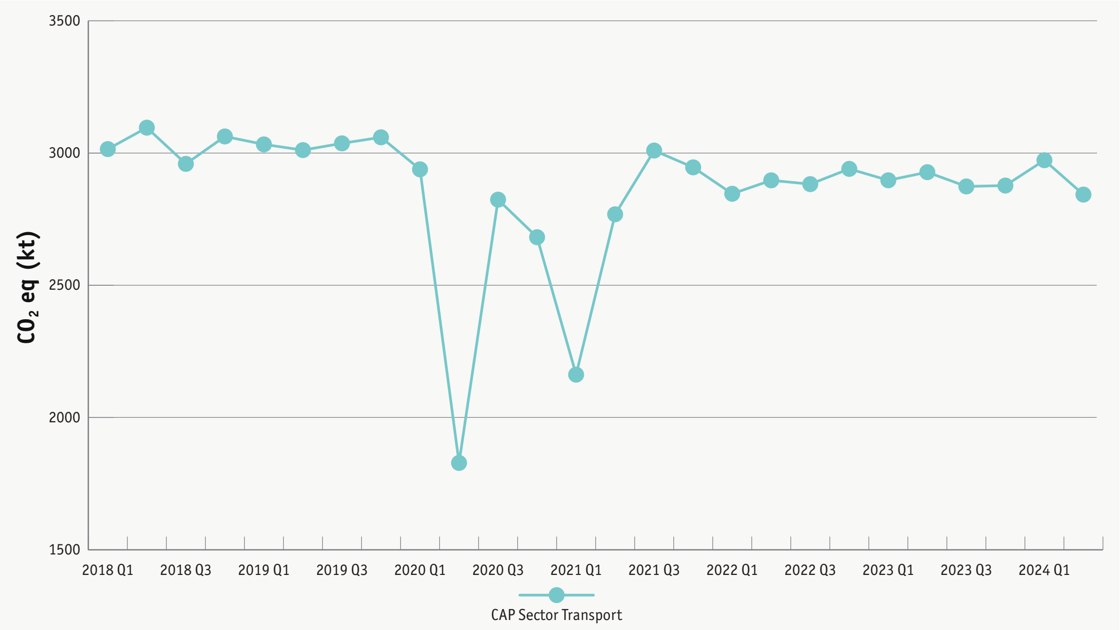
3.2 Transport

Subsectors: Domestic navigation, Other transportation, Railways, Road transportation

Number of indicator Categories: 10

Estimated total coverage of quarterly indicator categories compared to original annual National Inventory Report: 98.5%

Figure 11: Changes in emissions in the Transport Sector from Q1 2018 to Q2 2024, based on seasonally adjusted data



3.2.1 Transport Year-on-Year Change

Key finding

- The key driver for the -2.9% decrease in emissions attributed to the transport sector was decreased sales of diesel (-4.6%) and, despite an increase of 2.0% in the sales of petrol, the fraction by volume of biofuel in petrol has increased from 7.1% in Q2 2023 to 9.1% in Q2 2024.

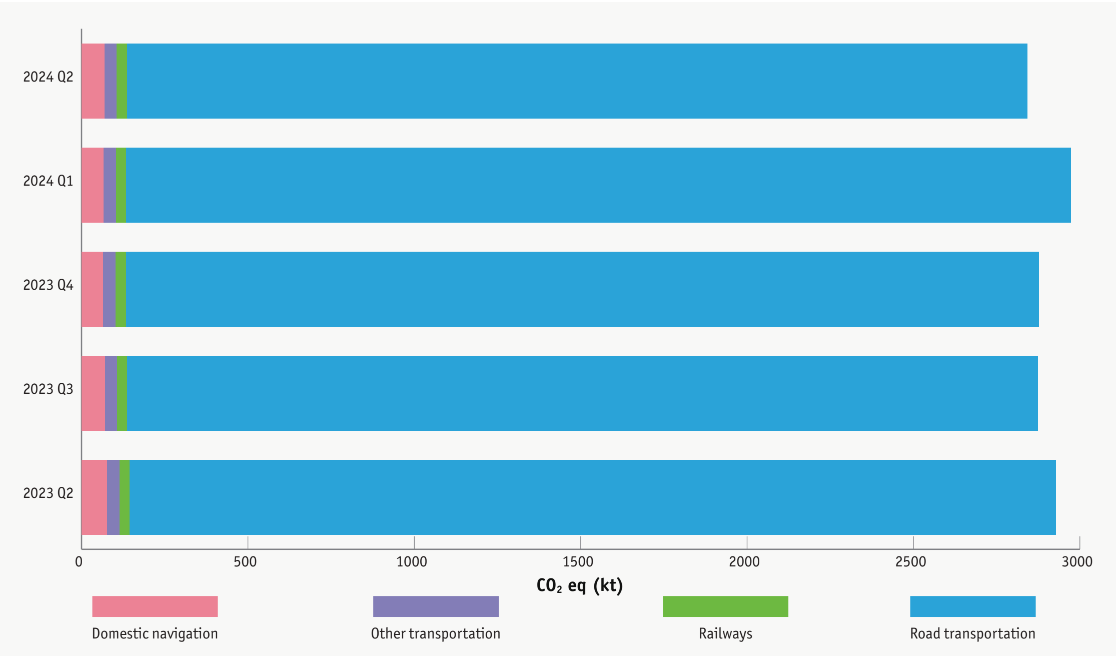
Looking at Quarter 2 2024 compared to Quarter 2 2023

- Transport greenhouse gas emissions decreased by -2.9% (-84.7 kt CO_2 eq) compared to the same quarter last year.
- The largest sectoral decrease in absolute emissions was observed in Road Transportation with a change of -2.8% (-76.7 kt CO_2 eq) associated with decreased diesel (-4.6%) sales.
- Driven by changes in European legislation and national policy, there was a 2.0% increase in the sales of petrol but, by volume, the fraction of biofuel in petrol increased from 7.1% in Quarter 2 2023 to 9.1% in Quarter 2 2024, leading to an overall increase of 4.1 thousand tonnes or 29.5% in the volume of biofuel in petrol sold.

Table 9: Summary Q2 2024 compared to Q2 2023 - Transport

Sector	Greenhouse Gas	Emissions Q2 2024 (kt CO_2 eq)	Comparisons with Q2 2023 (kt CO_2 eq)	Comparisons with Q2 2023 (%)
Transport	**CO_2**	**2,842.9**	**-84.7**	**-2.9**
Domestic navigation	CO_2	68.0	-7.7	-10.1
Other transportation	CO_2	37.3	-0.4	-1.2
Railways	CO_2	30.8	0.1	0.4
Road transportation	CO_2	2,706.8	-76.7	-2.8

Figure 12: Comparison of sub-sectoral breakdown in emissions for this quarter vs last four quarters, based on seasonally adjusted data



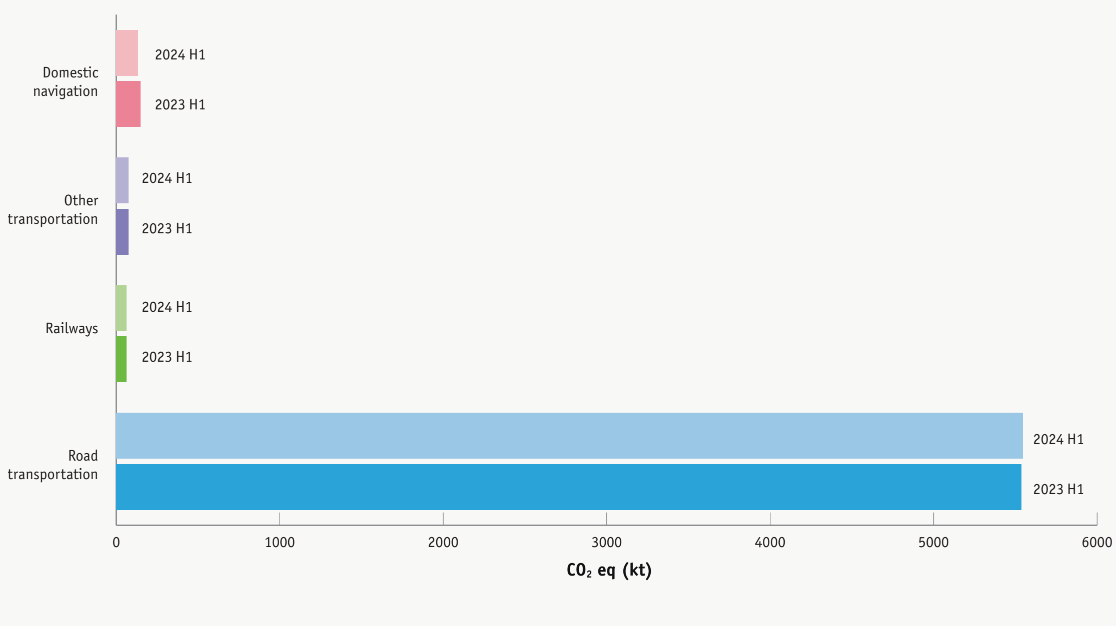
Looking at the first half of 2024 compared to the first half of 2023:

- In the first half of the year, cumulative emissions decreased by -0.2% (-8.8 kt CO_2 eq).
- The largest sub-sectoral decrease in emissions was observed in Domestic Navigation (-11.2%, -16.8 kt CO_2 eq).
- Road transportation emissions were relatively flat (+0.1%, -8.2 kt CO_2 eq) with diesel sales down –1.7% but petrol sales up 5.6% in the first half of the year.

Table 10: Summary H1 2024 compared to H1 2023 - Transport

Sector	Emissions H1 2024 (kt CO_2 eq)	Comparisons with H1 2023 (kt CO_2 eq)	Comparisons with H1 2023 (%)
Transport	**5,815.8**	**-8.8**	**-0.2**
Domestic navigation	133.0	-16.8	-11.2
Other transportation	75.1	-0.5	-0.7
Railways	61.7	0.3	0.5
Road transportation	5,546.0	8.2	0.1

Figure 13: Emissions in Transport subsectors in H1 2024 and H1 2023



3.2.2 Transport Quarter-on-Quarter Change

Key finding

- There was a -4.4% decrease in emissions attributed to the transport sector quarter-over-quarter driven by an decrease in emissions from road transportation on a seasonally-adjusted basis.

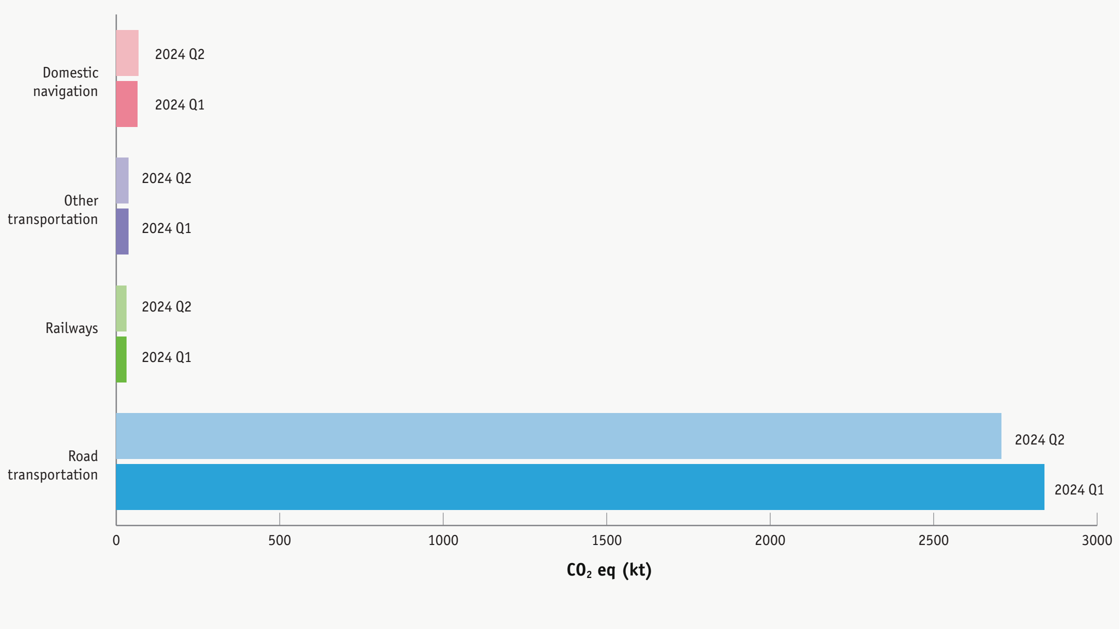
Looking at Quarter 2 2024 compared to Quarter 1 2024

- Transport greenhouse gas emissions decreased by -4.4% (-129.9 kt CO_2 eq) compared to the previous quarter (2024 Quarter 1) on a seasonally-adjusted basis.
- The largest sectoral decrease in emissions was observed in Road Transportation with a change of -4.7% (-132.4 kt CO_2 eq).

Table 11: Summary Q2 2024 compared to Q1 2024 - Transport

Sector	Greenhouse Gas	Emissions Q2 2024 (kt CO_2 eq)	Comparison with Q1 2024 (kt CO_2 eq)	Comparison with Q1 2024 (%)
Transport	**CO_2**	**2,842.9**	**-129.9**	**-4.4**
Domestic navigation	CO_2	68.0	3.0	4.6
Other transportation	CO_2	37.3	-0.5	-1.3
Railways	CO_2	30.8	-0.1	-0.3
Road transportation	CO_2	2,706.8	-132.4	-4.7

Figure 14: Changes in emissions in the Transport Subsectors from Q1 2024 to Q2 2024, based on seasonally adjusted data



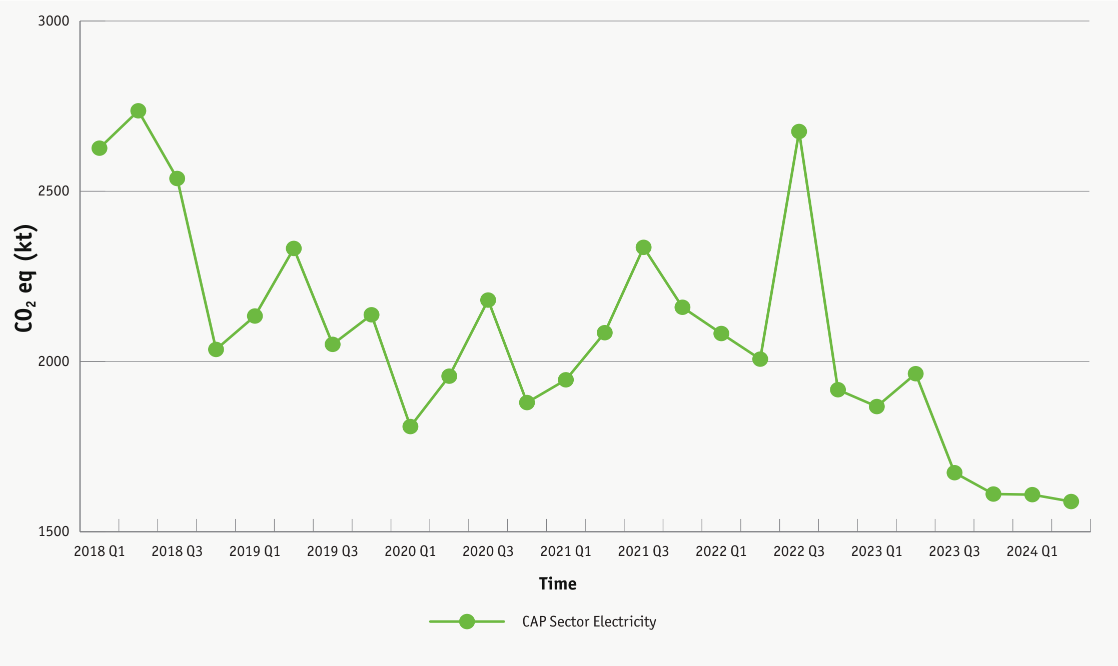
3.3 Electricity

Subsectors: Public electricity and heat production, Solid fuels and other energy industries

Number of indicator Categories: 5

Estimated total coverage of quarterly indicator categories compared to original annual National Inventory Report: 90.6%

Figure 15: Changes in emissions in the Electricity Sector from Q1 2018 to Q2 2024, based on seasonally adjusted data



3.3.1 Electricity Year-on-Year Change

Key finding

- Electricity generation emissions decreased by -19.1% (-376 kt CO_2 eq) due to the amount of net imported electricity in increasing from 10.9% to 18.1% of electricity supply, in combination with reductions in coal and gas use, and increases in renewables.

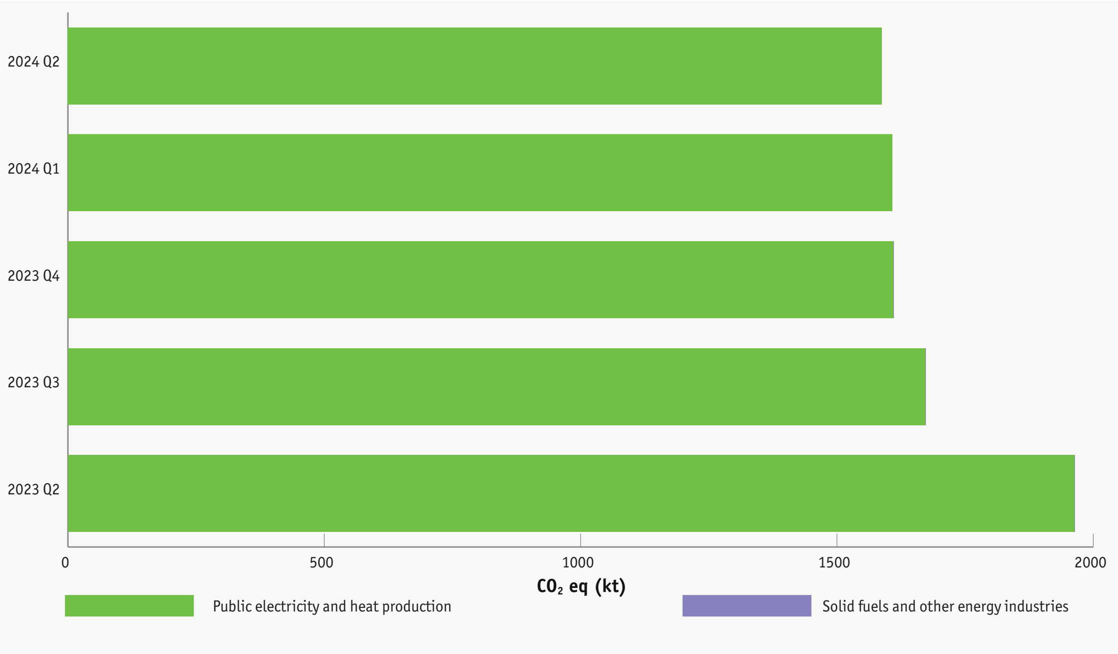
Looking at Quarter 2 2024 compared to Quarter 1 2023

- The Electricity Sector greenhouse gas emissions decreased by -19.1% (-375.5 kt CO_2 eq).
- This was driven by a significant decrease in the Public electricity and heat production sub-sector with emissions falling by -19.1% (-375.5 kt CO_2 eq).
- This aligns with a -12.9% reduction in electricity generation from natural gas (-513 GWh) and -33.8% reduction from coal (-92 GWh), and an increase of +4.6% from wind (+93 GWh) and +61.6% from solar (+99 GWh).

Table 12: Summary Q2 2024 compared to Q2 2023 - Electricity

Sector	Greenhouse Gas	Emissions Q2 2024 (kt CO_2 eq)	Comparisons with Q2 2023 (kt CO_2 eq)	Comparisons with Q2 2023 (%)
Electricity	**CO_2**	**1,588.7**	**-375.5**	**-19.1**
Public electricity and heat production	CO_2	1,587.6	-375.5	-19.1
Solid fuels and other energy industries	CO_2	1.1	0.0	-0.4

Figure 16: Comparison of sub-sectoral breakdown in emissions for this quarter vs last four quarters, based on seasonally adjusted data



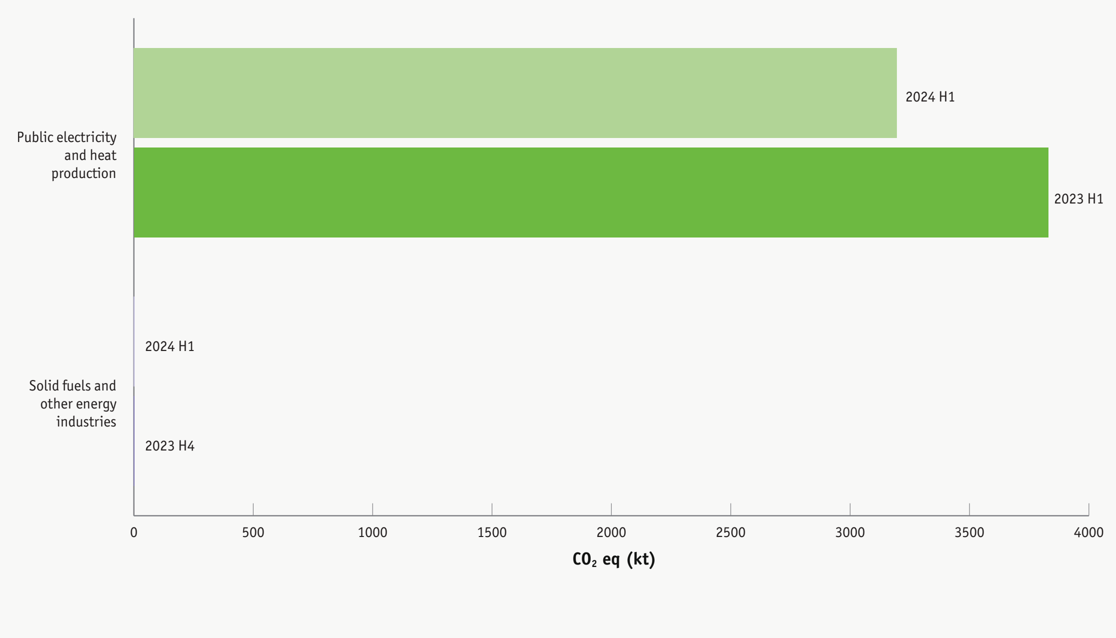
Looking at the first half of 2024 compared to the first half of 2023:

- Overall Electricity greenhouse gas emissions decreased by -16.6% (-634.2 kt CO_2 eq).
- The largest sub-sectoral decrease in emissions was observed in Public Electricity and Heat Production (-16.6%, -634.1 kt CO_2 eq).
- None of the electricity subsectors increased in emissions.

Table 13: Summary H1 2024 compared to H1 2023 - Electricity

Sector	Emissions H1 2024 (kt CO_2 eq)	Comparisons with H1 2023 (kt CO_2 eq)	Comparisons with H1 2023 (%)
Electricity	**3,197.6**	**-634.2**	**-16.6**
Public electricity and heat production	3,195.5	-634.1	-16.6
Solid fuels and other energy industries	2.1	-0.1	-3.1

Figure 17: Emissions in Electricity subsectors in H1 2024 and H1 2023



3.3.2 Electricity Quarter-on-Quarter Change

Key finding

- Greenhouse gas emissions decreased by -1.3% (-20.3 kt CO_2 eq) due to reductions in coal use and an increase in renewable energy and interconnector imports for electricity generation.

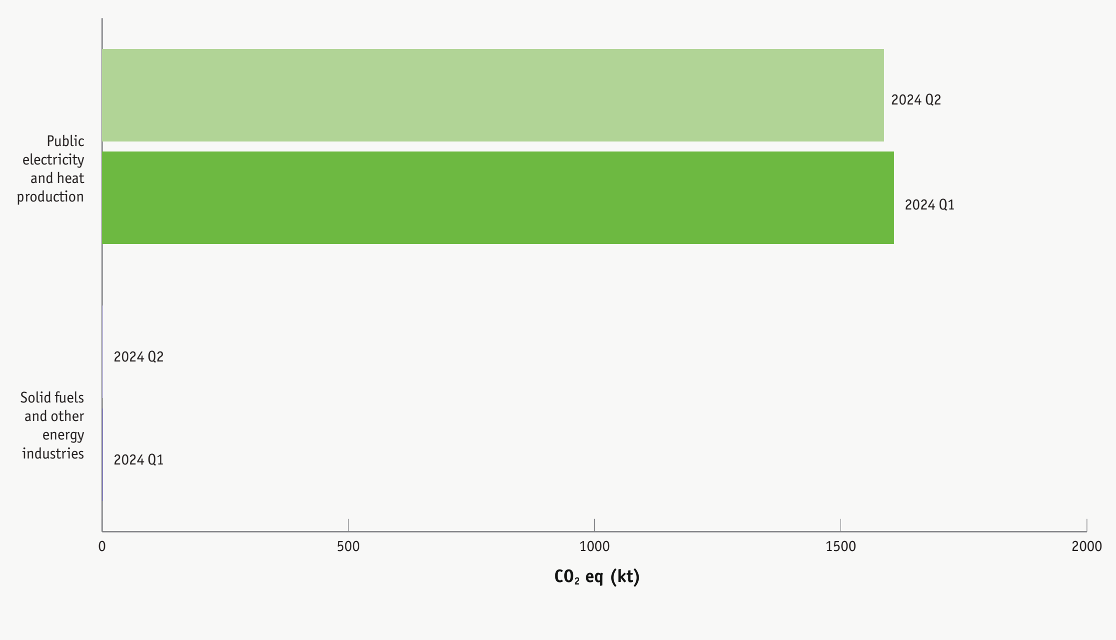
Looking at Quarter 2 2024 compared to Quarter 1 2024

- The Electricity sector greenhouse gas emissions decreased by -1.3% (-20.3 kt CO_2 eq).
- There was a -34.3% reduction in electricity generation from coal (-94 GWh) offset by an increase in gas use (+3.9%, +132 GWh), and a sharp increase of +265% from solar farms (+189 GWh) offset by a reduction in wind generation (-42%, -1,540 GWh).

Table 14: Summary Q2 2024 compared to Q1 2024 - Electricity

Sector	Greenhouse Gas	Emissions Q2 2024 (kt CO_2 eq)	Comparisons with Q1 2024 (kt CO_2 eq)	Comparisons with Q1 2024 (%)
Electricity	**CO_2**	**1,588.7**	**-20.3**	**-1.3**
Public electricity and heat production	CO_2	1,587.6	-20.3	-1.3
Solid fuels and other energy industries	CO_2	1.1	0.0	1.1

Figure 18: Emissions in Electricity subsectors in Q2 2024 and Q1 2024



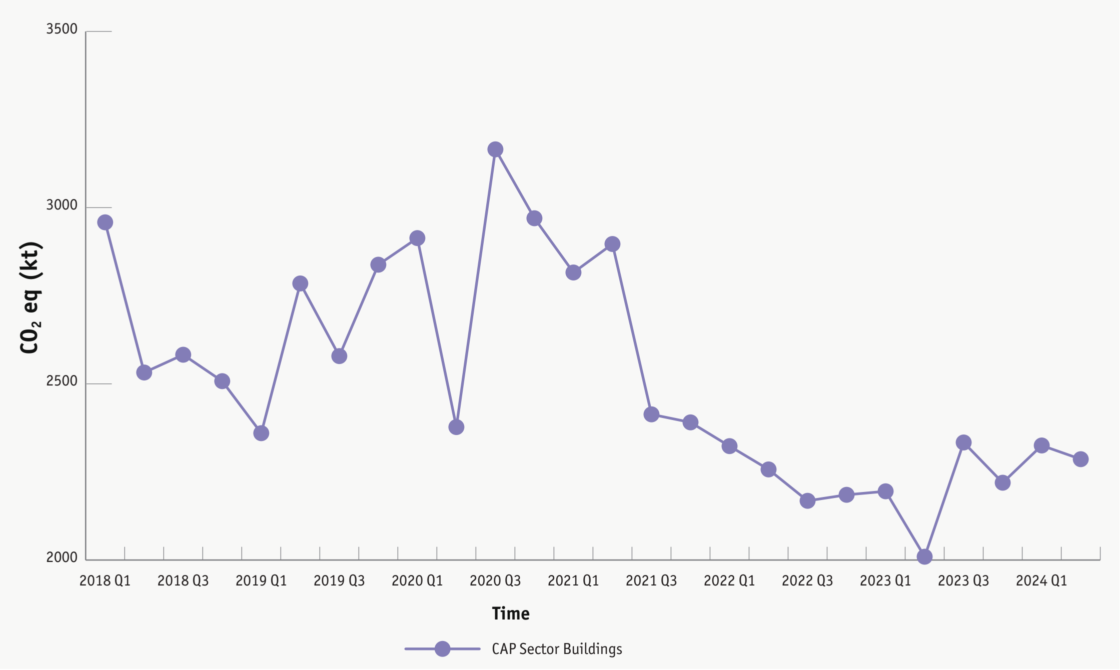
3.4 Buildings

Subsectors: Residential, Commercial & Public Services

Number of indicator Categories: 8

Estimated total coverage of quarterly indicator categories compared to original annual National Inventory Report: 93.4%

Figure 19: Changes in emissions in the Buildings Sector from Q1 2018 to Q2 2024, based on seasonally adjusted data



3.4.1 Buildings Year-on-Year Change

Key finding

- Overall GHG emissions from Buildings were up +12.1% (+276.0 kt CO_2 eq) due to increased energy demand for heating in the Residential sector (+16.7%, +278 kt CO_2 eq). There was 14.5% more heating degree days (HDD, days below 15.5 degrees Celsius where heating would be needed) in Quarter 2 2024 compared to Quarter 2 2023.

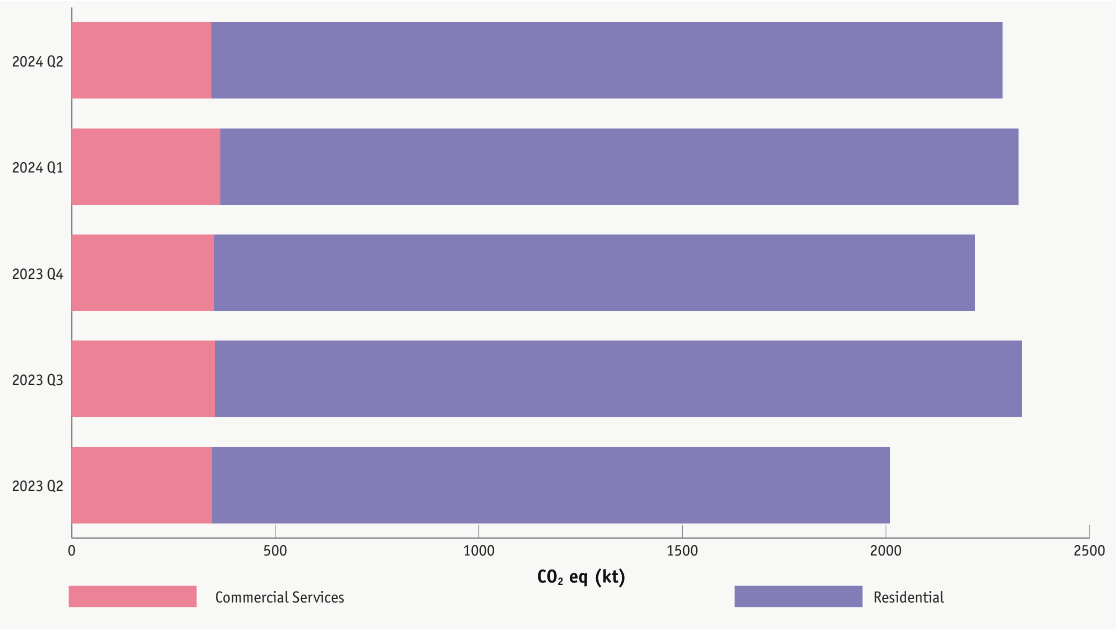
Looking at Quarter 2 2024 compared to Quarter 2 2023

- The overall buildings greenhouse gas emissions increased by +12.1% (+276 kt CO_2 eq)
- This was driven by an increase in emissions from Residential building (+16.7%, +278.0 kt CO_2 eq) partially offset by a small decrease in emissions from public and commercial services buildings (-0.5%, -2.0 kt CO_2 eq).
- There was 14.5% more HDD days in Quarter 2 2024 compared to Quarter 2 2023.
- Gas prices were 12.9% lower in Quarter 2 2024 than Quarter 2 2023 which could also impact gas usage for heating.

Table 15: Summary Q2 2024 compared to Q2 2023 - Buildings

Sector	Greenhouse Gas	Emissions Q2 2024 (kt CO_2 eq)	Comparisons with Q2 2023 (kt CO_2 eq)	Comparisons with Q2 2023 (%)
Commercial and Public Services	CO_2	342.7	-1.6	-0.5
Residential	CH_4, CO_2	1,943.5	278.3	16.7

Figure 20: Comparison of sub-sectoral breakdown in emissions for this quarter vs last four quarters, based on seasonally adjusted data



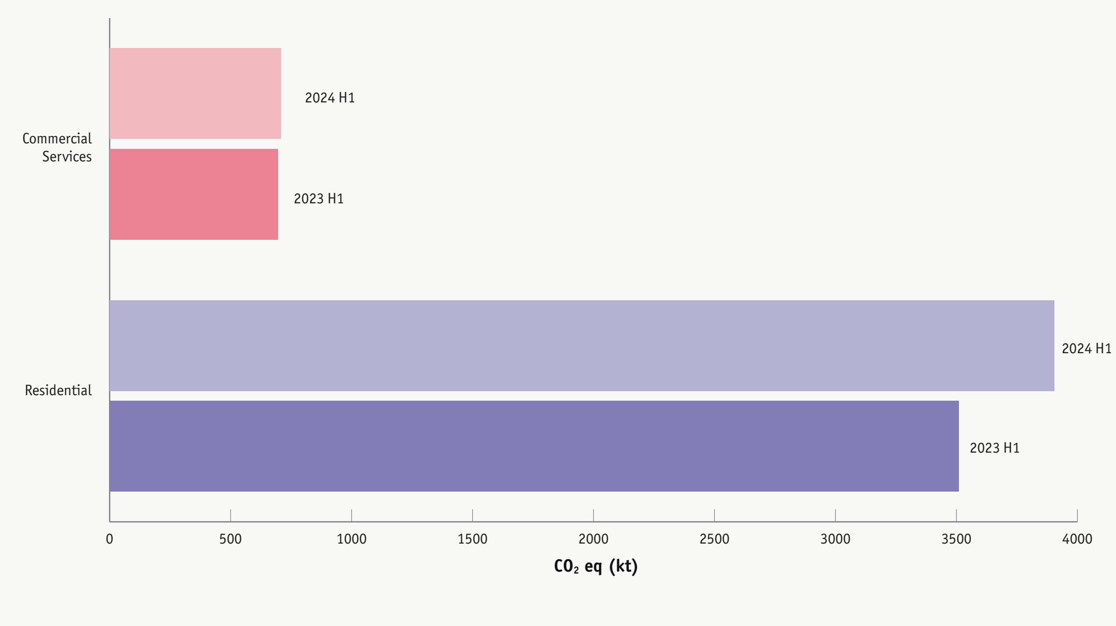
Looking at the first half of 2024 compared to the first half of 2023:

- Overall Buildings greenhouse gas emissions increased by +8.8% (+407 kt CO_2 eq).
- No sub-sectoral decrease in emissions was observed in the Buildings subsectors.
- The largest increase in emissions this half was observed in the Residential Buildings sub sector at +11.2% (+394.0 kt CO_2 eq).

Table 16: Summary H1 2024 compared to H1 2023 - Buildings

Sector	Emissions H1 2024 (kt CO_2 eq)	Comparisons with H1 2023 (kt CO_2 eq)	Comparisons with H1 2023 (%)
Commercial Services	707.7	12.6	1.8
Residential	3,903.6	394.2	11.2

Figure 21: Emissions in Buildings sectors in H1 2024 and H1 2023



3.4.2 Buildings Quarter-on-Quarter Change

Key finding

- GHG emissions from Buildings decreased -1.6% (-38.0 kt CO_2 eq) on a seasonally-adjusted basis with the largest decrease in Commercial & Public Services buildings (-6.1%, -0.8 kt CO_2 eq).

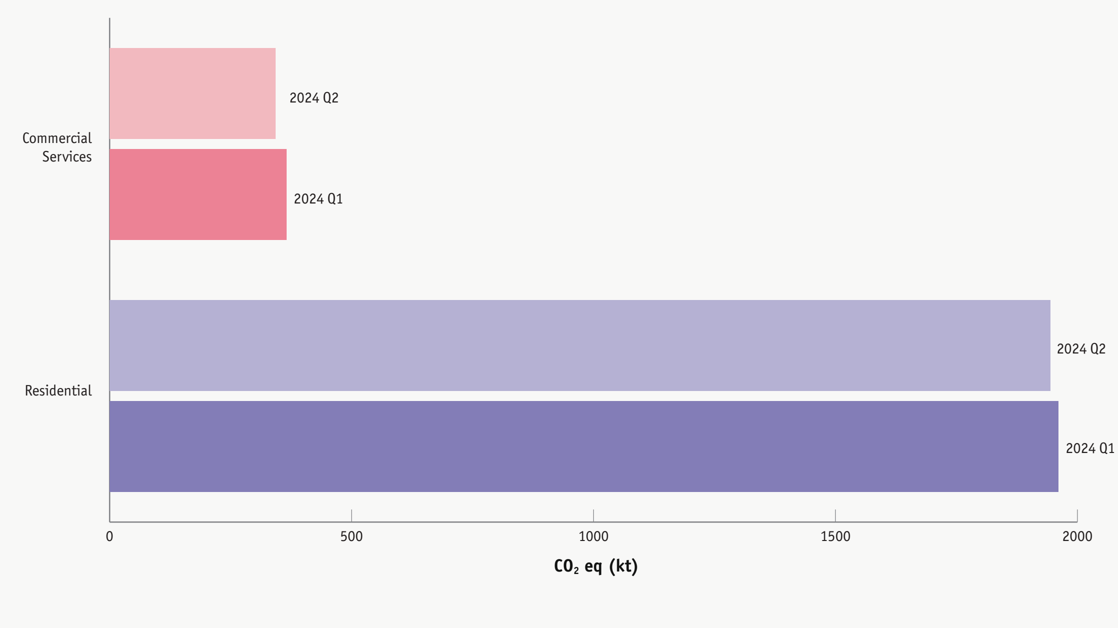
Looking at Quarter 2 2024 compared to Quarter 1 2024

- The overall buildings greenhouse gas emissions decreased by -1.6% (+38.0 kt CO_2 eq).
- Both sub sectors of Commercial & Public Services and Residential had decreased emissions quarter over quarter.
- Significant decreases were observed in the Commercial & Public Services sub-sector with emissions decreasing by -6.1% (-22.0 kt CO_2 eq).
- Emissions from the Residential sector also decreased by -0.8% (-16.0 kt CO_2 eq).

Table 17: Summary Q2 2024 compared to Q1 2024 - Buildings

Sector	Greenhouse Gas	Emissions Q2 2024 (kt CO_2 eq)	Comparisons with Q1 2024 (kt CO_2 eq)	Comparisons with Q1 2024 (%)
Commercial and Public Services	CO_2	342.7	-22.4	-6.1
Residential	CH_4, CO_2	1,943.5	-16.5	-0.8

Figure 22: Changes in emissions in the Building Subsectors from Q1 2024 to Q2 2024, based on seasonally adjusted data



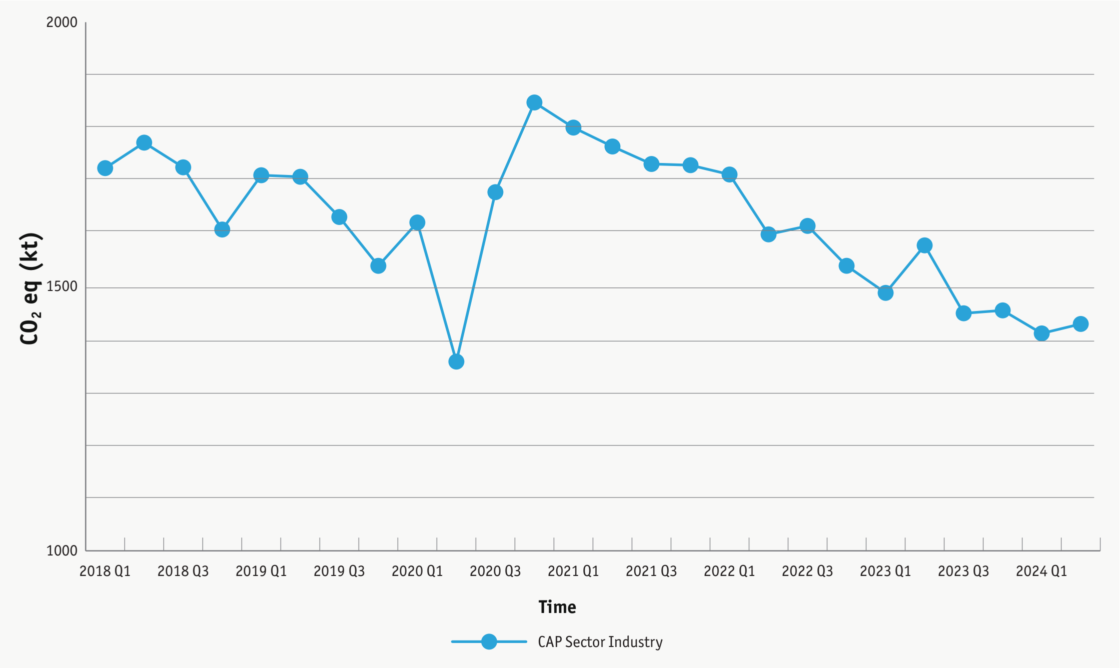
3.5 Industry

Subsectors: Manufacturing Combustion, Mineral Industry

Number of indicator Categories: 10

Estimated total coverage of quarterly indicator categories compared to original annual National Inventory Report: 93.9%

Figure 23: Changes in emissions in the Industry Sector from Q1 2018 to Q2 2024, based on seasonally adjusted data



3.5.1 Industry Year-on-Year Change

Key finding

- Industry emissions were down -9.4% (-148.7 kt CO_2 eq), driven mainly by reductions in both process and combustion emissions from the Mineral Industry (largely represented by the cement production sector and includes lime, brick and ceramic sectors).

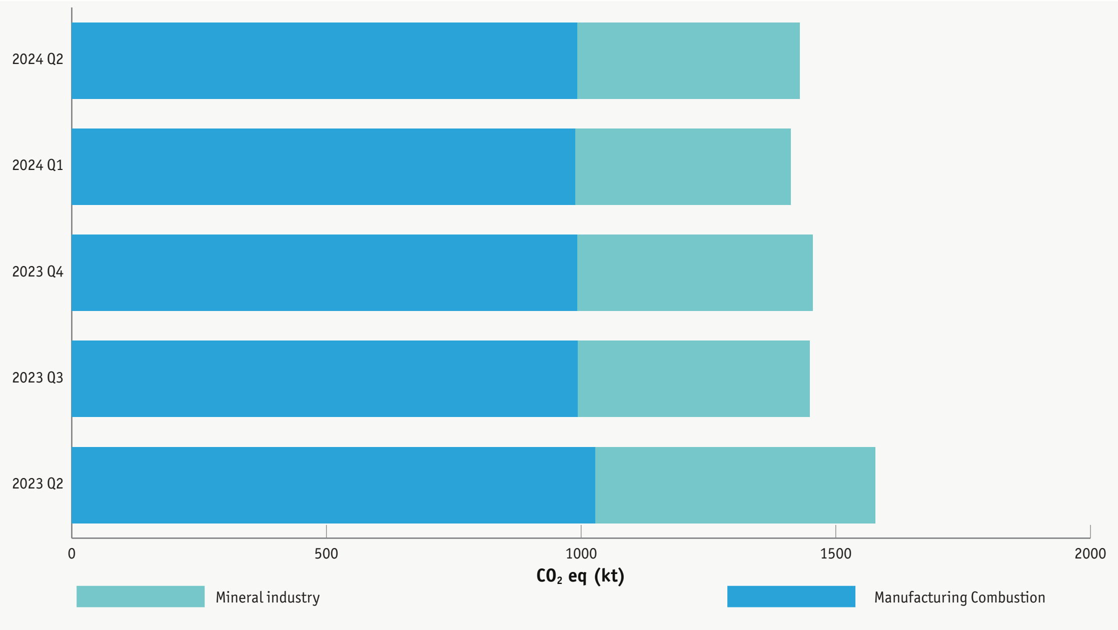
Looking at Quarter 2 2024 compared to Quarter 2 2023

- The overall Industry greenhouse gas emissions decreased by -9.4% (-148.7 kt CO_2 eq).
- This decrease was driven by the decrease in emissions in the Mineral industry sub sector, with emissions falling by -20.5% (-112.6 kt CO_2 eq).
- There was also a decrease in emissions observed in the Manufacturing Combustion sub-sector (largely represented by the cement production sector and includes lime, brick and ceramic sectors), which represents gas and liquid fuel use in beverage, food processing, chemical and mineral industries, at -3.5% (-36.0 kt CO_2 eq).

Table 18: Summary Q2 2024 compared to Q2 2023 - Industry

Sector	Greenhouse Gas	Emissions Q2 2024 (kt CO_2 eq)	Comparisons with Q2 2023 (kt CO_2 eq)	Comparisons with Q2 2023 (%)
Industry	**CO_2**	**1,429.2**	**-148.7**	**-9.4**
Manufacturing Combustion	CO_2	992.1	-36.0	-3.5
Mineral industry	CO_2	437.1	-112.6	-20.5

Figure 24: Comparison of sub-sectoral breakdown in emissions for this quarter vs last four quarters, based on seasonally adjusted data



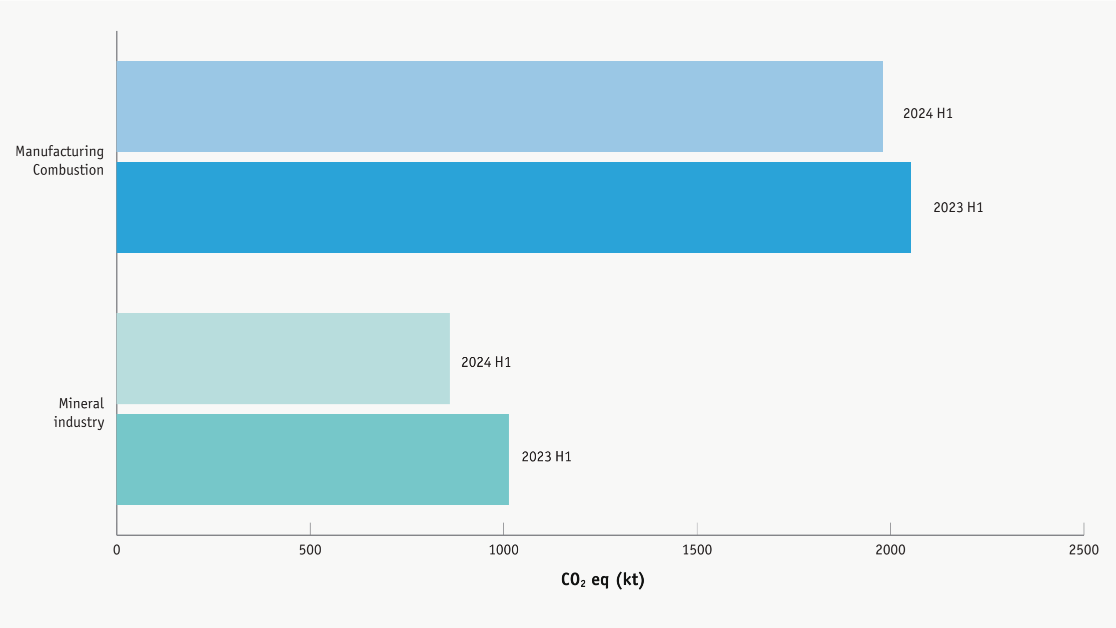
Looking at the first half of 2024 compared to the first half of 2023:

- Cumulative emissions in the first half of the year were down -7.3% (-225.3 kt CO_2 eq) on the previous year.
- The largest sub-sectoral decrease in emissions was observed in the Mineral Industry (-15.1%, -152.6 kt CO_2 eq).
- Emissions from Manufacturing Combustion also decreased by -3.5% (-72.7 kt CO_2 eq)

Table 19: Summary H1 2024 compared to H1 2023 - Industry

Sector	Emissions H1 2024 (kt CO_2 eq)	Comparisons with H1 2023 (kt CO_2 eq)	Comparisons with H1 2023 (%)
Industry	**2,840.4**	**-225.3**	**-7.3**
Manufacturing Combustion	1,980.4	-72.7	-3.5
Mineral industry	860.0	-152.6	-15.1

Figure 25: Emissions in Industry subsectors in H1 2024 and H1 2023



3.5.2 Industry Quarter-on-Quarter Change

Key finding

- Industry emissions were up +1.3% (+17.9 kt CO_2 eq), driven mainly by increases in both process and combustion emissions from the Mineral Industry on a seasonally-adjusted basis.

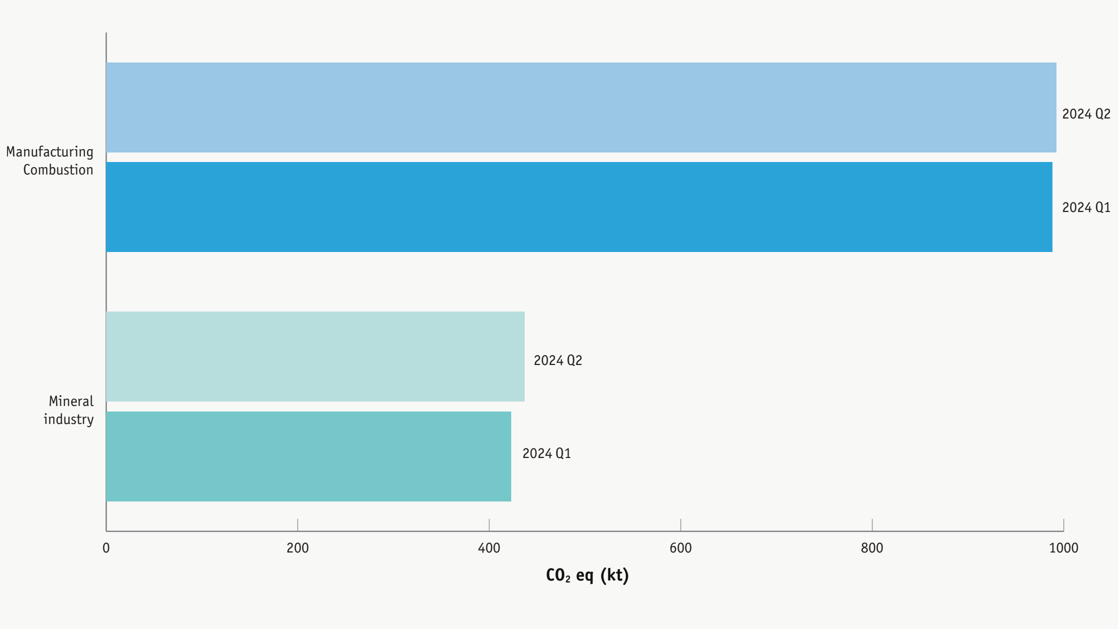
Looking at Quarter 2 2024 compared to Quarter 1 2024

- The overall Industry greenhouse gas emissions increased by +1.3% (+17.9 kt CO_2 eq).
- This was driven by increases in emissions from the Mineral Industry sub-sector (+3.3%, 14.1 kt CO_2 eq) and the Manufacturing Combustion sub sector (+0.4%, +3.8 kt CO_2 eq) on a seasonally-adjusted basis.

Table 20: Summary Q2 2024 compared to Q1 2024 - Industry

Sector	Greenhouse Gas	Emissions Q2 2024 (kt CO_2 eq)	Comparisons with Q1 2024 (kt CO_2 eq)	Comparisons with Q1 2024 (%)
Industry	**CO_2**	**1,429.2**	**17.9**	**1.3**
Manufacturing Combustion	CO_2	992.1	3.8	0.4
Mineral industry	CO_2	437.1	14.1	3.3

Figure 26: Changes in emissions in the Industry Subsectors from Q1 2024 to Q2 2024, based on seasonally adjusted data



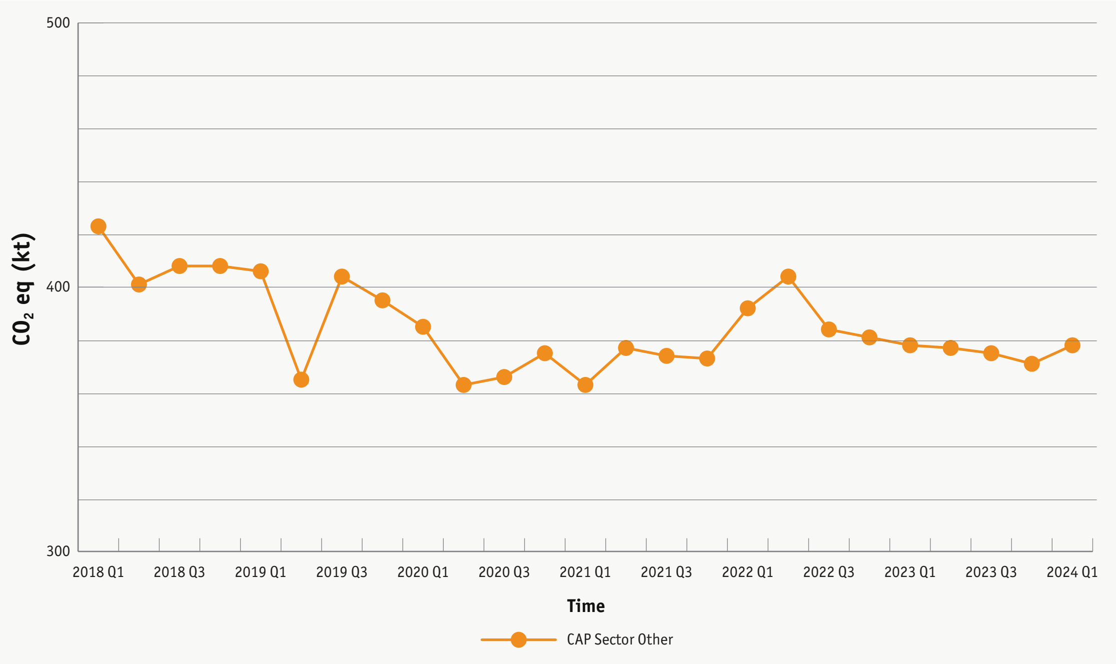
3.6 Other

Subsectors: F-Gases, Petroleum refining, Waste: Landfills, Waste: Wastewater treatment and discharge

Number of indicator Categories: 6

Estimated total coverage of quarterly indicator categories compared to original annual National Inventory Report: 90.3%

Figure 27: Changes in emissions in the Other Sector from Q1 2018 to Q2 2024, based on seasonally adjusted data



3.6.1 Other Year-on-Year Change

Key finding

- Emissions from Other sectors decreased by -1.7% (-6.5 kt CO_2 eq) with increases in emissions from landfilled waste (+18.8%, +27 kt CO_2 eq) offset by decreases from gas and liquid fuel combustion in Petroleum Refining (-43.1%, -33 kt CO_2 eq).

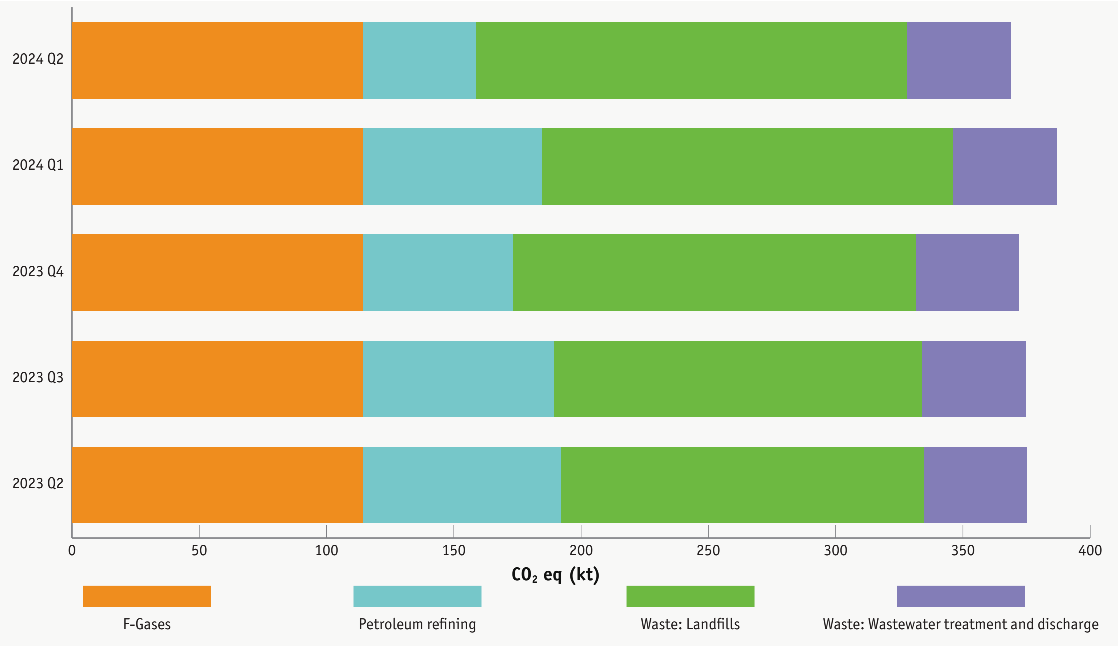
Looking at Quarter 2 2024 compared to Quarter 2 2023

- Greenhouse gas emissions from Other sectors decreased by -1.7% (-6.0 kt CO_2 eq).
- The largest sectoral decrease in emissions was from gas and liquid fuel combustion in Petroleum Refining with a change of -43.1% (-33.0 kt CO_2 eq). This is in line with reduced intake of these fuels to the remaining refinery facility in the state.
- Emissions from landfilled waste increased by +18.8% (+27.0 kt CO_2 eq) reflecting increases in biodegradable municipal waste being landfilled over this time.

Table 21: Summary Q2 2024 compared to Q2 2023 - Other

Sector	Greenhouse Gas	Emissions Q2 2024 (kt CO_2 eq)	Comparisons with Q2 2023 (kt CO_2 eq)	Comparisons with Q2 2023 (%)
Other	**CH_4, N_2O, HFC, PFC, SF_6, NF_3**	**368.7**	**-6.5**	**-1.7**
F-Gases	HFC, PFC, SF_6, NF_3	114.4	0.0	0.0
Petroleum refining	CO_2	44.0	-33.4	-43.1
Waste: Landfills	CH_4	169.6	26.9	18.8
Waste: Wastewater treatment and discharge	CH_4, N_2O	40.6	0.0	-0.1

Figure 28: Comparison of sub-sectoral breakdown in emissions for this quarter vs last four quarters, based on seasonally adjusted data



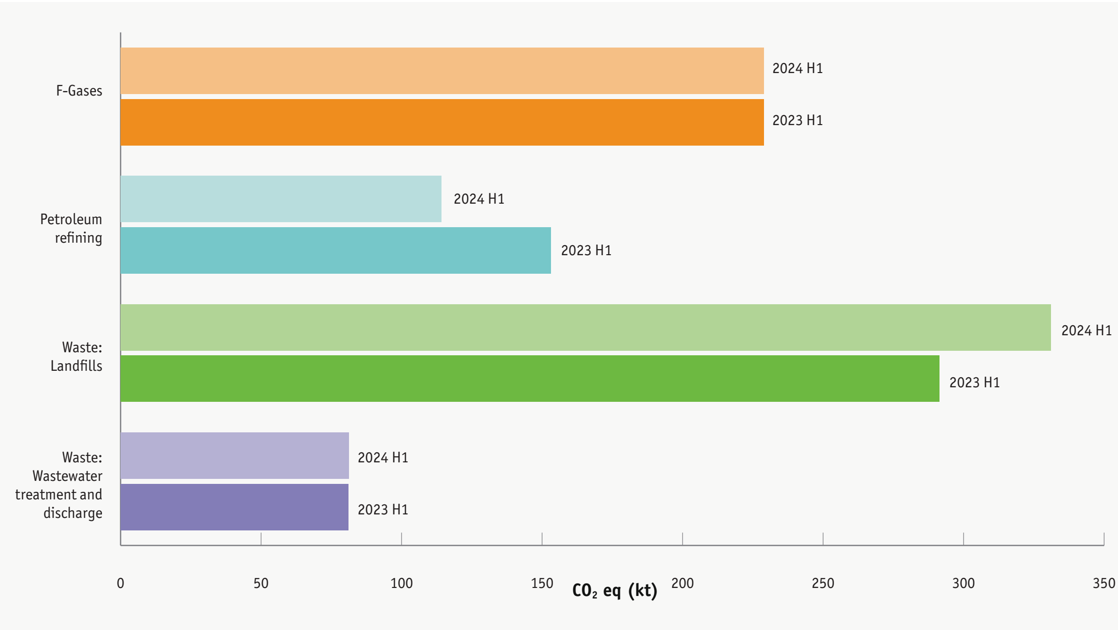
Looking at the first half of 2024 compared to the first half of 2023:

- There was little change overall (0.1% increase) compared to the first half of 2023.
- Large reductions in petroleum refining (-25.4%, -38.8 kt CO_2 eq) have been offset by an increase in Landfill waste emissions (+13.6%, 39.7 kt CO_2 eq)

Table 22: Summary H1 2024 compared to H1 2023 - Other

Sector	Emissions H1 2024 (kt CO_2 eq)	Comparisons with H1 2023 (kt CO_2 eq)	Comparisons with H1 2023 (%)
Other	**755.5**	**1.0**	**0.1**
F-Gases	228.9	-0.1	0.0
Petroleum refining	114.2	-38.8	-25.4
Waste: Landfills	331.1	39.7	13.6
Waste: Wastewater treatment and discharge	81.3	0.2	0.3

Figure 29: Emissions in Other subsectors in H1 2024 and H1 2023



3.6.2 Other Quarter-on-Quarter Change

Key finding

- Emissions from Other sectors decreased -4.7% driven mainly by a quarter-over-quarter decrease in gas and liquid fuel combustion in Petroleum Refining.

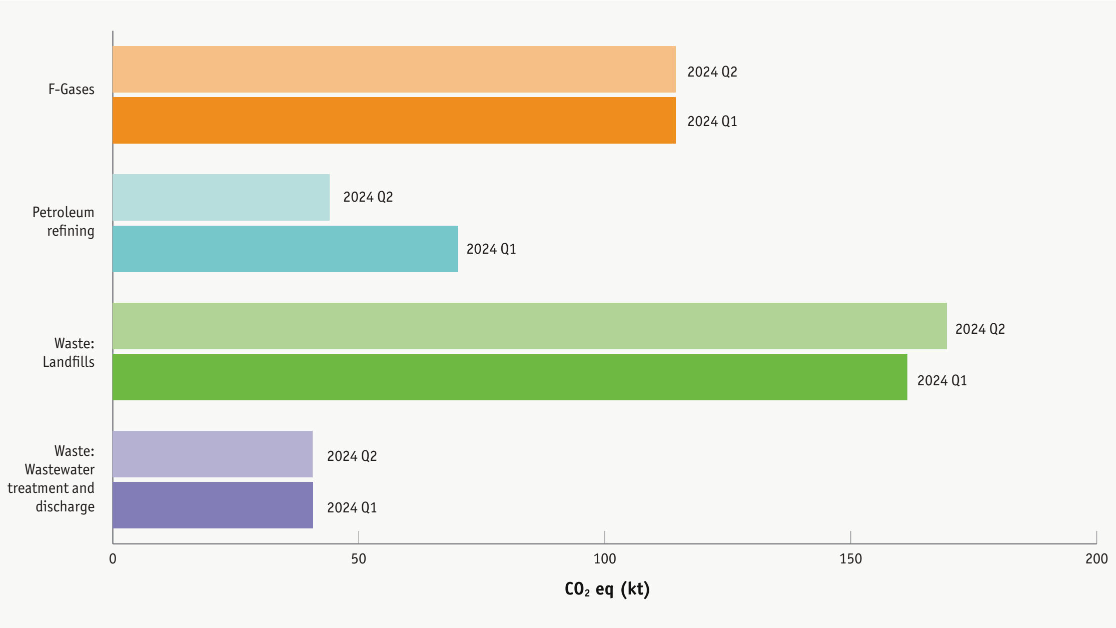
Looking at Quarter 2 2024 compared to Quarter 1 2024

- Greenhouse gas emissions from Other sectors decreased by -4.7% (-18.1 kt CO_2 eq) compared to the previous quarter (2024 Quarter 1) on a seasonally-adjusted basis.
- The largest sectoral decrease in emissions was from gas and liquid fuel combustion in Petroleum Refining with a change of =37.2 1% (-26.1 kt CO_2 eq).
- Emissions from landfilled waste increased by +5.0% (+8.1 kt CO_2 eq) in line with increases in biodegradable municipal waste being landfilled compared to the previous quarter.

Table 23: Summary Q2 2024 compared to Q1 2024 - Other

Sector	Greenhouse Gas	Emissions Q2 2024 (kt CO_2 eq)	Comparisons with Q1 2024 (kt CO_2 eq)	Comparisons with Q1 2024 (%)
Other	**CH_4, N_2O, HFC, PFC, SF_6, NF_3**	**368.7**	**-18.1**	**-4.7**
F-Gases	HFC, PFC, SF_6, NF_3	114.4	0.0	0.0
Petroleum refining	CO_2	44.0	-26.1	-37.2
Waste: Landfills	CH_4	169.6	8.1	5.0
Waste: Wastewater treatment and discharge	CH_4, N_2O	40.6	-0.1	-0.2

Figure 30: Changes in emissions in the Other Subsectors from Q2 2024 to Q1 2024, based on seasonally adjusted data



4 Data

All source data for this report is provided as a separate downloadable MS Excel file via the EPA website. For access to non-open licensed data, please contact the data provider directly.

5 Methodological Notes

This section provides an overview of the two key methodologies used to produce quarterly greenhouse gas emissions estimates:

- Temporal disaggregation and benchmarking of the existing EPA National Inventory Report emissions into quarterly values. The method allows for the estimation of quarterly emissions while adhering to the constraint that the sum of all four quarters will equal the reported total annual emission tonnage. In addition, quarters can be extrapolated beyond current annual data.
- Once quarterly data are available, either primary data or data estimated from temporal disaggregation and benchmarking, the degree of seasonality in the data is assessed and, when present, a robust method of seasonal adjustment is applied.

5.1 Summary Methodology

5.1.1 Temporal Disaggregation with Benchmarking

Temporal disaggregation divides the annual inventory time series into four quarterly values. The benchmarking process ensures that the sum of the four quarters equals the annual reported value for the years. Importantly, the method also extrapolates estimates forward in time to predict quarterly values for which the annual totals are not yet available.

Temporal disaggregation and extrapolation can be employed naively or with information from high frequency time series known as proxy indicators. As a first step, domain experts from each sector produce a list of potential proxy indicators. The indicators should approximate the quarterly behaviour or movement of the greenhouse gases emissions in each IPCC category. Examples of proxy indicator variables include monthly energy statistics, monthly trade data, daily gas meter usage data, quarterly census of animal population.

The appropriate method of temporal disaggregation depends on the length of the high frequency proxy time series available. In the ideal case of ten plus years of high frequency data, the first step is to aggregate the high frequency data into annual data and test for correlation with the annual inventory time series using Kendall's tau. It is important to detrend both series by obtaining the first differences before testing for correlation.

There are two recommended static regression methods for the case of ten plus years of high frequency data. The Chow-Lin method is suited for stationary or cointegrated series, and for series with stable growth rates. The alternative Fernandez method is recommended for unstable growth rates or for non-co-integrated data. The appropriate method is selected by comparing the model goodness of fit between Chow-Lin and Fernandez.

The next steps involve checking the quality of the disaggregated quarterly series. The ratio of the quarterly benchmark (the annual values divided by four) to the quarterly indicator over time should be stable. Both the disaggregated quarterly time series and quarterly indicator values are detrended by getting the first difference, and the correlation between the two is calculated using Kendall's tau on the detrended values.

To evaluate the forecast accuracy of the model, out of sample predictive performance for the disaggregated quarterly estimates are calculated. For each full year of available annual inventory data, a comparable annual value is predicted using only the preceding years disaggregated quarterly estimates data. The RMSE, MAE and BIAS between the two estimates as well as the average across years gives a measure of the performance of the disaggregated quarterly series in predicting the annual totals.

Finally, to gauge the volatility in disaggregated quarterly estimates over time, a number of different ratios are calculated between the quarterly estimates and annual totals. The calculated ratios also summarise which quarters, on average, contain the most emissions.

It is necessary to apply a slightly altered methodology for high frequency time series covering a period of five to ten years. As before, both Chow-Lin and Fernandez are applied, and the best fitting model chosen. However here we also implement the Denton-Chelotte method, which unlike the regression approaches, retains the movement of the high frequency series regardless of correlation with the annual series. The final model is selected based upon the quality of the disaggregated quarterly series produced from each approach. The Denton-Chelotte method can only accommodate one proxy indicator, and if a more complex model involving multiple indicators is required, a static regression method is used.

If only two to four years of high frequency are available, the implementation of a statistic regression method is not recommended. Here the Denton-Chelotte method is applied to produce disaggregated quarterly estimates. As before, the disaggregated quarterly time series is quality checked, and the predictive performance calculated.

5.1.2 Seasonal Adjustment

The first consideration is the length of the time series, and nine quarters of data is an absolute minimum for seasonal adjustment. If the disaggregated quarterly time series is less than nine quarters, then seasonal adjustment cannot be applied. Preferably, the time series will contain at least twenty quarters. If the time series contains more than nine but less than twenty quarters, a domain expert should be consulted to confirm if seasonal adjustment is necessary.

An important first step is to check for the presence of seasonality in the data. A number of different plots (ACF, PACF, Quarterly subseries, Lag correlation) are produced to visually inspect for seasonality. In combination with the visual inspection, three formal statistical tests are employed. The first known as the QS-test tests the null hypothesis that the first two seasonal lags for quarterly data (4 and 8) are zero. The second Kruskall Wallis test is non-parametric and tests if the means of each quarter are drawn from different distributions. The final Friedman test is also non-parametric and tests if the medians differ across quarters.12 If at least two out of the three tests identify seasonality, seasonal adjustment is implemented. If both the visual inspection, Kruskall Wallis and Friedman test fail to find any signal of seasonality (no seasonality or highly unstable seasonality), then the series is not adjusted.

All seasonal adjustment is implemented using the RJdemetra interface. As per CSO Methodology, X-13ARIMA-SEATS pre-treatment and the 'airline' model ARIMA(0, 1, 1, 0, 1, 1) are selected as an initial starting point. The software will test whether a log transformation is necessary and will automatically detect clear additive outliers, level shift outliers and temporary change outliers. It is important to check the quality of the model automatically selected by the RJdemetra interface. The normality, independence and linearity of the model residuals are tested, and the distribution of model residuals visually inspected. If the model is not a good fit, the fully automated model selection specification is used to find an appropriate model. If this also fails to produce a viable model and both Kruskall Wallis and Friedman tests also fail, then seasonal adjustment is not applied.

Given the conservative threshold of detection in automatic identification of outliers, the irregular component of the initial model is examined and points in the time series where the value is greater than 1.5 times the inter-quartile range are identified. The irregular component is visually inspected, and additional outliers are manually included into the model specification. After applying the new model, if the t-value of the additional outliers is greater than 2.0, then the outliers are included in the final model.

The quality of the seasonal adjustment is examined using a number of different outputs from RJdemetra. The idempotency test checks for residual seasonality in the adjusted series. The model decomposition is checked and a number of visual inspections on the diagnostic plots completed. An important output from RJdemetra is the Statistics Canada's Seasonal Adjustment Dashboard. The dashboard report includes graphs of the series, as well as summaries of individual seasonal effects and patterns. Additionally, key seasonal adjustment diagnostics are presented in a traffic light display, and the net effect of seasonal adjustment is decomposed into its various components. Red warnings on the Statistics Canada's Seasonal Adjustment Dashboard indicate poor seasonal adjustment.

If both the model and seasonal adjustment are deemed to be of good quality, then the model is implemented, and the resulting seasonally adjusted estimates used for reporting. However, if both the model and seasonal adjustment are considered poor quality, seasonal adjustment is not implemented, and the unadjusted estimates are used for reporting. In cases where either the model or seasonal adjustment are poor, CSO methodology are consulted to identify improvement actions.

5.2 Revisions and Methodological Changes of Note

For future reports, any revisions to past reported data or methodological changes implemented in latest data will be reported in this section.

Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

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