SWEDEN

Country Factsheet: 1.5°C Pathways for Europe

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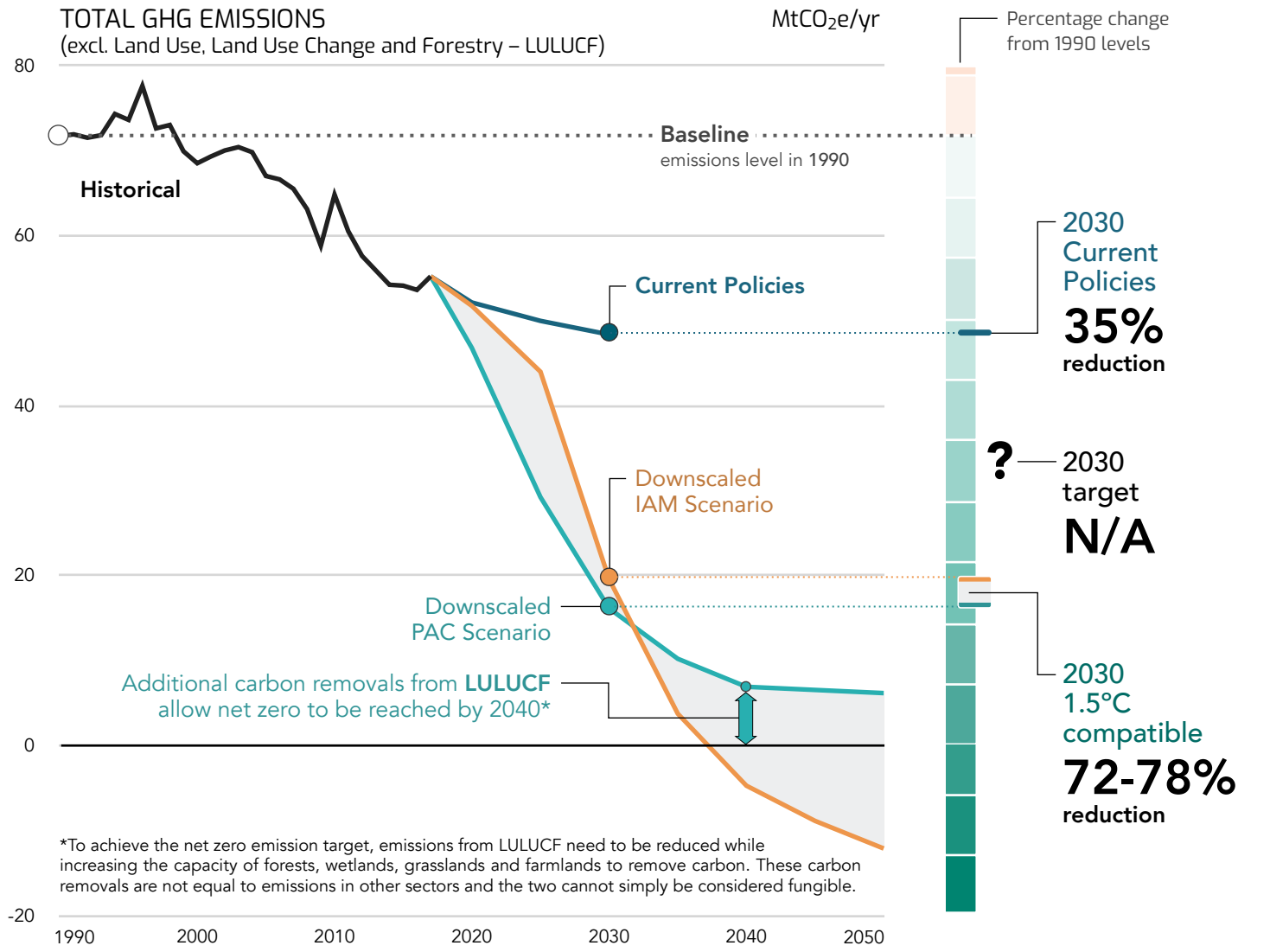
Sweden's current economy-wide 2030 target does not exist



Sweden has so far failed to set an economy-wide GHG emissions target

While Sweden has committed to an ambitious 2045 net zero emissions target, it has as yet failed to set an economy-wide 2030 GHG emissions target as is the case for most European countries.[1] Instead it has committed to a 63% reduction in emissions not covered by the EU emissions trading scheme (ETS) below 1990 levels by 2030, and a 70% reduction in transport emissions below 2010 levels by 2030.

Neither of these are sufficient in ambition to meet the range of 1.5°C compatible economy-wide 2030 targets derived in this analysis of a 72-78% reduction below 1990 levels.† To allow for full comparability and transparency, Sweden should adopt an economy-wide 2030 emissions target. To ensure Sweden is contributing its fair share to global climate mitigation efforts, additional emission reduction activities should also be supported in developing countries.[2]

† **Scope and limitations of downscaled emissions and energy mix pathways:**

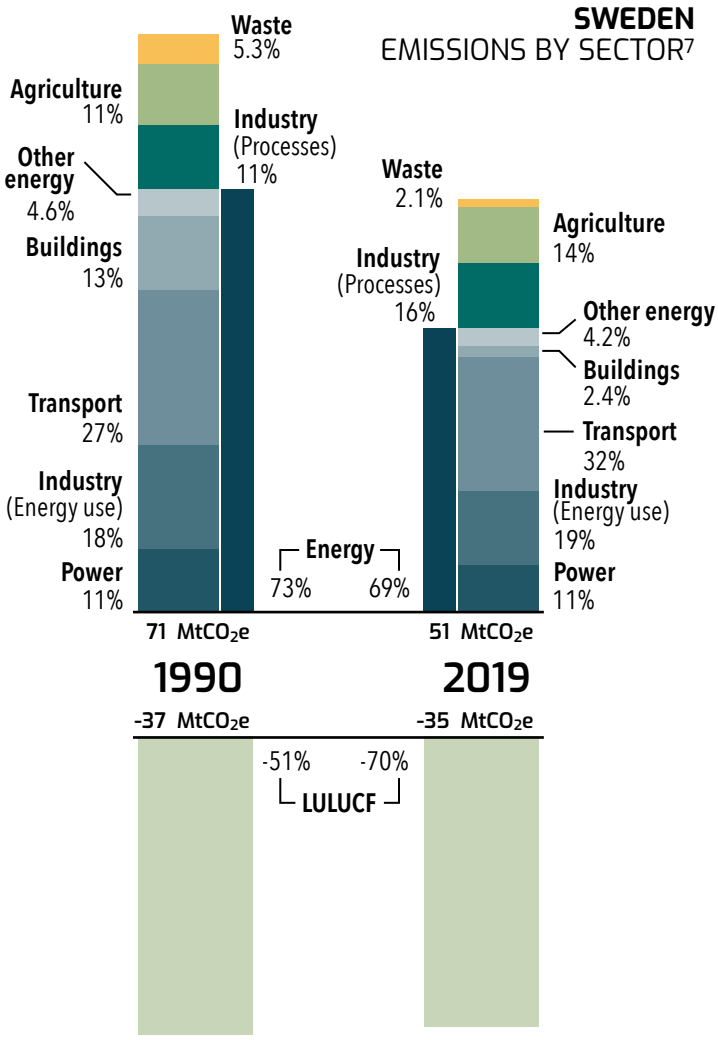
- Pathways were downscaled using the SIAMESE model developed by Climate Analytics. See 1.5°C Pathways for Europe Report[3] for details
- Land use, land use change and forestry (LULUCF), and international aviation and shipping emissions are not covered by this assessment
- Detailed macro-economic modelling was not conducted as part of this assessment
- Historical and future energy imports and exports were not considered

CURRENT SITUATION
Snapshot of Sweden's emissions and energy system

Emissions profile

Sweden's emissions excluding the LULUCF sector peaked in 1970 and have been trending down since. Since 1990, emissions have fallen 23%, led by the buildings sector, which saw an 87% drop in emissions over this time.[4] All sectors have seen emissions decline, though the transport and industry sectors under-performed compared to the economy-wide drop, falling just 14% and 19% since 1990 respectively. In addition, emissions from international aviation have increased significantly over this time.[5]

Emissions reductions in the industry sector were achieved through lower total energy demand and fuel switching between coal and oil to biomass, with coal consumption falling 42% between 1990 and 2019.[6] Though transport emissions are on the decline, they emit more than twice as many emissions as the next largest emitting sector, highlighting the need for ambitious and effective policies targeting this sector.



Energy overview and main policy gaps

Sweden's total primary energy supply has stayed relatively stable since 1990, though the composition of this energy supply has changed dramatically. Coal consumption fell 47% and now makes up just 4% of total primary energy, while oil consumption has fallen 31% and makes up a 20% share compared to 30% in 1990.[6] Renewables now make up 40% of total primary energy supply, with nuclear contributing a further 35% in 2019.

Sweden has a target of 100% renewable generation in the power sector by 2040, and a 50% energy reduction target below 2005 levels by 2030.[1] These are ambitious targets to be commended, but what is needed to ensure Sweden maintains a 1.5°C trajectory throughout the following decades according to the downscaled pathways, is a 2030 economy-wide emissions reduction target of at least 72% below 1990 levels (excl. LULUCF).

Civil Society & Global Integrated Assessment Models
1.5°C energy and climate scenarios for Europe

The aim of the 1.5°C Pathways for Europe Project is to derive Paris Agreement compatible emissions and energy mix pathways for key European countries. The project seeks to highlight existing scenarios that demonstrate that a **very high level of ambition on climate and energy policy *is possible* for the European Union.** To reflect the varied methodologies employed to construct such scenarios, we assess the Paris Agreement Compatible (PAC) energy scenario, and a scenario from the global REMIND integrated assessment model (IAM), both embodying high levels of 2030 climate ambition in the European Union region. We use the SIAMESE model developed by Climate Analytics to create country level pathways, using the PAC/REMIND scenario results for the European Union as input and downscaling them based on demographic, economic, energy system, and policy heterogeneity between countries.[8] We outline key differences between the two scenarios used as input for the SIAMESE downscaling process below.

PAC [9]
Paris Agreement Compatible Energy Scenario

The PAC scenario for the EU28 was developed through a bottom-up collective research exercise involving energy and climate experts and incorporating findings from relevant scientific literature.

Around 150 stakeholders from member organisations of the European Environmental Bureau (EEB) and Climate Action Network (CAN) Europe, and from science and industry were involved in the scenario building process.

The PAC scenario is an attempt to construct a European-wide energy scenario which is aligned with the Paris Agreement's objective to limit global warming to 1.5°C and which embodies the demands of civil society.

In doing this it suggests a trajectory with:

- **100%** renewable energy supply by 2040
- **At least 65% GHG** emissions reduction below 1990 levels by 2030
- Net zero emissions by **2040**

Carbon Capture and Storage (CCS):

A key assumption underpinning the PAC scenario is that carbon capture and storage **will not be required** to achieve net zero emissions for the European Union.

Global IAM [10,11]
An integrated scenario reaching 1.5°C

We assess the global REMIND 1.7 CEMICS-1.5-CDR8 scenario as an additional line of evidence for pathways for the European Union to achieve the 1.5°C long-term temperature goal of the Paris Agreement. REMIND is a global energy-economy-climate model that maximises inter-temporal welfare. It contains macro-economic, energy system, and climate modules that are integrated to attain exogenously prescribed climate targets.[12]

Population and GDP growth are key drivers of future energy demand and, thus, GHG emissions in IAMs. In our SIAMESE-based downscaling approach, we therefore take growth rates from the shared socio-economic pathway (SSP) scenarios, specifically SSP2, a middle of the road scenario, in order to assess what the EU-region results of this scenario imply for country-specific energy system transformation.

Key outputs for the EU region from this scenario are:

- **90%** renewable energy supply by 2040
- **62% GHG** emissions reduction below 1990 levels by 2030 (excl. LULUCF)
- Net zero emissions between **2045-2050**

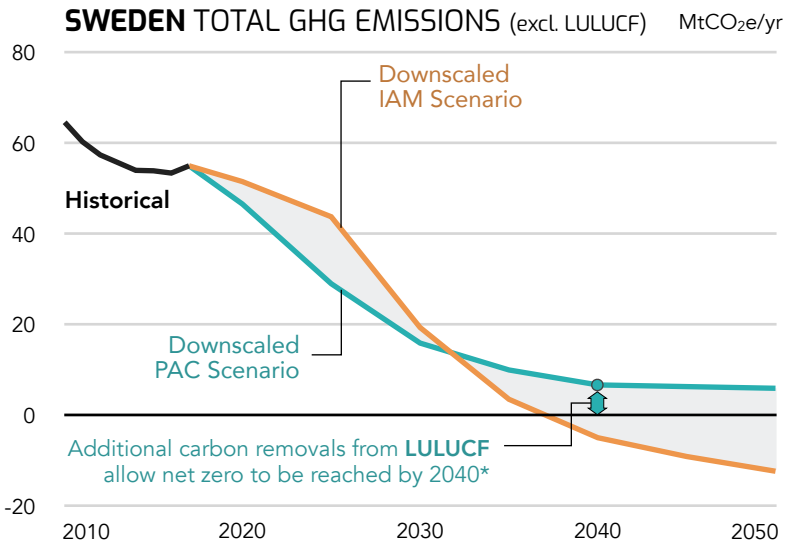
Carbon Capture and Storage (CCS):

This IAM scenario envisages some **natural gas and biomass** combustion with carbon capture and storage.

Economy-Wide 1.5°C Pathways

According to the analysis undertaken in this project, achieving a 1.5°C compatible economy for Sweden requires a 72-78% reduction in total GHG emissions (excluding LULUCF) by 2030 and reaching net zero emissions between 2040 and 2050.

There are numerous different pathways to achieving net zero emissions in this timeframe. In the downscaled PAC scenario where carbon capture and storage is not utilised, a LULUCF emissions sink of 7 $MtCO_2e$ would achieve net zero emissions in 2040. This is far less than the size of the current LULUCF sink, and the projected size of the sink under current policies in the latest year for which there are projections (2035).[5]



*To achieve the net zero emission target, emissions from LULUCF need to be reduced while increasing the capacity of forests, wetlands, grasslands and farmlands to remove carbon. These carbon removals are not equal to emissions in other sectors and the two cannot simply be considered fungible.

1.5°C Compatible 2030 primary energy mix*

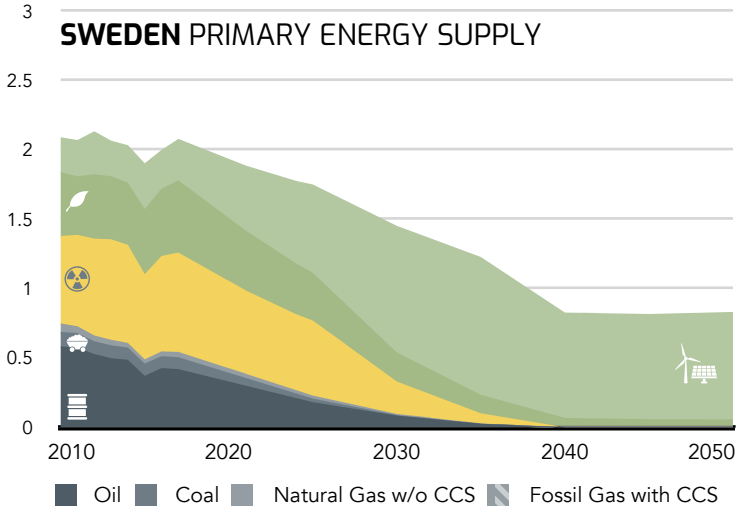
	2017[6]	2030
Renewables incl. biomass	39%	**77–84%** PAC IAM
Unabated Fossil Fuels	26%	**7–10%** PAC IAM
Nuclear	34%	**6–16%** IAM PAC

In the downscaled PAC and IAM pathways, the share of unabated fossil fuels in primary energy demand is reduced to between 7-10% by 2030, whereas the share of renewables including biomass reaches 77-84% by the same year.

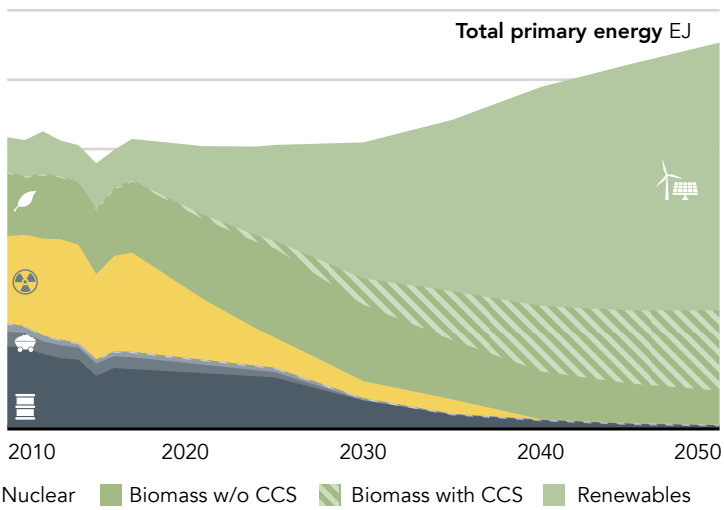
The transport and industry sectors constitute a combined 61% of total GHG emissions in Sweden (2019, excl. LULUCF), illustrating the need for strong policies to reduce the oil demand that produce these sectoral emissions.[7]

*Primary energy supply includes losses that occur during the conversion of nuclear and fossil fuels to electricity, resulting in a higher proportion of both nuclear and fossil fuels than in total final energy demand

Downscaled PAC Scenario



Downscaled IAM Scenario

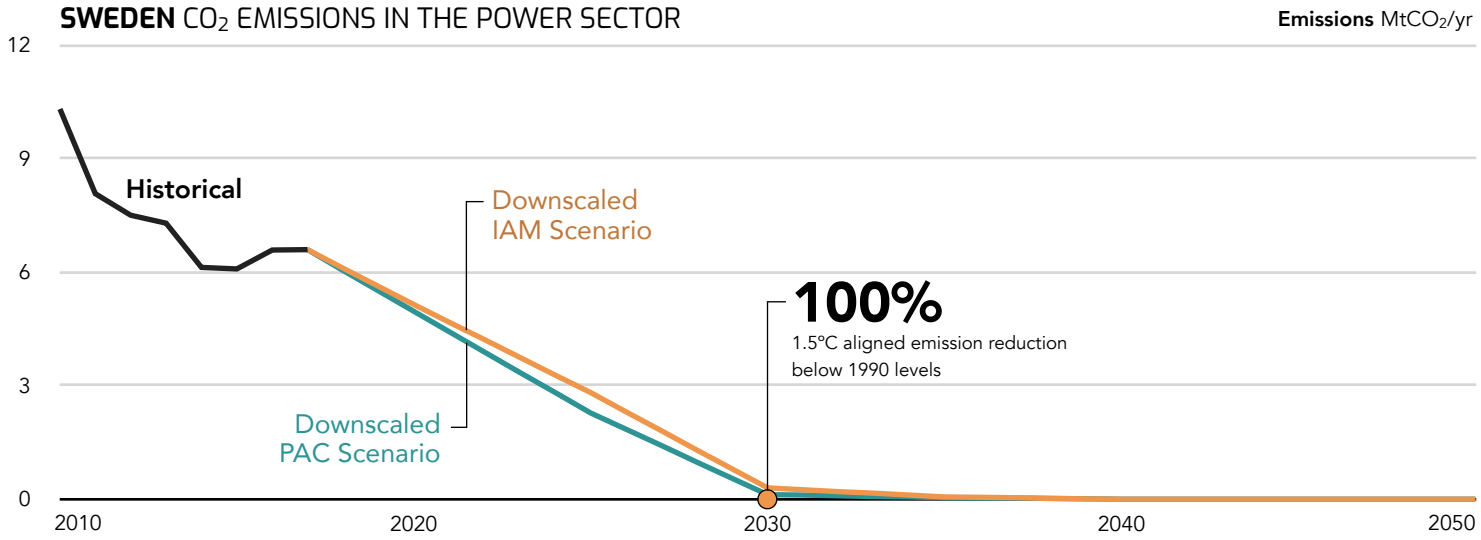


Oil | Coal | Natural Gas w/o CCS | Fossil Gas with CCS | Nuclear | Biomass w/o CCS | Biomass with CCS | Renewables

The PAC scenario depicts a future where total energy use rapidly declines through efficiency gains, largely from switching fossil fuel consumption to renewables, increased rates of material reuse and recycling, and consumer demand reduction.

The IAM scenario also achieves efficiency gains, but assumes energy demand continues to rise over time in line with historical regional growth trends. The large increase in national total primary energy supply reflects the overall increase in the modelled Europe-wide scenario results.

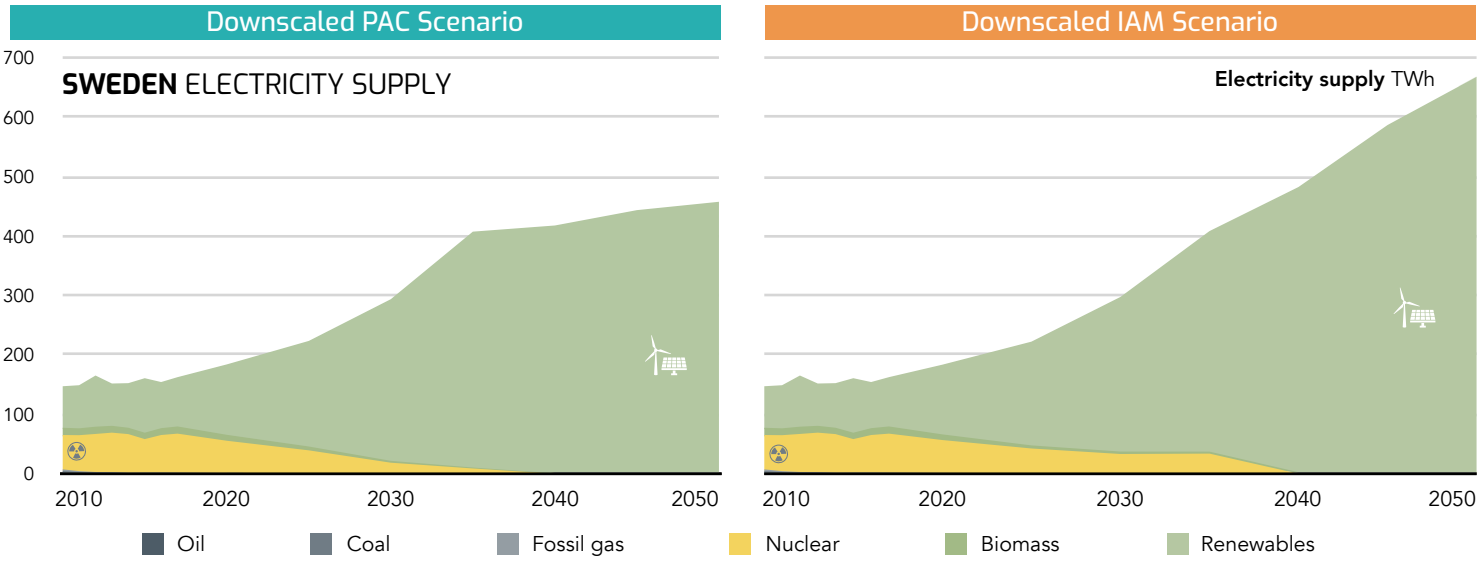
Sectoral decarbonisation: Power



1.5°C Compatible 2030 power sector fuel mix*

	Renewables incl. biomass	Coal	Fossil gas	Nuclear
2017 [6]	58%	1%	0%	40%
2030	90–95% IAM PAC	0%	0%	5–10% PAC IAM

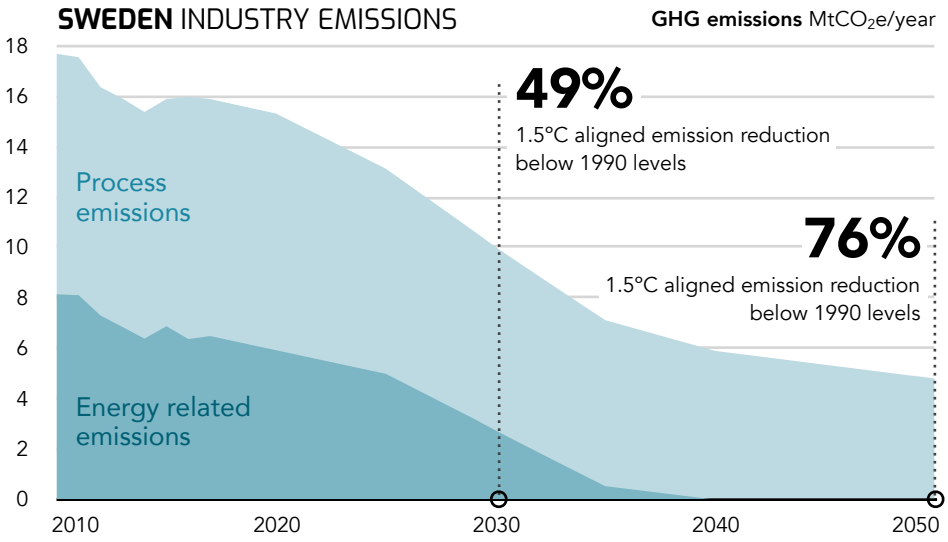
*No detailed wholesale electricity market modelling was undertaken for this assessment



Towards a fully decarbonised power sector

Sweden's power sector is largely decarbonised, with only a very small degree of fossil fuel based generation remaining. Phasing this out as rapidly as possible should be a priority. Due to the need to electrify the economy, total electricity demand in the two downscaled scenarios increases considerably over the coming decades, rising between 3-4 times above current levels by 2050. In these scenarios, biomass plays a diminishingly small role in the Swedish power sector, with non-biomass renewables displacing it and nuclear, and making up all of the increase in total demand.

Sectoral decarbonisation: Industry



Emissions from industry decline significantly until 2040 in the pathway downscaled from the PAC scenario, whereby energy-related emissions reach zero and further reductions occur more gradually. This is due to the nature of these residual (process) emissions that are harder to mitigate than those from fuel combustion.

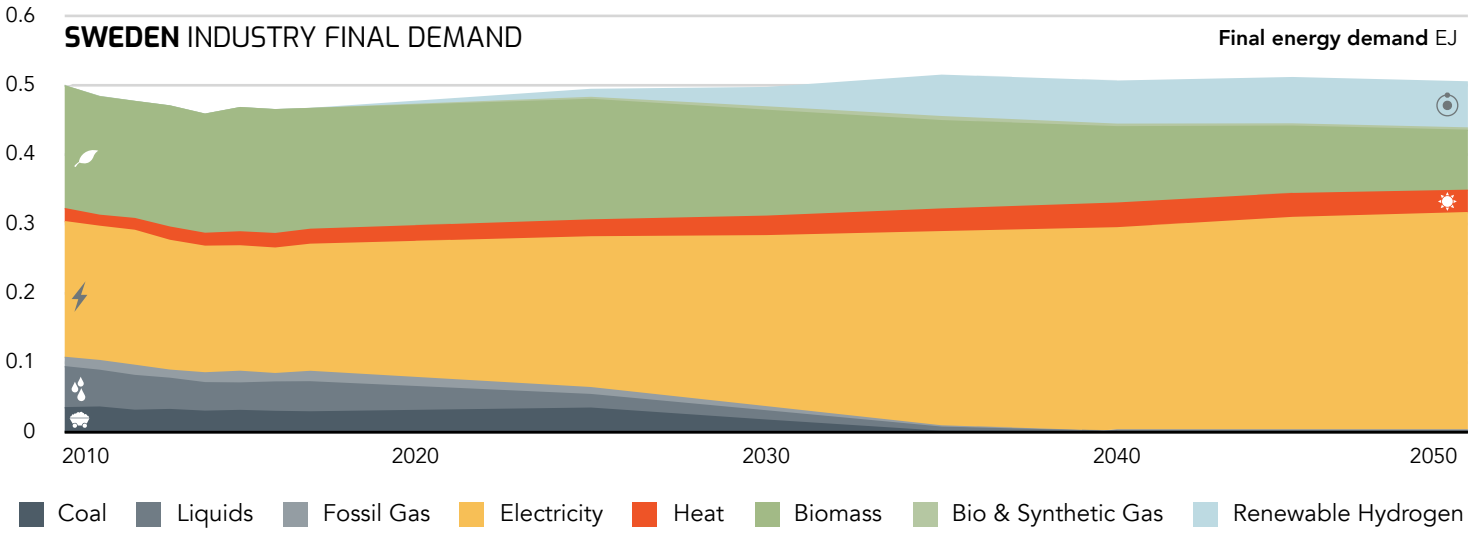
If Swedish steel and cement industries develop as planned, process emissions are likely to decrease more rapidly than in the downscaled PAC scenario shown here.

It was not possible to downscale the chosen IAM scenario due to a misalignment of scenario and historical energy data.

1.5°C Compatible 2030 industry sector final energy mix

	Electricity	Coal	Fossil gas	Renewable Hydrogen
2017 [6]	39%	6%	3%	0%
2030	**50%**	**3%**	**2%**	**6%**

Downscaled PAC Scenario



Towards a fully decarbonised industry sector

Sweden's industry sector is comparatively non-carbon intensive, with only small levels of fossil fuel consumption remaining.[6] Coal and oil demand has been replaced mostly with biomass, which is likely to form a large part of future demand in a decarbonised industry sector. Remaining fossil fuel use should be mostly phased out between 2030 and 2035 to ensure Sweden's industry sector is aligned with the 1.5°C compatible trajectory downscaled from the PAC scenario. Focus now should shift to eliminating Sweden's considerable industry process emissions as quickly as possible.

Closing the Ambition Gap

Key characteristics of Sweden's 1.5°C compatible pathways

	Historic	1.5°C compatible benchmarks		Country targets	
	2017	2030	2050	2030	2050 incl. LULUCF*
Total GHG excl. LULUCF	55 $MtCO_2e/yr$	16–20 $MtCO_2e/yr$	-5–7 $MtCO_2e/yr$	N/A	0 $MtCO_2e/yr$
	23 % below 1990	72–78 % below 1990	92–117 % below 1990	N/A	100 % below 1990
Emissions intensity of power generation**	7 gCO_2/kWh	0 gCO_2/kWh	0 gCO_2/kWh		
Share of renewable power	58 %	90–95 %	100 %		100 % (2040)
Share of unabated fossil fuel in power	1 %	0 %	0 %		
Share of nuclear power	40 %	5-10 %	0 %		
Industry electrification rate	39 %	50 %	71 %		

* 2050 target is shown including LULUCF emissions due to the absence of government projections for these emissions to 2050
** Does not include upstream emissions

Raising Ambition

Setting a 2030 economy-wide emissions target should be a priority for Sweden, and to ensure it is aligned with the 1.5°C compatible downscaled emissions pathways it should be in the range of 72-78% below 1990 levels (excl. LULUCF). Sweden has a high proportion of renewable and low carbon energy use, but a large amount of fossil fuel consumption (primarily oil and petroleum products) remains in the transport and industry sectors.[6] A 2030 target for reducing transport emissions by 70% below 2010 levels is in place, but what is needed is a suite of strong and effective policies.[1] Such policies need to both reduce reliance on personal vehicle use, through incentives and infrastructure for cycling, walking and using public transport, as well as ramp up vehicle electrification.

Other benchmarks

Naturskyddsföreningen: Fossil-free, renewable, flexible - The sustainable energy system of the future[13]

- Phase out of fossil fuels by 2030
- 100% renewables, nuclear phase out by 2040
- 37% reduction in total energy demand between 2017 and 2040

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About the author

Supporting science-based policy to prevent dangerous climate change, enabling sustainable development.

Climate Analytics is a non-profit climate science and policy institute based in Berlin, Germany with offices in New York, USA, Lomé, Togo and Perth, Australia, which brings together interdisciplinary expertise in the scientific and policy aspects of climate change. Our mission is to synthesise and advance scientific knowledge in the area of climate change.

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