The cost-effectiveness of climate protection measures in Austria

Study commissioned by the Fiscal Advisory Council[1]

We can assess climate action by looking at the various dimensions of their objectives. In particular, we consider measures' impact on CO2 emissions, greenhouse gas abatement costs and distributional effects, but also, importantly, political feasibility. Hence, we can achieve an optimal climate policy mix by taking into account the various advantages and disadvantages of price-dependent and rule-based measures, public investment and information campaigns. Austria's current National Energy and Climate Plan seems to attach rather little importance to the cost-effectiveness of climate action. Costly, but not very effective, measures like the KlimaTicket travel pass have been implemented, while cost-effective regulatory measures like reducing the speed limit on Austria's roads have not been considered. We find that making better use of regulatory measures and public information campaigns could help reduce CO2 emissions at much lower overall economic and fiscal cost.

Austria needs to follow an ambitious path toward reducing its greenhouse gas emissions to meet the targets set out in the European Commission's "Fit for 55" package and its national plan of achieving climate neutrality by 2040. The planned measures to reduce emissions entail high overall economic and fiscal costs. The Fiscal Advisory Council has commissioned this study to gain a better understanding of Austria's budgetary risks associated with climate action. Therefore, we focus on assessing the costs and benefits of the emission reduction measures contained in Austria's National Energy and Climate Plan (NECP). Given data constraints, we only look at selected NECP measures, especially those with a high budgetary impact.

We assess measures' **effectiveness in reducing CO2 emissions**, and calculate **greenhouse gas abatement costs**, i.e. the costs associated with achieving emission targets. **Cost-effectiveness** establishes a link between effectiveness and abatement cost. The degree of cost-effectiveness is measured in euro per avoided ton (t) of CO2 equivalents and presented in marginal abatement cost curves. Climate action may have an impact on GDP growth or cause changes in behavior and hence, in addition to abatement costs, may create **budgetary effects** on government revenues and expenditure. For example, if people use their cars less often or if there are, overall, fewer cars on Austria's roads, government revenues from the mineral oil tax and the engine-related insurance tax will fall. Finally, public acceptance, which is strongly influenced by social norms, often determines decisions on whether a measure is considered to be **politically feasible**, its adoption and sustained implementation.

There is a wide range of instruments that can be used to cut greenhouse gas emissions and adapt to climate change. We can distinguish between incentive-based and regulatory instruments. **Incentive-based instruments** use prices to offer incentives to emitters to reduce their greenhouse gas emissions. CO2 taxes and tradable emission certificates are practical examples of such instruments. Also, excise taxes on fuel, electricity and vehicles work in a way similar to CO2 taxes. However, in the former, the link between emission intensity and tax amount may be weaker and hence their effect may be smaller (i.e. equal amounts of tax revenues achieve less CO2 reduction). Subsidies can help reduce the price of energy from alternative sources and support climate-friendly production processes and the development and dissemination of new technologies. Given that in subsidization schemes, differentiating between emitters is only possible to a limited extent, the cost-effectiveness of this instrument is low compared to taxes

---

[1] The opinions expressed by the authors of this study, Johannes Holler and Susanne Maidorn, do not necessarily reflect those of the Austrian Fiscal Advisory Council.

that are directly linked to emission intensity or tradeable emission certificates. Public information campaigns can help nudge people toward climate-friendly behavior.

Governments can use **regulatory instruments** to limit or prevent behavior that is harmful to the climate. Legislative acts lay down in detail certain rules and standards (such as, in Austria, the Renewable Heat Act banning fossil fuels in heating systems of newly erected buildings), and it is key that compliance with these regulations is monitored, and breaches are sanctioned. Regulatory measures can sometimes be highly cost-effective (e.g. reducing speed limits).

In addition to market-based and regulatory instruments, governments may also take climate action through **public investment**. Price incentives and abatement costs usually play a minor role in decisions about public investment, not least because alternative economic policy goals, like, e.g., the provision of infrastructure, are also taken into account.

In this study, we focus on the cost-effectiveness of NECP measures in buildings and transport, which are among the largest emitting sectors outside the scope of the EU Emission Trading System (EU ETS), that also have a considerable budgetary impact.

1. BUILDINGS

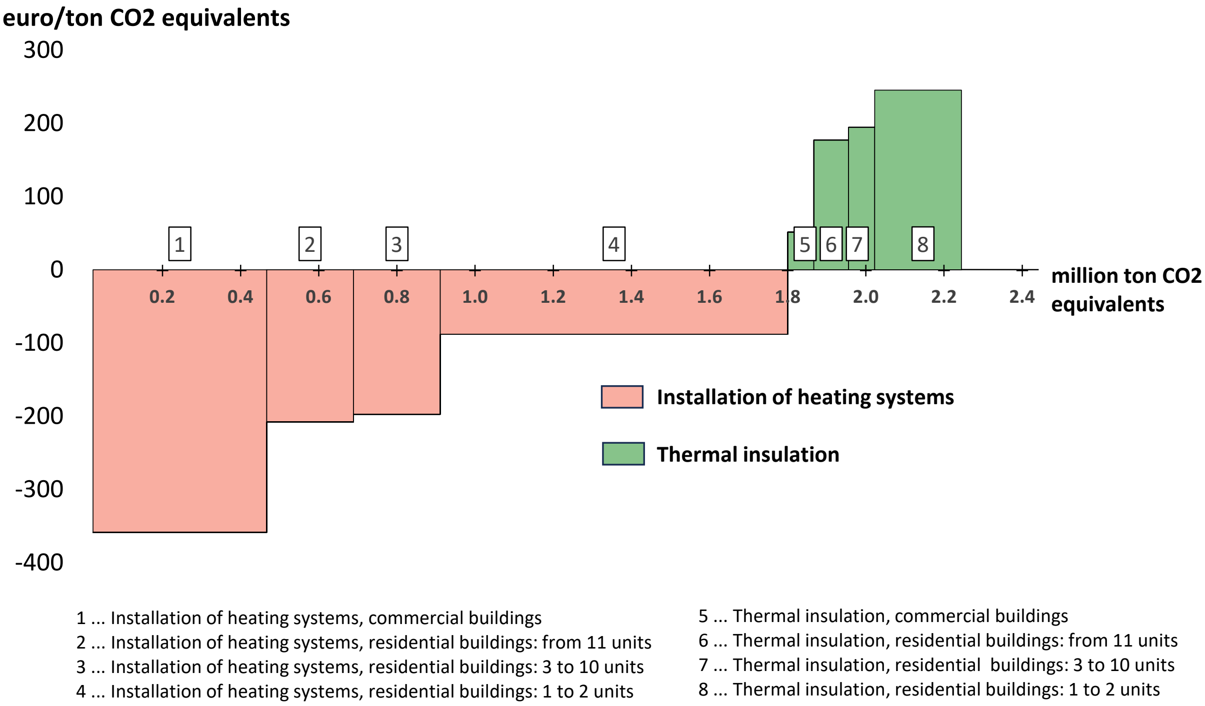
Thermal insulation and boiler replacements are effective in reducing emissions in buildings. Thermal insulation improves buildings' energy efficiency and substantially reduces energy consumption. Replacing old boilers with low-carbon models can also help significantly reduce emissions.

The data we use in our calculations have been provided by Environment Agency Austria (Umweltbundesamt – UBA) and are based on the "with additional measures" (WAM 2024) scenario of the NECP. This scenario assumes that current subsidies programs, e.g. "Raus aus Öl und Gas" ("Giving up oil and gas"), will be continued. We include owners' investments, including subsidies, that increase a building's thermal standard to a level higher than that achieved through maintenance alone. For boiler replacements, we include investments if they involve a change of energy source; of such investments, we include solely the portion that represents the additional costs compared to the costs of replacing a boiler with the same model. Calculating abatement costs, we distinguish between long-term investments in the renovation of buildings (capital expenditure – CAPEX) and the current costs of heating and hot water supply (operational expenditure – OPEX). All investment expenditure is spread over the life of an investment.

Chart 1 shows the marginal abatement cost curve for 2024 to 2030, taking into account the avoidance of direct and indirect greenhouse gas emissions. You can see abatement costs in euro per CO2 ton equivalents saved and the modeled scope of abatement in CO2 ton equivalents separately for low-carbon heating systems and the thermal insulation of a building's outer walls.

We show abatement costs by different types of buildings, distinguishing between commercial and residential buildings (the latter in different sizes: 1 to 2 housing units, 3 to 10 housing units, 11 and more housing units).

Chart 1: Marginal abatement cost curve for buildings 2024 to 2030



Source: e-think energy research (2024): Zentrum für Energiewirtschaft und Umwelt (e-think). WAM 2024 scenario, data: Umweltbundesamt (Environment Agency Austria); authors' calculations.

Our calculations show that investments in heating systems (boiler replacement) and thermal insulation as described in the NECP yield yearly emission savings in the amount of 2.2 million ton CO2 equivalents in the period from 2024 to 2030. These emission savings are achieved primarily in buildings and amount to some 30% of buildings' greenhouse gas emissions in 2022.[2] The marginal abatement costs drop with building size. In larger buildings, it is possible to achieve emission savings at lower cost because the surface that needs to be insulated is smaller in relation to living space, and boiler replacements are made for more living space. For all buildings, we see that a change in heating systems results in a drop in energy costs that exceeds the climate-relevant additional costs over the investment's life. This leads to negative abatement costs, which are even higher for larger buildings. Savings range from around 80 EUR/t CO2 equivalents in residential buildings with 1 to 2 units to around 360 EUR/t CO2 equivalents in commercial buildings.

2. TRANSPORT

In transport, the reduction in CO2 emissions is planned to be achieved through a mix of numerous individual measures, according to the "with existing measures" (WEM) and "with additional measures" (WAM) scenarios in the NECP. The measures we look at here are from the packages titled "Promoting electromobility" ("Forcierung der Elektromobilität") and "Making public transport better" ("Ausweitung und Attraktivierung des öffentlichen Verkehrs." The UBA was unable to provide us with data for calculating marginal abatement costs for individual measures in transport (like it did for measures in buildings),

2 Indirect emissions in the energy and industrial sectors see a moderate net increase.

because the transport modeling for the NECP is made at the sector level due to interactions in the transport system. Hence, the following discussion is based on our own calculations.

Promoting electromobility: Under its "Fit for 55" package, the EU has submitted an amended regulation[3] that lays down stricter CO2 performance standards for registered new cars and vans (fleet-wide average). Our calculations of the reduction in CO2 emissions are based on the assumption that the EU's fleet targets will be met. The abatement costs are the additional costs of electric cars compared to fossil-fuel cars, including operating and infrastructure costs. We also included programs for promoting the transition to emission-free buses in public passenger transport (Emissionsfreie Busse und Infrastruktur – EBIN) and to emission-free utility vehicles (Emissionsfreie Nutzfahrzeuge und Infrastruktur – ENIN), which are both part of the mix of measures in transport.

Making public transport better: Expanding and improving public transport shall help increase the number of people using public means of transport instead of cars. A key set of measures deals with railway infrastructure investments[4] as set out in ÖBB-Infrastruktur AG's 2024–2029 framework program[5]. In order to estimate the potential for reducing greenhouse gases and the associated abatement costs, we took into account those investments that, according to the framework program, reduce travel times (e.g. development of double track sections) and increase passenger numbers. Since the KlimaTicket was also launched to increase demand in public transport, we quantify the relevant abatement costs and CO2 savings. Finally, we also include measures to increase the share of electrified lines in the ÖBB's network, given that this shall also contribute to greenhouse gas avoidance.

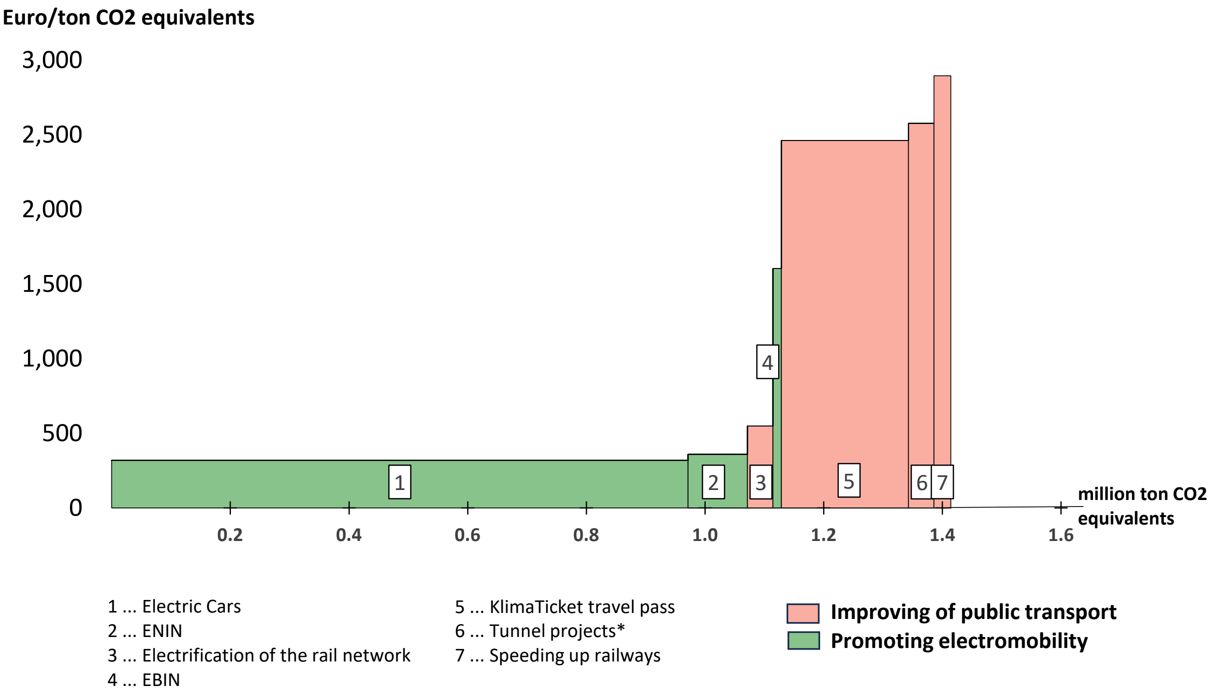
The abatement costs of the measures we analyzed individually vary widely. The use of electric cars incurs abatement costs of around 320 EUR/ton CO2 equivalents and is therefore, in relative terms, one of the most cost-effective measures. The associated abatement potential for the period 2024 to 2030 amounts to approximately 1 million ton CO2 equivalents, which represents 60% of the abatement potential of all transport-related measures.

3 Regulation (EU) No. 2023/851.

4 Maintenance investments are not taken into account.

5 See Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology and ÖBB-Infrastruktur AG (2023).

Chart 2: Marginal abatement cost curve in transport 2024 to 2030



* Brenner Base Tunnel, Semmering Base Tunnel, Koralm railway, Köstendorf-Salzburg Tunnel.
Source: Authors' calculations.

Among the measures aimed at improving public transport, the further electrification of the rail network is considerably more cost-efficient than the other measures, accounting for an abatement potential of far below 0.1 million tons CO2 equivalents and abatement costs of around 550 EUR/t CO2 equivalents. In contrast, we see low cost-efficiency in the investments under ÖBB-Infrastruktur AG's framework program for speeding up railways and large-scale projects like the Brenner Base Tunnel and the Koralm Railway, which incur high abatement costs of 2,900 EUR/t CO2 equivalents and 2,580 EUR/t CO2 equivalents, respectively.

That said, the assessment of the cost-effectiveness of investments in railway infrastructure cannot be limited to looking at their role in avoiding greenhouse gases. Such investments primarily serve to improve and provide infrastructure that helps reduce road traffic and makes Austria more attractive for businesses; climate protection is only a secondary goal. Subsidies for the KlimaTicket contributed 0.2 million tons CO2 equivalents to the avoidance of greenhouse gases in 2024, according to our calculations. At the same time, the associated marginal abatement costs were high at 2,460 EUR/t CO2 equivalents compared to other measures in the literature.

3. SUMMARY

The cost-effectiveness of individual measures has so far gained little attention when it comes to taking climate protection action at the international or national level. Our analysis calculated the cost-effectiveness of climate protection measures in Austria that have a considerable budgetary impact based on the National Energy and Climate Plan (NECP). We determine the degree of cost-effectiveness by looking at the marginal abatement cost of individual measures. This indicator measures the overall economic cost per ton of avoided CO_2. In addition, we show each measure's CO_2 avoidance potential. In the following, we summarize the key results of our analysis for measures in buildings and transport, two sectors that are particularly relevant in climate protection.

As regards buildings, the NECP measures focus on thermal insulation and heating. The marginal abatement costs in this area illustrate very well that it is above all a building's size that determines the cost-effectiveness of measures. In commercial and large residential buildings, thermal insulation and low-carbon heating systems can achieve the same amount of CO_2 avoidance at lower cost than in smaller buildings at higher cost. This is because larger buildings can be renovated and heated more efficiently. At the same time, our results show that smaller buildings have the highest CO_2 avoidance potential, while the marginal abatement costs are higher. For boiler replacements, however, the calculated marginal abatement costs are even negative for all types of buildings. This means that the discounted energy savings over the life of a new boiler exceed the related investment costs. This is a big incentive for switching to low-carbon heating. At the same time, renters' and owners' diverging interests and legal rights and duties make it difficult to push ahead with heating replacements in rented-out buildings. Our results suggest that it would pay off to step up information campaigns about potential cost savings through heating replacements and to make the necessary amendments to rental legislation. This could help reinforce the effects of subsidies programs and adjust the amount of funds without jeopardizing CO_2 reduction.

In transport, our analysis focuses on measures aimed at improving and promoting public transport and supporting electromobility. We find that these measures' marginal abatement costs indicate significantly lower cost-effectiveness compared to the analyzed measures in buildings. Increasing the number of electric cars to the EU fleet target level by 2030 is the most cost-efficient measure with the largest CO_2 avoidance potential. Except for the KlimaTicket, the measures aimed at improving public transport all relate to expanding and modernizing Austria's railway infrastructure. The marginal abatement costs of these measures are at a high 2,900 EUR/t CO_2 equivalents, even if we take into account that their effect unfolds for a very long time (up to 50 years). In other words, as climate measures, they are very cost-ineffective. That said, the costs and benefits of expanding and modernizing the rail infrastructure must not be assessed solely on the basis of CO_2 avoidance; rather, we must also acknowledge that these are primarily investments in important infrastructure. The KlimaTicket has the second largest CO_2 avoidance potential, next to electromobility, but at the same time incurs marginal abatement costs of 2,460 EUR/t CO_2 equivalents, which makes the travel pass a very ineffective climate protection measure.

The climate policy mix of the NECP is the result of political negotiations. In this process, much attention has been paid to political feasibility, while cost-effectiveness has played a minor role. The KlimaTicket is an example of a climate measure that is cost-ineffective, but popular, i.e. easy to implement from a political point of view. However, we see many cost-effective alternatives to the measures that have been chosen. They include regulatory measures like lower speed limits on Austria's roads as well as market-based instruments, e.g. higher CO_2 prices. Such measures are highly cost-effective but unpopular and, consequently, their political feasibility is challenging. The dilemma between cost-effective and rather unpopular measures on the one hand and cost-ineffective but more popular measures on the other highlights the competing nature of the different dimensions of the objectives of climate action.