Comparing CZ and AT NECP, New challenges resulting from Green Deal

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Financial support by

lebensministerium.at

Prague and Vienna, 2021

Abstract

The issue of global warming caused by human activity is very urgent. Thus, the European Union made its member states compose National Energy and Climate Plans (NECP) to showcase their individual ambitions towards the European goals for fighting climate change. The main task of this work is to identify, evaluate and discuss the most fundamental differences and connections between the National Energy and Climate Plan (NECP) of the Czech Republic and Austria. Both countries had to submit their draft NECP to the European Union, which assessed it according to certain European criteria. However, shortly after, the EU issued the “Green Deal”. The goal of the "Green Deal" is to transform today's society into a society that will prosper in accordance with the principle of sustainable living on this planet with the strong focus on decarbonization. Ideally, we can imagine a modern society that uses natural resources efficiently without producing any greenhouse gas emissions. This adds additional challenges to the NECPs. Both countries have only stated the bare minimum of emission savings in their NECPs, while Austria cannot even specify how to reach this goal, that not yet takes into account the European Green Deal (EGD). Austria’s economy is already more energy-efficient than the Czech Republic’s according to energy intensity of the GDP per capita, but both ambitions for further efficiency enhancements are considered low by the European Commission (EC). Due to high fossil imports, both countries need to work on their energy security, but the states already achieve EU 2030 targets in terms of interconnectivity. The main difficulty in comparing both NECPs is that the starting positions of the two countries are very different, both in terms of geographical and the current state of the energy mix in these countries and the planned pathways for transforming into a decarbonised society. This work aims to analyse possible connections and differences and point out possible problematic points. NECPs will be reviewed in the future based on newly available data, so it is appropriate to address these contexts, all the more so in the case of two neighbouring countries. Both countries face many challenges, which are described in these documents and analysed here.

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Introduction and general information

National Energy and Climate Plans

c The aim of which is not to let global warming exceed 2ºC while trying to stay below 1.5ºC increase compared to pre-industrial levels [2]. The climate change we have seen in recent years is becoming unbearable. Atmospheric temperatures are rising dramatically, which is already causing significant problems in many regions. There is still very high emissions of GHGs on the planet, despite the measures taken so far. Of the 8 million species living on the earth, more than a million are threatened with extinction. This fact is mainly due to current world developments.[3] To contribute to this goal, the European Union (EU) initiated the "Clean Energy for all Europeans package" in 2016, including eight legislative processes. Those legislations focus on different areas, such as "Energy performance in buildings", "Renewable Energy", "Energy Efficiency", or "Governance of the energy union", among others. The EU member countries are given 1-2 years to transform those EU rules into national law. Under the "Governance of the energy union" focus area, each EU member is obliged to create a "National energy and climate plan" (NECP). The NECPs encompass how each member state plans to accomplish their goals regarding the five dimensions[1] of the energy union. The NECP's time horizon is 2021 – 2030, with a long-term vision until 2050 [4]. Final plans had to be submitted by the end of 2019, and a progress report is required every second year. The system of controlling and updating NECP's is shown in Figure 1. The EC assessed each NECP of the 28 member states and published the results. As a combined summary for the 2030 goals based on the assessment, the EC concluded for each of the five dimensions [5]:

- Renewable Energy: A combined commitment by EU members slightly above the existing target of **32%** renewable energy
- Energy Efficiency: Slight shortcoming in net savings compared to the EU target of **32.5%** energy efficiency savings
- GHG Emissions: Likely achieving the 2030 GHG reduction target of **40%** (compared to 1990)
- Internal Energy Markets and Energy Security: Traditionally not at risk but improvement potential for more market flexibility
- Research & Innovation: Potential for improvement → Linkage to climate and energy goals not obvious

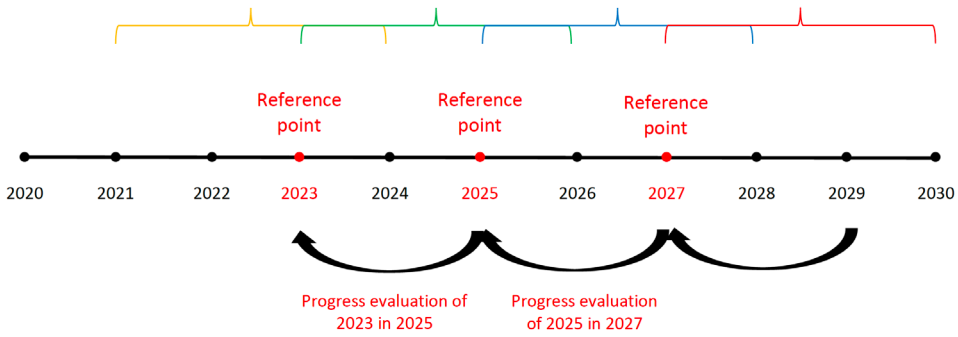

Figure 1: Scheme of controlling national climate and energy plans

The European Green Deal

A more recent approach towards CO_2 reduction GHG emissions by the EC is the European Green Deal (EGD). Introduced in late 2019, it aims to make the European Union's economy sustainable. The EGD

[1] 5 dimensions: "Energy security, solidarity and trust, integrated internal energy market, energy efficiency, climate action & decarbonisation and research innovation and competitiveness" [38].

is built around the core theme of having net-zero GHG emissions by 2050 without leaving anybody behind. A milestone of 50-55% emission reductions compared to 1990 is envisioned for 2030 [6], [7]. Carbon pricing in sectors other than energy should have a crucial impact. According to the Green Deal, in June 2021, the European Commission will review the state of EU ETS, the emissions trading system and will discuss the introduction of these allowances in other areas of industry. This measure should provide a financial incentive for both the public and private sectors to invest in renewable energy sources. [3] The EU ETS is a key instrument of European climate policy. Under this system, almost half of all emissions produced in the EU are traded. This system includes emissions of carbon dioxide (CO2), nitrous oxide (N2O) and perfluorocarbons (PFCs). [8] The setup of this system in the first two allocation periods (2005-7, 2008-2012) was ineffective, because of too many emission allowances were released into the system, and their price remained consistently low. The economic recession associated with the industrial decline in production played a significant role in this. [7]

The "Market stability reserve" approved in 2017 responded to this. A system that can react flexibly to surpluses or shortages of emission allowances. If there is too much surplus of emission allowances in the system, the MSR control mechanism will take a part of them and keep them for a significant shortage in the future. However, the total volume does not change with this mechanism.[9]

Figure 2: Historical emissions allowance prize [8]

Europe thereby plans to become a pioneer in carbon-neutral economies. To compensate for the difficulties of regions with high dependency carbon-intensive economy, the Just Transit Mechanism (JTM) fund was initiated. One trillion euros are allocated to finance the complete EGD, coming from a mix of private and public funds [10]. Furthermore, to compensate for the imposed difficulties to carbon-intensive economies, the EGD initiated the Just Transition Mechanism (JTM) as eastern member states criticised the deal [11]. The green deal has several policy areas, which range from biodiversity and sustainable farming/agriculture over clean energy and pollution regulation to sustainable industry, buildings and mobility [7] and which are further described in Table 1.

Table 1 European Green Deal Policy Areas [7]

Policy Area EGD	Description
Biodiversity [12]	Recovery and increase of resilience of Europe's biodiversity • EU network of protected land and sea zones extension • Nature restauration plan • Establishment of measures

From farm to fork [13]	Healthier food system including reduction of pesticides, excess nutrients, antibiotics and an increase of organic farming • Minus 50% of dangerous pesticides • Minus 50% nutrient losses • Minus 20% fertiliser use • Minus 50% of sale of antimicrobials to animal farming • 25% organic farming
Sustainable agriculture [14]	Common Agriculture Policy (CAP) for more sustainability in agriculture and rural areas
Clean energy [15]	Clean energy generation, hydrogen strategy and system integration strategy • Priority on energy efficiency and renewable power sector • Energy security and affordability • Interconnection and digitalisation of EU energy market
Sustainable industry [16]	Industry based on the circular economy, especially in sectors such as textiles, construction, electronics and plastics that require many resources
Building and renovation [17]	Enhancements of building energy performance through price incentives, circular economy and digitalisation.
Sustainable mobility [18]	Reduce transport-related emissions by digitalisation, variation of modes of transport, price increase and fuel changes • Minus 90% transport-related emissions by 2050
Eliminating pollution [19]	Zero pollution by 2050 with 2030 key target as milestones (air, water and soil) • Better air quality → minus 55% air pollution associated premature deaths • Better water quality → minus 50% plastic litter and minus 30% microplastic in sea • Better soil quality → See farm to fork • Minus 30% of society disturbed by transport noise • Minus 50% residual municipal waste and significantly overall waste
Climate Action	Policies to achieve the goals

Even though the EGD is very controversially discussed, it significantly raises the bar for environmental action for the EU member countries. Therefore, existing problem areas of specific countries will become even more problematic, and new bottlenecks in the energy and climate plans will emerge. Thus, the motivation of this work is to identify pre-EGD bottlenecks of the Czech and Austrian NCEPs, identify which additional areas of focus become problematic due to the EGD and compare those. Further, the bottleneck areas of Austria and the Czech Republic will be compared for opportunity of support or complementation of technology or knowledge. Due to the high correlation of specific NECP dimension and their complexity (e.g. GHG emissions & Renewable Energy), the topic is very convoluted. Thus, this work only focuses on a very high-level analysis of the five dimensions without going too deep into specific subtopics. Additionally the subjective opinion of the authors is added in the discussion. The motivation to do this is to reveal similarities and differences in the approach of the energy transition of the two countries. Furthermore, treating the NECPs comparison as a holistic approach will unveil areas that will be interesting to compare in more depth for future work. These areas can be based on topics where both countries have similar trouble or where one country is far ahead and knowledge could be transferred to another country. Without doing this initial holistic analysis, a deep dive into a specific topic would be difficult to justify.

The remaining study is structured as followed. First, "Methodology" describes the analysis approach comprehensively and is followed by the "Analysis of the Czech National Climate Plan". There the results of the analysis are presented. Finally, in "Discussion and Conclusion", the study is summed up and evaluated against the motivation.

Methodology

This work is based on literature research and analysis and addresses Austria and the Czech Republic. Figure 3 gives an overview of the used methodology.

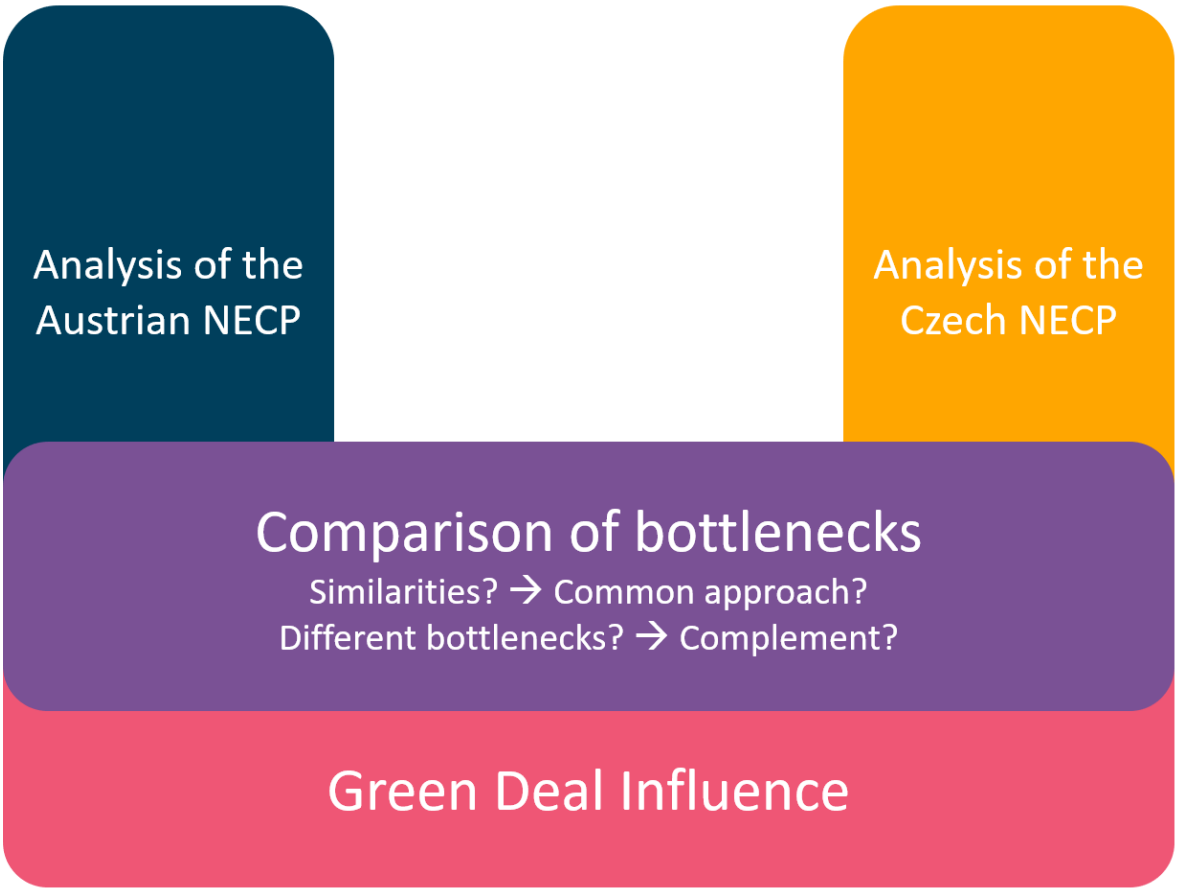

Figure 3: Methodological approach

As it can be seen, first, each country's NECP is analysed regarding the five main points presented in the plan:

- Decarbonisation
- Energy Efficiency
- Energy Security of Supply
- Internal Energy Market
- Research, innovation and competitiveness

For this analysis, mainly official documents, such as the NECPs themselves and their assessments by the European Commission (EC) or supportive documents, are used. This is followed by comparing the main NECP topic between Austria and the Czech Republic to identify similar or different bottlenecks. Finally, it is assessed how the Green Deal might affect the NECPs. Which areas will have to be improved? Which areas will have to be added?

Analysis of the Czech National Climate Plan

The Czech Republic's national plan in the field of energy and climate responds to the requirements of Regulation 2018/2019 of the European Parliament and the Council on the governance of the Energy Union and climate action.[8] Air quality and overall quality of life have improved significantly over the

last 20 years. But it is not satisfactory in almost any place in our country. In every small village, there is a boiler burning coal, which is a major air pollutant. Emissions from car internal combustion engines, namely particulate matter (PM), are also a significant burden, especially in the centres of large cities.[20][8]

According to European Union directives, there will have to be a significant reduction in pollutant emissions in the coming years. Commitments for 2030 are often more than doubled for 2050. Therefore, it is clear that further action will be needed in the development of energy in general to meet these commitments.[8]

Decarbonisation

The European Union has set a target of reducing greenhouse gas emissions by at least 40% by 2030 compared to 1990. In the energy sector in the EU ETS, the target is even stricter, at around 43%. All European countries are heading for the same goal in 2030, but the shares in each country range from 0% to 40%. The Czech Republic should reduce its carbon emissions by 14% by 2030 compared to 2005. The first revision of the document will take place by the end of 2021. Another central review is then planned for 2023. [8] The Czech Republic should have at least 22% of the energy produced from RES in 2030.20]

The Czech Republic plans to reach the share of 22% Renewable Energy Sources (RES) in final consumption by 2030. This share of 22% in RES corresponds to the requirement to achieve a binding EU target by 2030 of 32.0% for the entire European Union. The target for 2022 was met in 2017 (14.62%). In 2027, the value of the share in the Czech Republic should be 18.85%. [20][21]

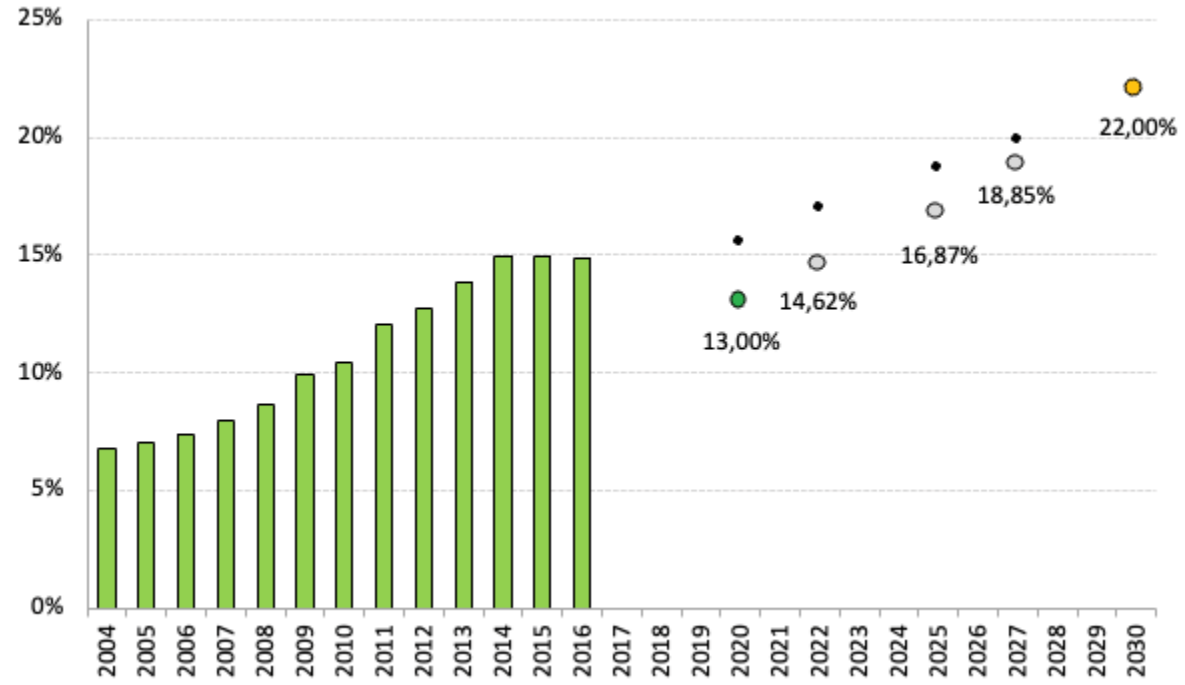

Figure 4 - Percentage of RES sources in Czech Republic [8]

The prediction of installed capacity divided into capacity from modernisation and new capacity is relatively problematic as it anticipates the decision-making of private entities responding to specific market conditions. However, the Czech Republic also carried out some analysis about setting up the support scheme for the period 2021–2030, among other things considering the incentive measures to modernise the source.[5][21]

Table 2 - Predicted res installed power in future years without modernisation of RES power plants [8]

	Capacity in 2016 (MWe)	Capacity in 2030 (MWe)	Capacity in 2035 (MWe)
Wind power plants	282	91–206	0–160
Photovoltaic power plants	2 068	1 615–1 887	0–1 226
Biogas stations	368	287-356	N/A

In the Czech Republic, it is essential to emphasise the role of nuclear energy, which should gradually replace the electricity now produced from coal. Increasing the share of nuclear energy and renewables at the expense of fossil fuels is a key tool for achieving long-term commitments to reduce greenhouse gas emissions and achieve climate neutrality by 2050. [8]

Table 3 - Targets for CZ in years 2030, 2040 and 2050 [8]

Main target by 2030	By 2030, reduce emissions of the Czech Republic by at least **44 Mt CO_2 eq.** compared to 2005 (corresponding to a reduction of **30 % compared to 2005**).
Indicative target by 2040	Approach the indicative level of **70 Mt CO_2 eq.** of emissions in 2040.
Indicative target by 2050	Approach the indicative level **of 39 Mt CO_2 eq.** of emissions in 2050 (corresponding to a reduction of **80 % compared to 1990**).

Energy Efficiency

In this part of the document, we will focus on energy efficiency. Until 2030, the Czech Republic considers it most appropriate to set a national target for the energy performance of the economy. It reflects the influence of external factors on final energy consumption. The national target of the Czech Republic is also expressed in the final energy consumption, which should not exceed 990 PJ or 1 735 PJ in primary energy consumption. [8][5]

The national target is determined as the maximum potential for reducing energy consumption in individual sectors of the economy of the Czech Republic. This potential will reflect the effect of both the approved and planned strategies, policies, and measures to be implemented in the period up to 2030 with the view to the year 2050, under the following assumptions:

- *GDP growth in line with the assumptions*
- *annual increase in residential area, taking into account the demographic developments in the Czech Republic in accordance with the assumptions*
- *a change in the structure of the economy (growth of the services sector and a decrease of heavy industry)* [8]

For the year 2030, the revised EU Energy Efficiency Directive sets a target of at least 32.5 % when converted to absolute values. In this case, the primary energy consumption should not exceed 1 273 Mtoe, and final energy consumption should not exceed 956 Mtoe for the EU.[8]

Because of Directive 2012/27/EU and the rules for setting the commitment, the Czech Republic's target under Article 7 for 2021–2030 was set at 84 PJ of new energy savings, i.e. 462 PJ of cumulated energy savings by 2030**.** The commitment respects the requirement to meet the minimum annual energy savings of 0.8 % of annual final energy consumption. [22]
The target calculation baseline is the final energy consumption according to Eurostat data. In the following period, 2021–2030, the Czech Republic doesn't exercise the option of deducting or counting additional savings under the 'exemption system'.
Next, Table 2 shows the number of average final consumptions between the years 2016 to 2018 and the number of savings in PJ. It shows single commitments. [23]

Table 4: Calculation of energy savings

Commitment	Value
Averaged final consumption (2016–2018)	1 050 PJ
Relative amount of the commitment	0.8 %
Annual commitment	8.4 PJ
Total commitment	84 PJ
Cumulative commitment	462 PJ

Figure 5 shows two scenarios of energy savings in the Czech Republic between the years 2021 to 2030. The BaU (Business as Usual) scenario is based on measures already in place that contributed to the renovation of the building stock in 2014–2020. On the other hand, the Real Scenario for residential buildings does not expect an increased number of renovated buildings, so the renovation rate for both scenarios remains unchanged. The predicted depth of renovation has a significant influence on the development of building renovation. So as one can see, in both scenarios, the savings are pretty high compared to nowadays. [8]

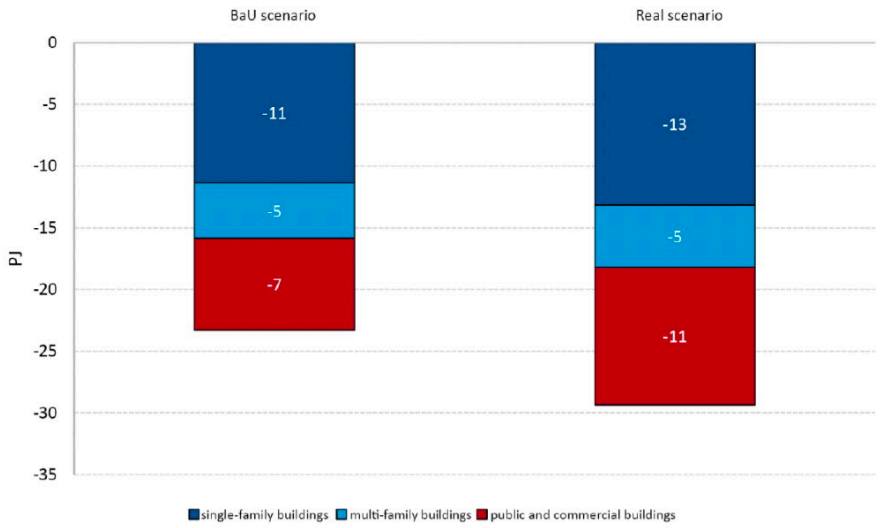

Figure 5: Final energy consumption savings for 2021–2030 (in PJ)

Energy Security of Supply

Diversification targets are summarised in the target corridors of the State Energy Policy of the Czech Republic. The import dependence target is not to exceed 65 % of import dependence by 2030 and 70 % of import dependence by 2040. The Czech Republic will strive for the highest possible diversification of the energy mix and the minimisation of sources using large quantities of input fuel imported from abroad (mainly gas from Russia). The strategically optimal electricity mix for 2040 is specified in the approved in main strategic documents of the Czech Republic.[24][8]

. In 2030 and beyond, the Czech Republic will change from net exporter to importer of electricity. In the worse case, about 2400 to 3600 MW may be missing peak performance in manageable sources. If the Czech Republic wants to remain energetic self-sufficient, it needs to develop renewable sources, gas and nuclear sources. In this case, it is imperative to improve RES sources. [25]

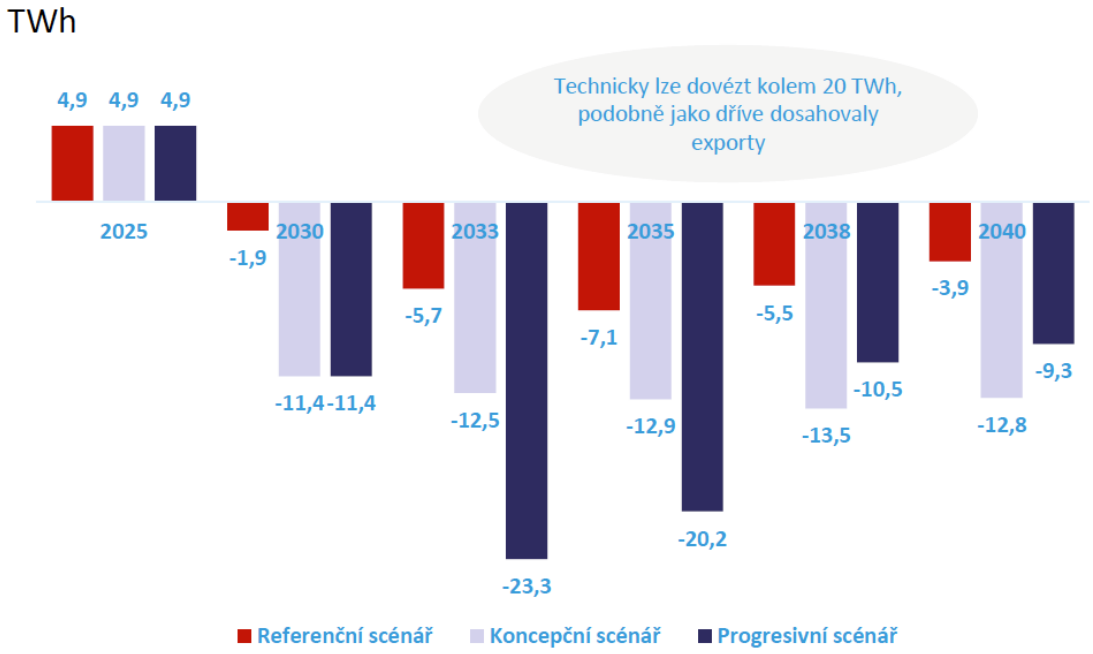

Figure 6 – Referentia(red)l, conceptua(grey)l and progressive(blue) scenarios of Czech electricity import/export

The Czech Republic has made energy security targets in four categories. In electricity, gas, oil and heating sector. For the electricity sector, goals are: maintaining high-quality energy, ensuring self-sufficiency in electricity generation, maintaining a positive power balance and ensuring the adequacy of the power reserves and control outputs, ensure diversification of primary energy sources in accordance with the target corridors of the State Energy Policy of the Czech Republic, which, among other things, means the continued development of nuclear energy in the Czech Republic. [8]

The Czech Republic has a relatively well-diversified energy mix. The targets for the diversification of energy sources are mainly incorporated in the target corridors of the State Energy Policy of the Czech Republic. With regards to the targets concerning the supply of energy commodities from third countries.

- *ensure permanent self-sufficiency in electricity supply at a minimum level of 90 %;*
- *reduce and sustain the diversification of primary energy sources below 0.25;*
- *facilitate and maintain the diversification of gross electricity generation below 0.35;*
- *reduce and maintain the diversification of imports below 0.30;*

- *reduce the share of energy imports in gross value added below 2010 levels;*
- *stabilise the effect of energy imports on the balance of payments.* [8]

The share of individual fuels in gross electricity generation is well shown in Table 5. Coal and other non-renewable sources are reduced from 50 % to a minimum of 11 %. Because of this very high reduction, on the opposite side, electricity from nuclear power plants will increase from 29 % in 2016 to in maximum of 58 % in 2040.[8] Maybe there will be a change in increasing renewable and secondary sources because 25 % in 2040 is perhaps not enough.

Table 5: Share of individual fuels in gross electricity generation [8]

	2016 level	2040 target level
Coal and other solid non-renewable fuels	50 %	11–21 %
Nuclear energy	29 %	46–58 %
Natural gas	8 %	5–15 %
Renewable and secondary energy sources	13 %	18–25 %

Internal Energy Market

The 2030 interconnectivity target of the transmission system corresponds to maintaining its import and export capacity relative to the maximum load at a level of at least 30 % and 35 %, respectively.

In general, it can be stated that the target under the State Energy Policy of the Czech Republic corresponds to the 15 % target because the share of the maximum load in relation to the installed capacity corresponds to approximately 50 % (53 % in 2017). The Year Network Development Plan assesses the progress towards the 2012 Barcelona criterion of 10 % of the transmission systems interconnectivity and the 2030 connectivity target at 15 %. Table 6 specifies the projected 2030 interconnectivity level (both for export and import) relative to the maximum load in two scenarios. In both cases, the 30 % and 35 % targets should be achieved with a relatively significant margin.

To achieve the set goals, it is vital to improving the energy transformation infrastructure. It is essential to have an excellent functional infrastructure in the Czech Republic and connections with our neighbouring countries. With a higher share of electricity produced from RES, this need is still growing.

National targets for other aspects of the internal energy market include increasing system flexibility, interconnection and market integration, increasing the tradable capacity of existing interconnectors, smart grids, aggregation, and better response to energy demand or storage.

The integration of daily and intraday markets across Europe, based on implicit cross-border capacity allocation, has a history of more than 15 years. This interconnection initially concerned only neighbouring states based on bilateral or other agreements. Today, we already have several common markets within the EU.
Other benefits resulting from the integration of short-term electricity markets can be summarised as follows:

- *optimal use of cross-border transmission capacities;*
- *integration helps to balance the electricity systems of individual countries;*
- *price indices become stabilised, and the volatility of the difference in spot electricity prices across EU markets decreases;*
- *purchases of often unused capacities of cross-border profiles in explicit auctions are limited;*

- *there is a decrease in risks associated with the purchase of cross-border capacity without the ownership of electricity in export/import and vice versa.* [8]

Research, Innovation and Competitiveness

Within the framework of climate protection, the Czech Republic has not set any specific goals in public research, development and innovation that would relate to establishing an energy union within Europe. Setting energy and climate targets is complex and is due, among other things, to the non-sectoral structure of public funding for research, development and innovation. In the Czech Republic, it is provided within the framework of national and ministerial support programs. The strategic goals are described in more detail in the relevant strategic documents of the Czech Republic. We can name, for example, the National Research and Innovation Strategy for Smart Specialization and the National Priorities of Oriented Research, Experimental Development and Innovation. [8]

Priority area title	Share of funds
Competitive knowledge-based economy	20 %
Sustainability of energy and material resources	18 %
Environment for quality life	18 %
Social and cultural challenges	10 %
Healthy population	20 %
Secure society	14 %

Figure 7 - Czech's national research priorities

The Czech Republic has no specific national 2050 objectives for the deployment of low-carbon technologies. Also, the introduction of specific technologies should be primarily market-driven. The State may create conditions in research, development and innovation, possibly to partially support specific technologies in accordance with the State aid rules. Still, it is arguable whether the State should specify targets for introducing specific technologies and thereby distort the market environment.[8][5]

Analysis of the Austrian NECP

In their National Energy and Climate Plan, Austria focuses on five dimensions. These dimensions are decarbonisation, energy efficiency, security of energy supply, the internal energy market and finally, research, innovation and competitiveness. These dimensions mentioned in “National Energy and Climate Plans” are predefined by the European Union to be addressed by each member country. Austria’s NECP is based on the country’s Climate and Energy Strategy, also called “#mission2030”, in which Austria already reflected all the points required by the European Commission [26], [27].

Decarbonisation

Compared to 2005, Austria aims to reduce GHG emissions (non-ETS) by 36% by 2030 [26]. Figure 8 shows the sectoral development of the GHG emissions in Austria as published by the Environment Agency until 2019. The majority of the emissions is related to the energy & industry sectors. However, only around 15% of these are non-ETS emissions. Thus, the highest share of non-ETS emissions is transport-related. Those are also the only sector that did not decrease emissions compared to 1990 but increased them by around 75%. Additionally, since 2014, transportation-related emissions increased slightly but continuously [28][29].

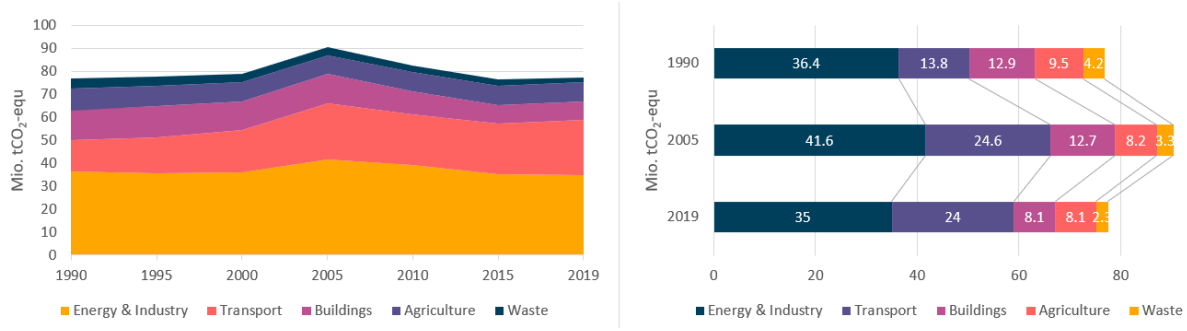

Figure 8 Austrian GHG emissions development by sector [28]

Austria has modelled two scenarios for GHG reduction until 2030 for non-ETS GHG emissions, namely the "with existing measures" (WEM), similarly to the Czech BaU scenario, and the "with additional measures" (WAM) scenario. As shown in Figure 9, neither of the two models achieve to reduce non-ETS GHG emissions by 36% until 2030, which is shown as the grey line. The WEM scenario only reduces emissions by 16% and the WAM by 27%, of which a majority would be transport-related. The NECP only states that further measures would need to be taken to bridge the gap of 9% to reach the decarbonisation goal. However, none of these measures is mentioned, which is also criticised by the NECP assessment of the European Commission [26], [30].

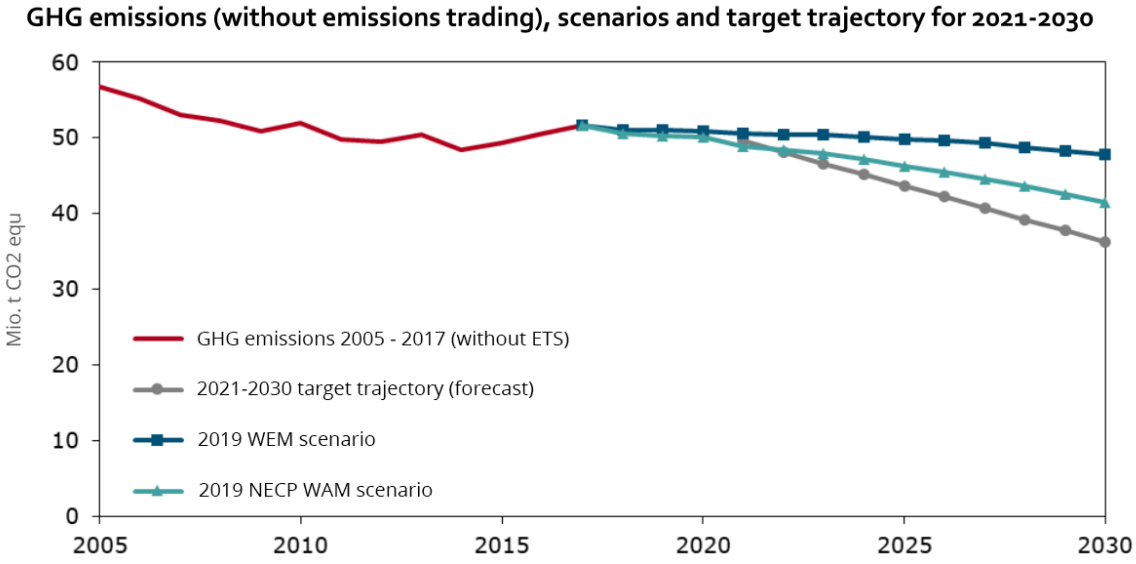

Figure 9 Emission reduction by scenario [26]

Since the transport and building sector are the most significant contributors to non-ETS GHG emissions, the focus is laid on those with reductions of 7.9 mt CO_2eq and 3 mt CO_2eq, respectively. In transportation, the three strategies are to *avoid* unessential transport, shift to more efficient modes, and *improve* technology. The building sector plans to achieve its reduction goal by thermal insulation, reduction of fossil fuels and district heating. In the agricultural sector, mainly animal-related farming could yield emission reduction and anything where machinery is involved. However, no quantitative goals are mentioned. More specific goals, measures, and respective instruments planned for each sector can be seen in Table 8 in "Appendix 1: Measures and instruments GHG emission reduction".

As a decarbonisation contribution of the energy sector, Austria plans to raise the share of renewable energy in the gross final energy to 46-50% and generate 100% of their electricity consumption from renewable sources by 2030. The 46% target is assessed to be adequate, but at the bottom end of the

requirements by the EC [26], [30]. Additionally, as can be seen in Figure 10 and Figure 11, Austria's domestic generation of primary energy already is very renewable. However, when looking at the gross energy consumption, the share of gas oil and coal is still very high, explained by highly fossil-based imports.

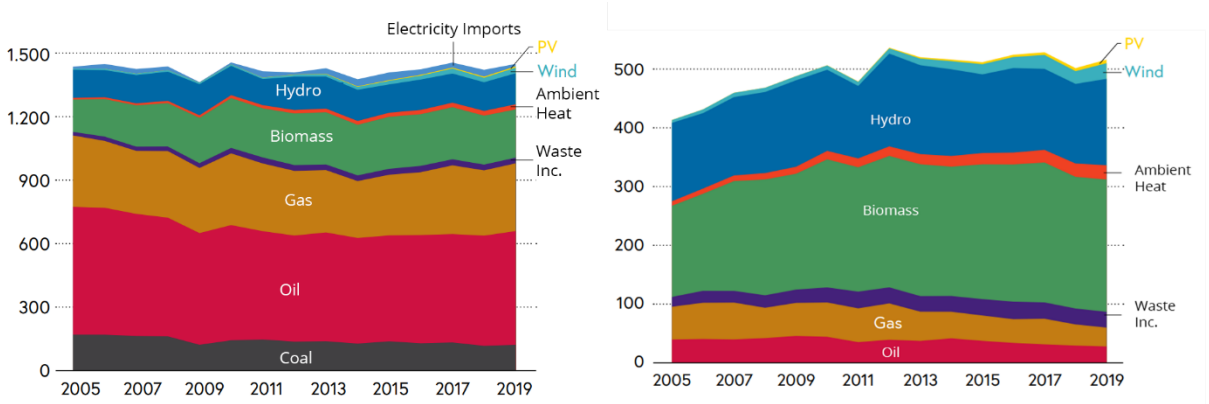

Figure 10 Right: Gross energy consumption in PJ; Left: Primary energy generation domestic in PJ [31]

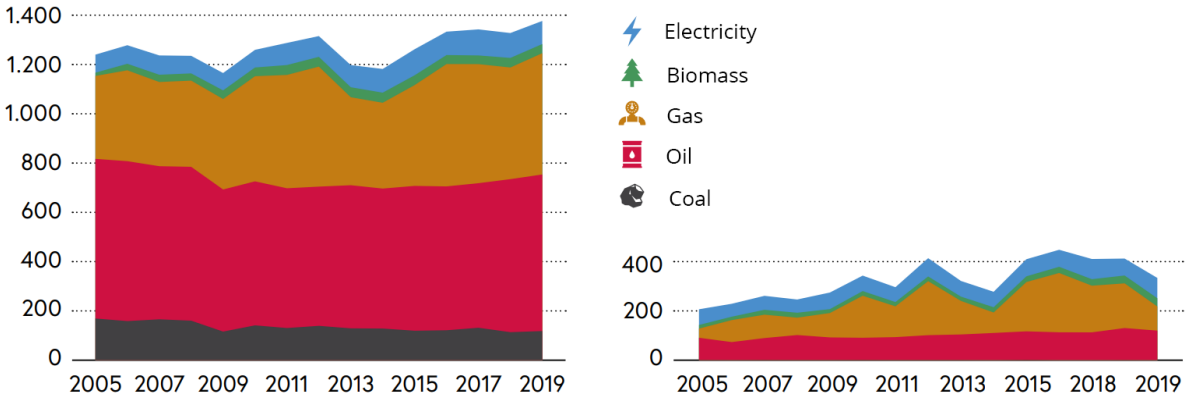

Figure 11 Import and export of energy [31]

The share of renewable electricity in the Austrian grid mix is already very advanced, as illustrated in Figure 12. Hydro energy and solid biomass play a significant role in the grid mix while wind picks up momentum.

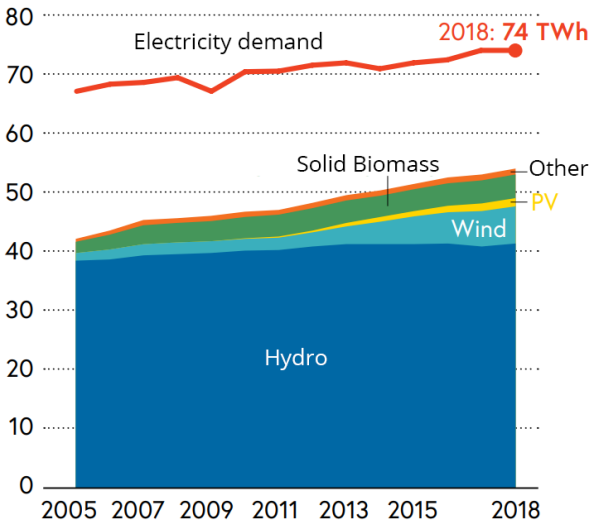

Figure 12 Renewable electricity generation in TWh [31]

Table 7 shows which renewable energy technologies are projected to grow most until 2030. According to the WAM scenario, wind and PV show the most relevant growth, while also hydrogen and synthetic gases will grow but very small in absolute terms. More specific goals, measures and instruments can be consulted in Table 9 in "Appendix 2: Measures and instruments renewable share increase."

Table 6 Development of each renewable energy technology according to WAM scenario [26]

	2021	2023	2025	2028	2030
Solid biomass	189	190	191	198	202
Liquid biomass	29	30	34	34	36
Ambient heat	18	19	21	23	25
Hydro electric	157	158	159	161	160
Wind power	31	37	43	53	60
PV	13	20	26	35	42
Electricity from biomass	19	19	19	20	20
Electricity and district heating from geothermal energy	1	1	2	2	2
Hydrogen	0	0	0	1	4
Syngases	3	4	6	10	13
Transformation input power for H2	0	0	0	-1	-4

Energy Efficiency

The European Union gives energy efficiency a top priority in terms of the energy transition ("energy efficiency first") and asks member states to aim at an energy efficiency target of 32.5%. Austria seeks to enhance primary energy intensity to 25-30% until 2030 (compared to 2015). This translates to 28.7-30.8 Mtoe and 24.0-25.6 Mtoe for primary energy and final energy consumption, respectively. The European Commission regards this as a "low ambition". Furthermore, it criticises the lack of clarity regarding how energy efficiency would be prioritised [26], [30]. Planned measures for this subcategory can be consulted under "Appendix 3: Measures and instruments efficiency enhancement"

Energy Security of Supply

As shown in Figure 10 and Figure 11, Austria is strongly reliant on mainly fossil energy imports in the form of gas and oil. This definitely is not a good indicator for energy security due to local fossil fuel scarcity, diversity and potential political conflicts with the supplying countries. Austria itself states in their NECP to have a high level of energy security due to the existing grid infrastructure, power plant availability and domestic resources. This might be true for electricity, however, Austria is strongly reliant on imports in other sectors. Additionally, even though hydropower is relatively stable, it still suffers from seasonal fluctuations. The European Commission mentions that Austria does not specify objectives on diversification on oil and gas supply, reducing energy import and enhancing the national grid resilience and flexibility. While Austria says these points and investment in storage capacity and grid expansion, the NECP fails to address particular goals [26], [30].

Internal Energy Market

Today, Austria has already surpassed the EU-set mark for interconnectivity among neighbouring countries of 15%. This means that there has to be grid infrastructure in place to transfer at least 15% of electricity generated at a given moment beyond country borders. To shift towards a renewable energy system, Austria mentions the following pillars in their NECP:

- Assuring grid stability
- Fair division of infrastructure-related expenses
- Price signals to market operators have to be on point
- Flexibility enhancements through storage

The EC criticises that no development overview of a diverse portfolio of flexibility sources is presented. Furthermore, there is lacking information on market conditions for gas and electricity. Austria is one of the key transit points in terms of gas transfer to the EU [26], [30].

In Austria, 3.2% and 20.3% of all households are classified as energy-poor or at risk of poverty, respectively.

Research, Innovation and Competitiveness

Austria mentions the following points within their NECP to address the strategy of research innovation and competitiveness:

- Cooperation businesses & government
- Research-enhancing environment creation
- Funding for research to market diffusion
- Research priorities towards specific energy system challenges
- Key technology development
- Sector coupling
- Digitalisation and smart systems
- Internationalisation

Furthermore, the Federal Ministry for Transport Innovation and Technology issued energy and mobility research programmes, of which the main topics are shown in Figure 13. €2-2.5 billion of private funding are expected to support this innovation program [26].

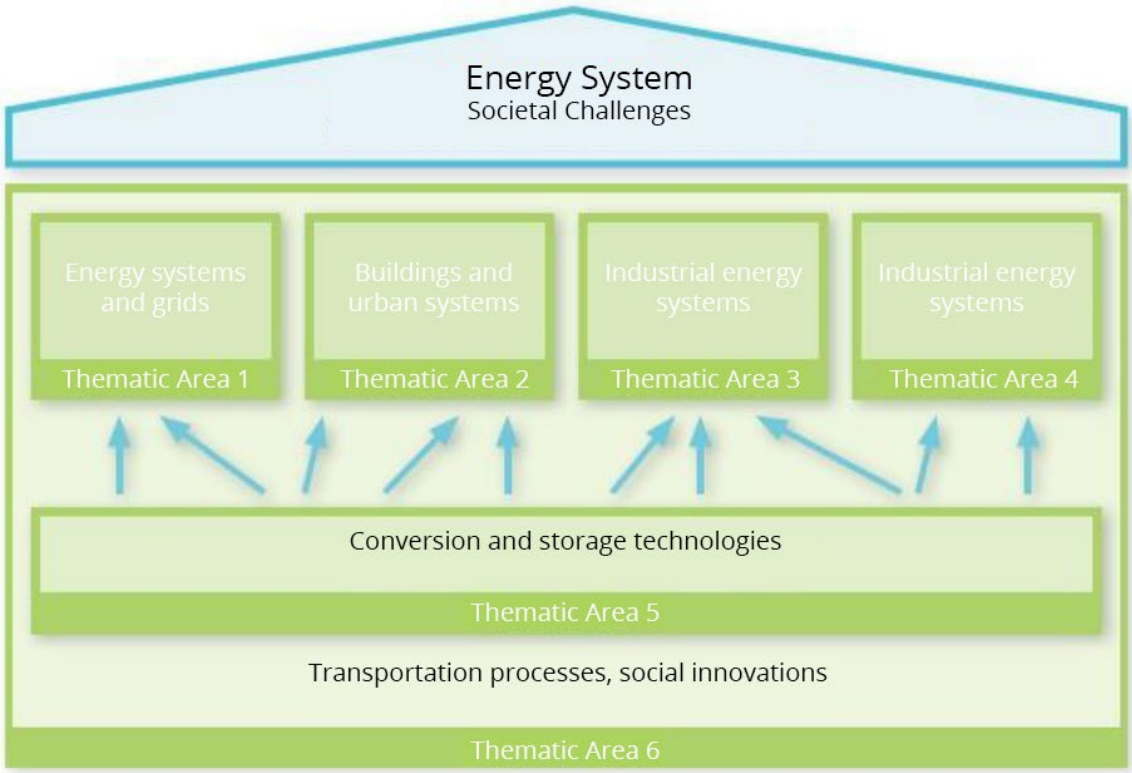

Figure 13 Austria's thematic areas in energy research and innovation [26]

The assessment by the EC highlights the excellent connection to the Strategic Energy Technology (SET) plan. Overall, the EC mentions that critical research and development points are highlighted and considered credible according to the attached roadmaps. However, the linkage to the policy objectives is missing [30].

Comparing Austrian and Czech NECP

Decarbonisation

Due to the effort sharing regulation, Austria and the Czech Republic have very different agreed targets of GHG reduction for 2030, depending on the GDP per capita but also on the fuel mix and the historical structure of the economy. This shall ensure a fair distribution of emission reduction towards member states with a lower income. With 35,610 €/c, Austria's GDP per capita is almost twice as high as the 17,250 €/c of the Czech Republic. Thus, Austria's contribution as per the ESR is much higher, with a 36% reduction in non-ETS GHG emissions by 2030 compared to 2005. The Czech Republic, on the other hand, only needs to achieve a reduction of 14%. In the NECP, this goal seems to be well achievable. On the other hand, Austria is missing 9% of decline according to their modelled scenario with additional measures. Therefore, further action would be needed to achieve -36% GHG emission by 2030. Austrian's NECP, however, does not specify how they plan to close the gap towards their 2030 goal [32], [33].

Regarding the renewable energy share of gross final energy consumption, Austria sets its target at 46-50%, while the Czech Republic aims at 22% by 2030. According to the individual assessments by the European Commission, both plans are considered to be unambitious. However, while Austria would just meet the target defined by the Commissions formula with 46%, the Czech Republic would slightly miss it by 1%. Additionally, Austria wants to be 100% renewable in terms of electricity supply according

to a national balance, while the Czech Republic aims at a renewable grid contribution of only 16.9% in 2030. While the Czech goal looks remarkably unambitious, one has to understand that Austria is fortunate enough to have great hydropower resources thanks to its mountainous landscape. This significantly helps in achieving a high share of renewable energy in the electricity mix.

Energy Efficiency

If taken the energy intensity of the economy as an indicator, Austria is more than twice as energy-efficient as the Czech Republic, with 105 kgoe/1000€GDP to 239 kgoe/1000€GDP in 2017 respectively [34]. This also becomes clear within the countries' NECP energy efficiency contributions for 2030. Here, Austria wants to reduce its primary energy intensity by 25-30%. This would translate to 28.7-30.8 Mtoe and 24.0-25.6 Mtoe for primary energy and final energy consumption, respectively. This is assessed as "low ambition" by the EC. On the other hand, the Czech Republic plans a contribution to the EU wide demand of 41.4 Mtoe (primary energy consumption) and 23.7 Mtoe (final energy consumption). The primary energy goal is regarded as a "low ambition", while the final energy one is "modest". These values also show a significantly higher primary energy intensity in the Czech Republic. This is most likely due to the high dependency on fossil fuels in the electricity mix [30], [35].

Energy Security of Supply

In their NECPs, both countries make every effort to ensure security of the energy supply. Thanks to its extensive infrastructure, Austria has a high level of security of supply, but only electricity. Austria is highly dependent of foreign gas and oil. Those fossil fuels are mainly used in transport. The transport sector is comparable in terms of energy sources in Austria and the Czech Republic. Local oil and gas sources are neglectable, however, the Czech Republic produces quite a lot of coal used for electricity generation mainly. In the field of electricity, the Czech Republic is now a clear exporter of electricity, in 2025, it will still be, but in 2030, with the slow development of energy from renewable sources and the slow construction of new nuclear sources, it could become a direct importer. This fact would significantly reduce the security of the electricity supply. The Czech Republic has set itself the goal of not exceeding 65% dependence on imports in 2030 and 70% in 2040. In our opinion, these percentages should be significantly lower, provided that the Czech Republic is now a net exporter.

Internal Energy Market

In this dimension, both countries declare the achievement of the 15% target by 2030. This means that there has to be grid infrastructure in place to transfer at least 15% of electricity generated at a given moment beyond country borders. The Czech Republic NECP presents the current state of 30% of transmission capacity for cross-border trade.

Research, Innovation and Competitiveness

The R&D approaches of both NECPs also deviate significantly. Austria mentions an ambitious R&D strategy as part of their mission30. They include different research areas and include various stages of technology readiness, from basic research to market integration. On the other hand, the Czech Republic has no quantitative targets for public R&D, specifically concerning the EU objectives. In addition, two out of their six priority areas of national research, development and innovation include nuclear and more efficient use of fossil fuels, both non-renewable technologies. While nuclear energy would at least reduce CO_2 emissions, the inclusion of enhancing fossil fuel-based energy generation in the priorities does not show a very high willingness to abandon these types of technologies.

Discussion and Conclusion on the Green deal and collaboration

While Austria and the Czech Republic are already struggling to fulfil specific goals set by the European Commission in their National Energy and Climate Plans, the European Green Deal adds further challenges for the European member states. The zero-GHG emission goal by 2050 can only be reached with a more ambitious milestone for 2030. Thus, compared to the previous aim to reduce emissions by 40% by 2030, the EGD imposes 50-55% reductions. As emissions are strongly correlated with the other milestones such as energy efficiency and share of renewable energy, all of them will become more challenging to achieve. In addition to more ambitious emission-related goals, the EGD is broader than the NECPs. It includes agricultural and food-related goals that go beyond the reduction of emissions in these sectors. This includes the reduction of pesticides or antibiotics or the increase of organic farming. Furthermore, while the main focus of the green deal is on greenhouse gas emissions, the EGD also has ambitions towards the reduction of local air pollution, noise pollution, land and water pollution through plastics and other waste with quantified goals. Thus, member states have to update their NECPs to account for the more ambitious GHG emissions goals. Furthermore, they have to include new aspects to the NECPs or address those goals out of the plan's scope.

It isn't easy to compare the National Energy and Climate Plans of the Czech Republic and Austria. This is due to the geographical conditions, the historical fuel mix and the structure of the national economies such as heavy energy-intensive industry.

Geographic conditions determine opportunities in terms of renewable energy generation or fossil fuel reserves. For instance, the Czech Republic is bordered by mountainous areas, which are, however, rather an exception, and in most of these areas, there are national parks and other protected areas. Therefore, the Czech hydropower potential is difficult to exploit. Compared to the Czech Republic, Austria is a very mountainous country, which has incomparable opportunities, such as hydropower. Furthermore, the Austrian GDP per capita is more than twice as high as the Czech currently. Therefore, one could argue that as a much wealthier country per capita, Austria has better monetary resources to approach environmental issues and potentially contributed more vital to the current environmental disaster. Additionally, the Czech Republic holds significant coal reserves and is among the biggest coal producers in Europe alongside Poland, Germany, and the UK [36]. Coal represents the major share of the final energy consumption in the Czech Republic and allows them to be an electricity net exporter. Furthermore, coal itself is also an exporting product in the Czech Republic, even to Austria (neglectable amount) [37]. Therefore, on one side, Austria has a relatively high share of renewables (at least in the electricity mix) and a wealthy economy. On the other side, the Czech Republic, with a coal-based energy system and a relatively poor economy according to the GDP per capita. This brings up the question, if the effort sharing regulation for emission reduction will buy the Czech Republic enough time to convert their economy to emission-free energy sources, as by definition, no matter how fair the efforts are distributed, also they will have to be emission-free by 2050. This leads to a very interesting potential future topic of comparison, namely their different approaches towards the decarbonisation of the electricity mix. In particular, the extremely different perceived significance of nuclear energy in the future grid mix would be very exciting to compare between the Czech Republic and Austria.

Another point where both countries need to improve and could collaborate is the transport sector. It is one of the most polluting sectors, and in addition to a shift in technology, it also requires a behaviour change. Here, the neighbouring countries could jointly work on transport schemes based on electric mobility, hydrogen or biofuels, bicycles and walking. Furthermore, elaborate common concepts of behaviour change, such as a shift towards a less possession-based system and a sharing economy in mobility. On the other hand, the significantly different grid mix might make common transport

strategy difficult. Here, Austria's high renewable penetrated grid favours electrification, while the coal-based Czech electricity currently would not be the most suitable option for clean e-mobility.

Another option would be that countries cooperate mainly on higher possibilities of using biomass and biogas or biomethane produced from it, which significantly reduces their dependence on imported gas and reduces greenhouse gas emissions. The Czech Republic does not currently have such a high share of electricity emitted from gas, but with the rapid shutdown of coal-fired power plants, this could also change. There is also a need to put pressure on the governments and authorities of both countries for faster and easier permits to build ecological and sustainable sources of electricity.

Finally, an aspect that could be equally important for energy efficiency and decarbonisation for both countries would be changing the societies' behaviour. Austria touches upon this topic in the form of demand-side management but does not elaborate much. Here, common ways could be developed between Austria and the Czech Republic to reduce energy consumption and/or change the way of consumption. In our opinion, first, the nature of consumption needs to change to more sustainable behaviour. Renewable energy solutions should not be a tool to continue our unsustainable lifestyle but to supply us with the clean energy we actually need.

Thus, due to the different backgrounds and starting points and different pathways for decarbonising the economy, it is very complicated to distinguish where the countries can support each other. Even in the area of R&D, the governments focus on slightly different topics. Specific elements have to be compared in more depth to see where opportunities for cooperation arise. This said, it could be concluded that both countries have a long way to decarbonise their economy. Both countries will face additional challenges concerning the EGD since initial targets were already not laid out to the complete satisfaction of the EGD European Commission in the NECPs.

Appendix 1: Measures and instruments GHG emission reduction

Table 7 Measures and instruments to contribute towards reduction of GHG emissions per sector [26]

Sector	Measure	Instrument
Transport	Enhancement public transport (incl. electrification)	Public acquisitions, development of infrastr., funding, facing out of unfavourable incentives
	Mobility management (businesses and public sector)	Awareness, enhancement of infrastr., funding
	More walking and biking	Awareness, enhancement of infrastr., funding
	Road to rail shift for goods	Funding
	Private e-mobility	Funding (infrastr. & vehicle), regulations, R&D
	Investigation of acceptable zero-emission targeting incentives in tax and funding system	Tax law
	Making standard fuel consumption tax (SFCT) greener	Tax law (Tax reform act 2020)
	Insurance tax related to engine greener	Tax law (Tax reform act 2020)
	Electric bike/ e-motorbikes input tax deduction for businesses	Tax law (Tax reform act 2020)
Buildings	Heating and cooling demand of new building without fossil fuels if possible and indeed without oil	Regulation (National & EU wide), phase-out of unfavourable incentives
Non-ETS Energy and Industry	Promotion for changing energy sources towards renewables & for energy efficiency in heating and cooling	Regulation (National & EU wide), new incentives and phase-put of unfavourable ones
Agriculture	Prevent CH_4 and NOx emissions →fertilisation, manure to biogas; grassland conservation, Animal farming modifications	Funding, Regulations, Awareness, Phase-out of unfavourable incentives
Forestry	Keep equilibrium of timber harvest and growth	Phase-out of unfavourable incentives
Waste Management	Prevent CH_4 and CO_2 emissions → avoid aerobic and anaerobic waste biogenic waste treatment; less plastic; more recycling	Regulations (National & EU wide), Awareness, Phase-out of unfavourable incentives
Flourinated Gases	Avoid F-emissions → lower building cooling requirements	Regulations (National & EU wide), awareness, funding, Phase-out of unfavourable incentives
Spatial planning	Enhance (energy) spatial planning	Planning, regulations, phase-out of unfavourable incentives

Appendix 2: Measures and instruments renewable share increase

Table 8 Measures and instruments to contribute towards the uptake of renewable energy [26]

Sector	Measure	Instrument
Higher share of renewables (46-50%) in final energy consumption and 100% renewable electiricty mix	Increase of renewable energy under "Renewable Energy Expansion Act", "100 000 rooftops solar panel and small-scale storage programme", H_2 and bio CH_4 in existing CH_4 grid, hydrogen strategy, sector-dependent spendings in CHx industry (mining)	Funding, market-regulated tendering, regulations, incentives and phase-out of unfavourable incentives
	Tax benefit for H_2 and bio CH_4	Tax law/Tax Reform Act 2020
	No tax on self-generated electricity	Tax law/Tax Reform Act 2020
Transport	Share of renewable energy in transport by 2030 to more than 14% → biofuels and higher share of e-mobiliy	Regulation, incentives, phase out of unfavourable incentives
Buildings	Replacement of fossil fuels with renewables for heating, DHW and cooling and complete abolishment of oil-heating	Funding, regulations, phase-out of unfavourbale incentives
Agriculture and forestry	Increase bioenergy generation	Incentives and phase-out of infavourbale incentives

Appendix 3: Measures and instruments efficiency enhancement

➔ Primary energy intensity enhancement of 25-35% in comparison to 2015

Table 9 Measures and instruments to contribute towards enhancement of efficiency [26]

Sector	Measure	Instrument
Buildings	Thermal renovations, more efficient heating systems	Funding, consultation
	More efficient renewable energy sources and district heating and cooling as well as hot water storage	Funding, regulations, phase-out of unfavourable incentives
Transport	Public transport, walking, cycling, transportation of goods, e-mobility	Same as in decarbonisation
Industry	Heat recovery, other efficiency measures, renovation, obligation of audits	Funding, regulation, phase-out of unfavourable incentives
All	EU's Energy Efficiency Directive Implementation	Regulation and awareness

Appendix 4: Further measures

Table 10 Measures and instruments to contribute towards further goals [26]

Energy Security of Supply		
Sector	Measure	Instrument
All	Investment in all kind of grids (electricity, heating, cooling) and storage. Maintainment of existing technology. Demand response.	Regulation and market incentives
Internal Energy Market		
Sector	Measure	Instrument
All	Simplification of licensing, power line regulations, grid infrastructure plan, flexibility, adjustment of grid tariff structure	Regulation, Incentives and bureaucracy reduction
Research, Innovation and competitiveness		
All	Austrian strategy in cooperation with SET plan; transnational and global cooperation	R&D
Dimension spanning		
Sector	Measure	Instrument
	Tax, funding and incentives effectiveness evaluation	Tax, funding, incentives
	Analyse other countries	Tax, funding, incentives
	Find and phase-out bad incentives and subsidies	Tax, funding, incentives
	Further greening	Tax, funding, incentives
	ETS extension to other sectors	Economic instrument
	Use ETS revenue for climate concerning topics	Funding

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