# ELECTRO_COUP

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## Electrification of heating and mobility: Socioeconomic impacts of non-ETS policies with sector coupling and sectoral linkages

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# FACTSHEET

**This factsheet summarizes the results of the project ELECTRO_COUP. The project was funded by Austrian Climate and Energy Fund as part of the „Austrian Climate Research Programme" and carried out by Centre of Economic Scenario Analysis and Research (CESAR) and the University of Münster.**

### Project aim:

The ELECTRO_COUP project is about finding ways to make **transportation and heating** in Austria cleaner and more climate friendly. The main focus is on the topics of **electrification** and **sector coupling between electricity, heating, and mobility**. The project looks at several **decarbonisation scenarios** to see how different measures can help reduce carbon emissions and how they will affect the economy and energy usage in the country. Through this analysis, the project aims to find the best ways to achieve Austria's climate goals for 2030 and 2040.

### Important questions:

- How can the electrification of the Austrian mobility and heating sectors and sector coupling contribute to deliver the Austrian decarbonisation targets for 2030 and 2040?
- What are the expected consequences on common energy and socio-economic indicators (e.g., $CO_2$ emissions, energy efficiency, GDP by industry, employment by industry)?
- How much additional electricity is needed to couple the power sector with transport and heating and how is this additional electricity supplied?

## Decarbonization, sector coupling and electrification

**Decarbonization** refers to the process of reducing greenhouse gas emissions, particularly carbon dioxide ($CO_2$), to mitigate climate change. It involves shifting away from fossil fuels (such as coal, oil, and natural gas) and adopting cleaner energy sources and technologies to minimize the $CO_2$ pollution of various sectors, such as electricity generation, transportation, and buildings.

**Sector coupling,** on the other hand, is about integrating and connecting different sectors of the energy system to achieve greater efficiency and flexibility. It involves linking sectors like electricity, heating, and transportation, allowing them to work together and share energy resources and infrastructure.

**Electrification** refers to the process of replacing traditional fossil fuel-based technologies with electric-powered alternatives. It implies using electricity as the primary energy source in various sectors, such as transportation, heating, and industry, instead of relying on fossil fuels. The advantages of electrification are that electricity can be generated from renewable energy sources, such as solar, wind, and hydro power. By electrifying different sectors, we can reduce greenhouse gas emissions and make significant progress towards decarbonization.

# Decarbonizing transport and heating

The EU climate policy architecture distinguishes sectors covered by the EU Emissions Trading Scheme (ETS) from sectors not included in the EU ETS. The EU ETS is the key climate policy to drive the decarbonization of the EU electricity system. However, the emissions from transport and heating are not included. Especially in these sectors the potential for reducing $CO_2$ emissions is seen to be substantial. While about 80% of the total electricity generation in Austria already comes from renewable sources, fossil fuels still dominate in the areas of heating and mobility/transport.

**Austria's policy targets related to the decarbonization of heating and mobility:**

- 100 % of total electricity consumption with renewable energy sources from 2030 onwards.
- goal of 80% reduction in building sector GHG emissions by 2050 compared to 1990.
- phase-out of fossil fuel heating systems by 2040
- 100% emission-free passenger cars from 2035 onwards.

# The ELECTRO_COUP Scenarios

**Aim:** Achieving decarbonization in the sectors transport and heating by 2040

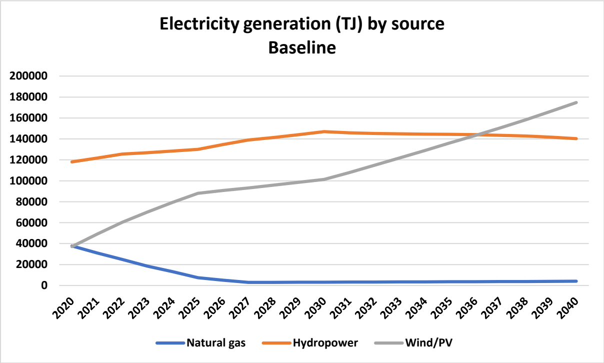
We designed three decarbonization scenarios tailored specifically for mobility and space heating in Austria. These scenarios explore paths for electrification in both the transport and heating sector, as well as sector coupling, all with the aim of contributing to achieving full decarbonization by 2040.

The scenarios were simulated using an integrated energy-economy model to see how they would affect energy use, carbon emissions, and the economy. The modeling provides estimates for several indicators, including gross domestic product (GDP), $CO_2$ emissions, energy efficiency, value added, and employment by industry. The simulations were carried out up to the year 2040.

**Baseline scenario:**

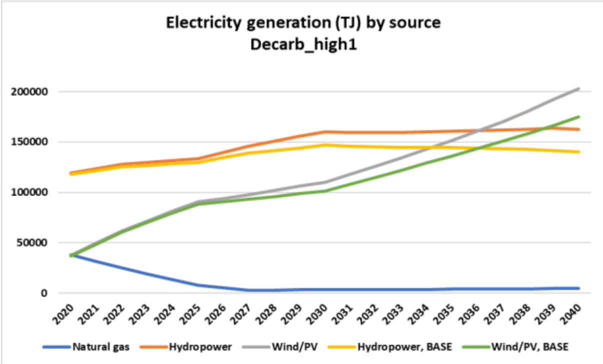
The baseline scenario is designed to achieve the ambitious objective of generating 100% of electricity from renewable sources by the year 2030. However, it does not account for decarbonization efforts in the transport and heating sectors.

The figure shows that, in terms of electricity generation, natural gas production is fading out, while wind and photovoltaic plants are expanding strongly, and hydropower is developing at an almost constant rate. Under these general conditions, GDP grows at 2.0% p.a. and overall economic energy efficiency (per unit of GDP) increases by 0.4% p.a., while $CO_2$ emissions decline by approx. 1% p.a. (in line with the trend since 2005).

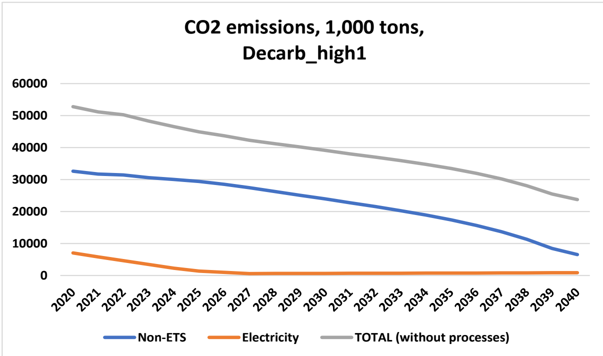


### Decarbonizing 2040 – High System Efficiency 1 (Decarb_high1):

High $CO_2$ prices lead to changes in demand due to refurbishments and a shift towards using electric vehicles, resulting in decarbonization of the transport and heating sectors and the generation of additional renewable electricity. The additional electricity needed comes from renewable energy sources. The use of wind and PV as well as hydropower increase compared to the baseline scenario, while gas generation drops to zero by 2030, as in the baseline scenario (see figure beside).

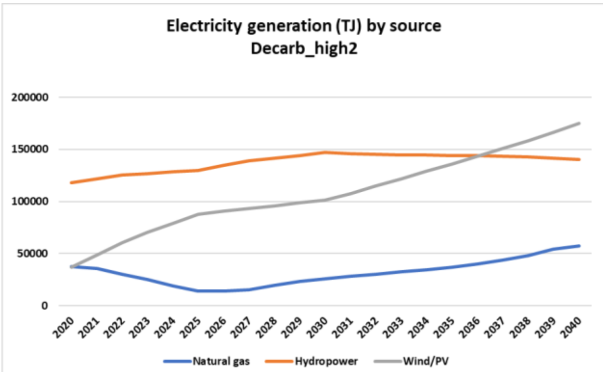



GDP growth is barely higher on average than in the baseline scenario, overall economic energy efficiency increases by 0.9% p.a., and by as much as 1.4% p.a. in the 2030-40 period, largely due to the efficiency effect of road transport electrification. The amount of electricity needed for decarbonization can be produced with renewable inputs (+28 PJ wind/PV by 2040). The higher renewable energy deployment results in large decreases in $CO_2$ emissions. The electricity sector is $CO_2$-free from 2030 onwards, the emissions in the non-ETS sectors can be reduced substantially (see figure beside).

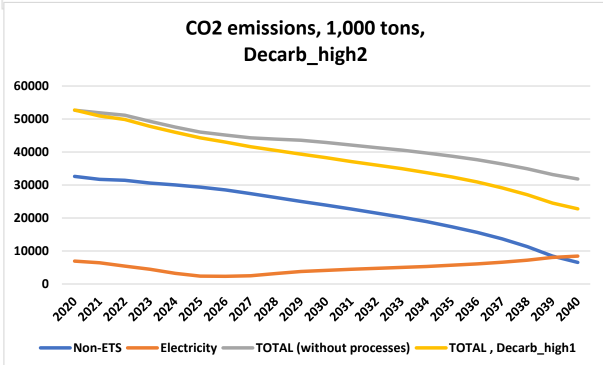



### Decarbonizing 2040 – High System Efficiency 2 (Decarb_high2):

In the second high system efficiency scenario, we explore an alternative pathway. Here, we consider the possibility of using gas for electricity generation instead of renewables. In the non-ETS sectors, the same decarbonization measures are applied as in the first scenario. The additional electricity needed is provided exclusively with a higher electricity generation from gas (+53 PJ natural gas by 2040).



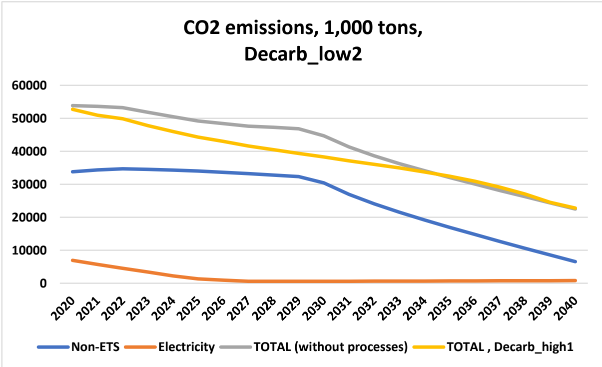

This scenario leads to fewer investments in renewable energy compared to Decarb_high1. Additionally, higher costs for emission permits result in a 20% increase in electricity prices by 2040. Consequently, both these factors make the scenario Decarb_high2 less effective in achieving decarbonization. The impact on GDP is similar as in Decarb_high1.




This scenario shows a negative sector coupling effect that increases $CO_2$ emissions from electricity generation by 9 Mio tons in 2040, offsetting 44% of decarbonization in non-ETS sectors.

### Decarbonizing 2040 – Low System Efficiency (Decarb_low):

In this scenario, we focus on an alternative approach to decarbonization. Instead of improving efficiency and using direct electricity, we explore the option of replacing fossil fuels with e-fuels. However, it's important to note that this is a hypothetical scenario, as it is unlikely that e-fuel technologies would be widely adopted, because they are expensive. While this scenario still achieves a similar path of emission reduction as the other two scenarios, it comes at higher costs (aggregate price level) and yields lower positive economic impacts.




## Conclusions from the project

Overall, the study shows that policy interventions are essential for successful decarbonization, and using more electricity from renewable sources is a key part of the solution.

ELECTRO_COUP looked at different ways to decarbonize the non-ETS sectors transport and heating by using better technology and renewable electricity. It is found that sector coupling and replacing fossil fuels by electricity can work well. But if not done carefully, some of the pollution reduction could be lost. It is important to note that sector coupling can lead to higher electricity prices and dampen the positive economic impacts of decarbonization efforts.

The scenarios offer valuable insights into different pathways to reduce $CO_2$ emissions in transport and heating, emphasizing the importance of renewable energy adoption and the potential challenges posed by fossil fuel-based electricity generation or hypothetical technologies like e-fuels. Altogether, the project has significantly improved our understanding of the decarbonization potential of sector coupling and the interconnections between the Emissions Trading System (ETS) and non-ETS sectors.

## ELECTRO_COUP

**Duration:** 1st October 2021 – 30th June 2023

**Lead:** Centre of Economic Scenario Analysis and Research (CESAR)

**Partner:** Westfälische Wilhelms-Universität Münster (WWU) Münster, Lehrstuhl für Mikroökonomik, insbes. Energie- und Ressourcenökonomik

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