ELECTRO_COUP

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

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POLICY BRIEF

The role of sector coupling in Austria's decarbonization: Integrating electricity, heating, and mobility

Insights from the ELECTRO_COUP project

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.

ELECTRO_COUP KEY POINTS:

- **Sector coupling** is a key strategy that can help Austria to achieve its ambitious climate goals. It involves **integrating the electricity, heating, and mobility** sectors to work together more effectively and share energy resources and infrastructure.
- Carefully designed sector coupling strategies have the **potential to significantly reduce CO_2 emissions** in the heating and transport sectors. However, there is a risk of losing some of the saving potential, if for example part of the carbon reduced in heating and transport may reappear in the electricity sector (**sector leakage**).
- The outcome of leakage in the electricity sector depends on how the additional electricity demand is covered. This emphasizes the utmost **importance of thoughtful planning and implementation** to prevent unintended consequences in the decarbonization process.
- Policy measures such as **carbon pricing** are crucial in promoting decarbonization heating and mobility. These measures incentivize **energy efficiency improvements** and the **direct use of electricity** (electrification) for heating and transportation. The advantage of using electricity lies in its efficiency, making the overall decarbonization process more effective in reducing emissions and advancing towards a cleaner and more sustainable future.
- Sector coupling is only one part of a **comprehensive decarbonisation strategy**. In addition to coupling the electricity, heat and transport sectors, the proposed climate protection goals would only be achieved with a substantial **reduction in consumption**, combined with higher shares of renewable energies.

Sector coupling, the integration of electricity, heating, and mobility sectors, presents an important cornerstone for Austria to achieve its ambitious decarbonization goals.

After providing some insights from the scenario modelling of ELECTRO_COUP this policy brief outlines the potential benefits, challenges, and key policy recommendations for effective sector coupling to ensure the transition towards a sustainable and low-carbon future.

Some insights from the ELECTRO_COUP Scenarios

Methodology of ELECTRO_COUP:

In addition to a baseline scenario, 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.

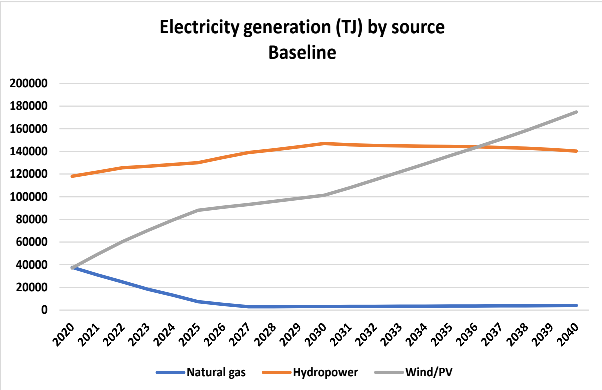
Results of scenario modeling:

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. Making heating and mobility more climate friendly depends on policy measures like **carbon pricing**. These policies encourage **energy efficiency** and **using more electricity** (electrification) instead of fossil fuels. Even without specific decarbonization measures, there is already a significant increase in using electricity for heating and transportation in the baseline scenario. In the decarbonization scenarios, electrification becomes even more important.

Baseline scenario:

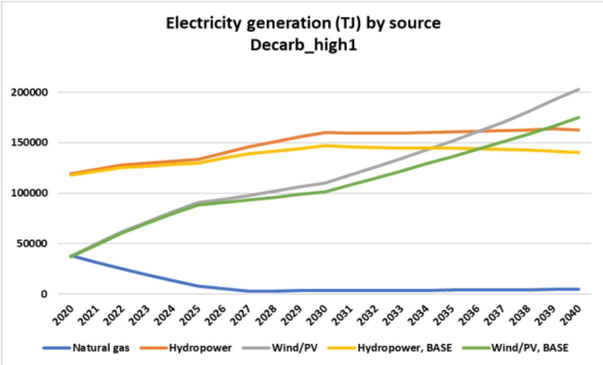
The baseline scenario is designed to achieve the ambitious objective of generating 100% of electricity from renewable sources by the year 2030. However, it does not account for decarbonization efforts in the transport and heating sectors.

The figure shows that, in terms of electricity generation, natural gas production is phasing 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). Even in the baseline scenario, there is a substantial reduction in the demand for some fossil fuels, specifically oil products.

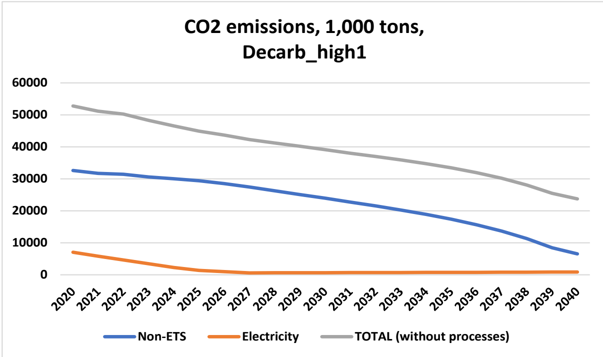


Decarbonizing 2040 – High System Efficiency 1 (Decarb_high1):

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).

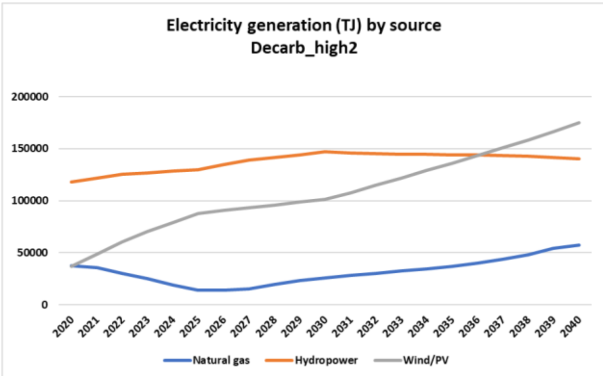


GDP growth is barely higher on average than in the baseline scenario, overall economic energy efficiency increases by 0.9% p.a., and by as much as 1.4% p.a. in the 2030-40 period, largely due to the efficiency effect of road transport electrification. The amount of electricity needed for decarbonization 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).



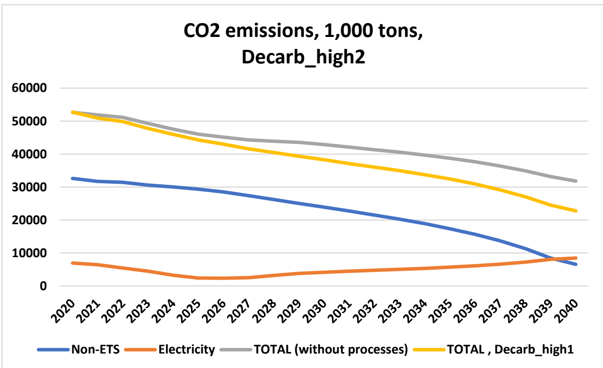
Decarbonizing 2040 – High System Efficiency 2 (Decarb_high2):

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 heating and transport sectors, the same decarbonization measures are applied as in the first scenario. The additional electricity needed is provided exclusively with higher electricity generation from gas (+53 PJ natural gas by the year 2040).



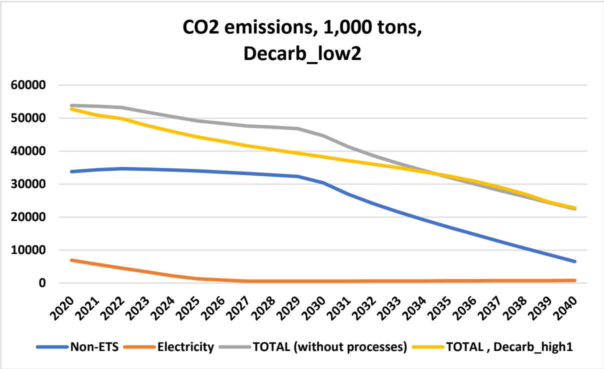
This scenario leads to fewer investments in renewable energy compared to Decarb_high1. Additionally, higher costs for emission permits result in a 20% increase in electricity prices by 2040. Consequently, both these factors make the scenario Decarb_high2 less effective in achieving decarbonization. The 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 and not widely available. 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 scenarios:

ELECTRO_COUP has examined different ways to decarbonize the non-ETS sectors transport and heating by using better technology and renewable electricity. Sector coupling and electrification, through the replacement of fossil fuels with electricity, have proven to be effective strategies. However, if not carefully managed, there is a risk of losing some of the reduction benefits. Additionally, sector coupling might lead to higher electricity prices and could potentially dampen the positive economic impacts of decarbonization efforts.

The scenarios have provided valuable insights into various pathways for reducing CO_2 emissions in transportation 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.

Advantages of sector coupling

Decarbonization opportunities: The coupling of sectors enables the adoption of cleaner energy sources, promoting the shift away from fossil fuels towards renewable energy technologies.

Enhanced energy efficiency: Sector coupling allows for better coordination and integration between different energy sectors, leading to increased overall energy efficiency. For instance, excess electricity from renewable sources can be used to power electric vehicles or provide heating, making the best use of available energy resources.

Flexibility and resilience: By coupling different energy sectors, the energy system becomes more flexible and resilient to fluctuations in energy supply and demand. This enables the effective management of energy resources and ensures a stable and reliable energy supply.

Energy storage and demand response: Sector coupling facilitates the integration of energy storage technologies and demand response mechanisms, resulting in efficient energy storage and the flexibility to adjust energy consumption patterns in response to demand.

Technological innovation: The integration of different energy sectors encourages technological advancements and innovations, fostering the development of more efficient energy solutions.

Economic opportunities: Sector coupling opens up new economic opportunities by promoting the growth of renewable energy industries, creating jobs, and stimulating economic growth in related sectors.

Grid stability: Integrating diverse energy sources through sector coupling enhances grid stability, ensuring a secure and reliable energy supply even with the increasing penetration of intermittent renewable energy sources.

Energy Independence: Sector coupling can reduce dependency on imported fossil fuels, enhancing energy security and increasing the resilience of the energy system against external shocks.

Challenges of sector coupling

Technological integration: Ensuring seamless integration between sectors requires advances in technology, infrastructure upgrades, and smart energy management systems.

Policy coordination: Successful sector coupling necessitates collaboration between different government departments and stakeholders to develop cohesive and supportive policies.

Cost and investment: Implementing sector coupling may require upfront investments, but the long-term benefits in terms of reduced emissions and energy savings outweigh the initial costs.

Infrastructure requirements: Effective sector coupling often requires significant investments in infrastructure, such as smart grids, energy storage facilities, and advanced communication systems. Building and upgrading these infrastructures can be costly and time-consuming.

Regulatory and policy barriers: Existing regulations and policies may not always support sector coupling initiatives. Policy frameworks need to be adapted and streamlined to encourage and facilitate integration.

Overcoming inertia: Traditional practices and established energy systems can hinder the adoption of sector coupling. Overcoming inertia and promoting a shift towards integrated energy systems may encounter resistance.

Behavioral changes: Sector coupling may require behavioral changes from consumers and businesses, such as adopting new energy practices and technologies. Convincing stakeholders to embrace these changes can be a challenge.

Policy uncertainty: The success of sector coupling relies on long-term, stable policies that provide certainty to investors and stakeholders. Policy uncertainty can deter investments and slow down the adoption of integrated energy systems.

Policy recommendations

To effectively reduce carbon emissions in Austria, the concept of sector coupling must be considered, emphasizing the interconnectedness of electrification, heating, and mobility. This approach fosters efficient collaboration among these sectors, allowing them to leverage clean energy sources and technologies synergistically.

Careful consideration of sector coupling strategies is essential to enable a successful transition towards a low-carbon future while effectively addressing potential challenges and minimizing negative impacts on the overall decarbonization efforts.

Electrification of heating and mobility reduces carbon emissions, improves energy efficiency, and supports the integration of renewable energy sources. However, challenges include infrastructure requirements, range anxiety, and initial costs. Overcoming these hurdles is essential to achieve widespread adoption and reap the benefits of electrification.

While sector coupling and electrification are important aspects in reducing carbon emissions, a successful and comprehensive decarbonization strategy requires a holistic approach, integrating various measures and policies. Combining sector coupling with energy efficiency improvements, renewable energy adoption, innovative technologies, and well-designed policy interventions amplifies the impact of our decarbonization efforts. This holistic approach addresses the complexity of transitioning to clean energy and fosters a resilient and environmentally friendly energy system.

Summary and conclusions

This policy brief highlights the importance of sector coupling for achieving sustainable decarbonization in Austria. Sector coupling involves integrating electricity, heating, and mobility sectors to optimize energy use and reduce emissions.

The integration of carbon pricing and strategic policy measures, coupled with the promotion of electrification, plays a crucial role in unlocking the potential for decarbonization and creating a more energy-efficient and environmentally conscious economy. Nonetheless, it is crucial to carefully consider the effects and challenges of sector coupling when designing decarbonization policies.

The ELECTRO_COUP project has conducted a comprehensive analysis of sector coupling's potential to reduce carbon emissions in heating and mobility. By examining various decarbonization scenarios, the project has explored the impact of different measures on carbon reduction, on the economy, and on energy consumption in Austria. The findings provide valuable insights into the feasibility and implications of sector coupling as a crucial strategy in achieving sustainable and low-carbon energy systems.

However, the analysis has some limitations, such as focusing only on Austria and not considering feedback from the EU permit market. Addressing these limitations in future analyses will provide a more comprehensive understanding of sector coupling and enhance decarbonization predictions. Overall, sector coupling offers a promising pathway towards sustainable and efficient decarbonization in Austria.

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