Interdisciplinary Bilateral Winter and Summer School on Energy Systems in Austria and the Czech Republic

National Energy and Climate Plans:

Comparing Czech Republic and Austria

&

New Challenges Resulting from Green Deal

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1 Introduction

In the face of accelerating climate change and pressing environmental challenges, nations around the world are recognizing the imperative to adopt comprehensive and transformative strategies to achieve sustainability. At the forefront of this global effort is the European Green Deal, an ambitious and visionary program aimed at propelling Europe towards becoming the world's first climate-neutral continent by 2050.

This seminar paper delves into the implementation and impact of the Green Deal in two European countries, Czech Republic, and Austria, shedding light on their individual approaches and experiences in driving environmental revolution. It is written as a part of Interdisciplinary Czech-Austrian spring and summer school on energy.

2 Overview of the European Green Deal

The European Green Deal is a package of policy initiatives by the European Commission, with the overarching aim of making the European Union (EU) climate-neutral by 2050 [1] [3] [4]. The plan is to transform the EU into a modern, resource-efficient, and competitive economy, ensuring no net emissions of greenhouse gases by 2050, economic growth decoupled from resource use, and no person and no place left behind [1] [2] [3].

The EU's Green Deal also aspires to serve as a global showcase, demonstrating that economic growth and the reduction of greenhouse gas emissions can go hand in hand. By leading through example, the EU aims to provide a replicable model for the rest of the world, showcasing that sustainability and prosperity are not mutually exclusive. Through its ambitious goals and comprehensive strategies, the EU wants to inspire and encourage other nations to adopt similar approaches, fostering a collective effort towards a sustainable future for the planet.

The European Commission has adopted a set of proposals to make the EU's climate, energy, transport, and taxation policies fit for reducing net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels. One third of the €1.8 trillion investments from the NextGenerationEU Recovery Plan and the EU’s seven-year budget will finance the European Green Deal [1].

The European Green Deal will improve the well-being and health of citizens and future generations by providing fresh air, clean water, healthy soil and biodiversity; renovated, energy-efficient buildings; healthy and affordable food; more public transport; cleaner energy and cutting-edge clean technological innovation; longer-lasting products that can be repaired, recycled and re-used; future-proof jobs and skills training for the transition; globally competitive and resilient industry [1].

3 Challenges for Austria

With the aim of transitioning to 100% renewable electricity by 2030 and becoming climate-neutral by 2040, Austria demonstrates ambition. To achieve these goals, Austria implements numerous regulatory measures and invests heavily in environmentally friendly mobility, renewable energy, more sustainable industries, eco-innovations, pollution containment, and ecological farming. The Austrian National Energy and Climate Plan acknowledges the need for more concerted implementation and further efforts in combating climate change [5].

The following figure shows the Total energy supply (TES) by source, Austria 1990-2021.

As seen in the figure below, there is a massive growth in biofuels and waste. Since 2004 the energy supply has doubled, from about 150 EJ to 273 EJ. Other renewables apart from hydro experience a steady increase. Hydro power, on the other hand, has reached its limit in terms of expansion. It is evident that Austria has a significant reliance on fossil fuels, that must be compensated in order to achieve its climate goals.

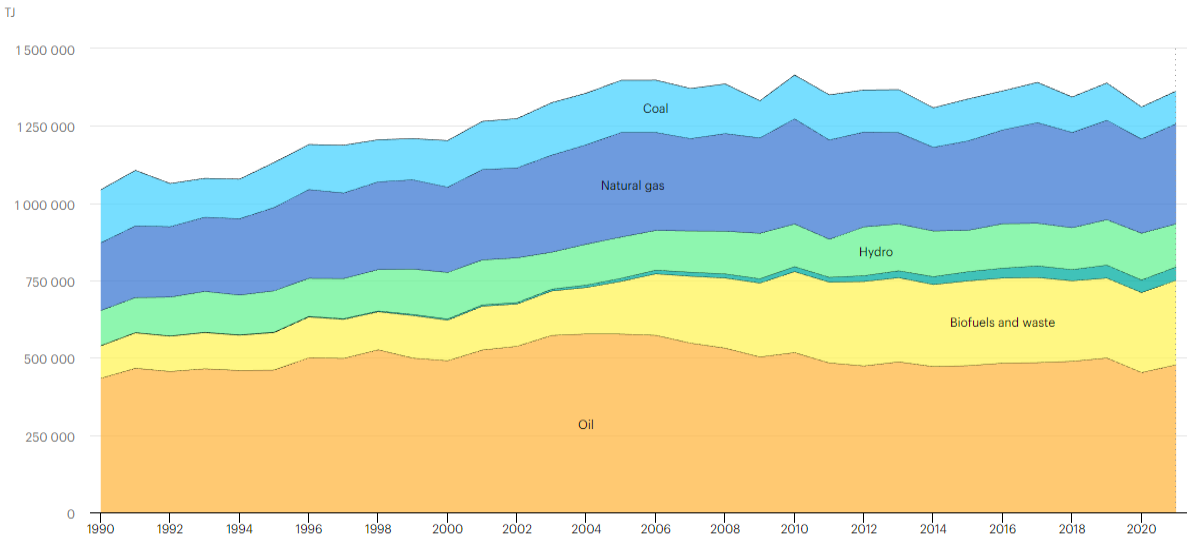

Figure 1: Total energy supply (TES) by source [18]

3.1 Economic Challenges

To achieve EU climate neutrality by 2050, it is essential to separate economic growth from resource use and transition to circular systems in production and consumption [13]. In December 2020, the Council adopted implementations on a new circular economy action plan presented by the Commission in March 2020. The implementations emphasized the importance of the circular economy in ensuring a green recovery from COVID-19. The action plan includes over 30 action points targeting sectors such as electronics and ICT, batteries, packaging, plastics, textiles, construction and buildings, and food. It focuses on designing sustainable products, incorporating circularity into production processes, and empowering consumers and public buyers.

The European Union collaborates with Austria to achieve common climate protection goals. In this regard, Austria receives support from the following funding programs of the EU budget [5]:

- 3.5 billion euros from the Recovery and Resilience Facility (RRF)
- 4.9 billion euros from the European Agricultural Guarantee Fund (EAGF)
- 4.1 billion euros from the European Agricultural Fund for Rural Development (EAFRD)

- 136 million euros from the Just Transition Fund (JTF)
- 216 million euros from the Corona Structural Aid (REACT-EU 2021)
- 1.147 billion euros from Cohesion Policy (funds from ESF+, ERDF, Interreg)
- 91 billion euros from the Horizon Europe research and innovation investment program
- 9.1 billion euros from the InvestEU investment fund
- 20.7 billion euros from the Connecting Europe Facility (transport, energy, digital)
- 860 million euros from the Technical Support Instrument for implementing reforms
- 5.4 billion euros from the LIFE environmental program
- 20 billion euros from the Innovation Fund (for the development of low-carbon technologies)

3.2 Social Challenges

Increasing public awareness about the urgency of addressing climate change and the importance of sustainable practices can be a challenge. Encouraging active citizen engagement and promoting behavioral changes towards more sustainable lifestyles requires effective communication, education, and outreach initiatives.

One social challenge for Austria, in terms of the Green New Deal, is securing social acceptance of new technologies and infrastructure changes. The transition to a green economy necessitates adopting innovative technologies and implementing new infrastructure, such as renewable energy installations and electric vehicle charging stations, as well as the usage of public transport. However, gaining social acceptance for these changes can be challenging especially in terms of transportation.

Many people find it hard to transition from using a car to relying on public transportation in Austria due to various factors. One key reason is the convenience and flexibility offered by private vehicles, allowing individuals to travel according to their own schedules and preferences. Additionally, public transportation may be perceived as less reliable or less accessible in certain regions, making car ownership a necessity for many. Furthermore, concerns related to overcrowding, longer travel times, and limited routes or connectivity can contribute to the reluctance to switch to public transport. Overcoming these barriers requires improvements in the quality, accessibility, and efficiency of public transportation systems, along with effective communication and awareness campaigns to highlight the benefits while addressing the concerns of potential users.

One such campagne to convince more people to use public transport, is the “Klimaticket”. It is a nationwide ticket introduced by Austria in October 2021, that offers almost unlimited public transport use across the country for a full year [8]. The ticket costs EUR 1,095 per year for adults (EUR 3 per day) [8]. It is one of Austria’s key policies to incentivize the use of public transport. In parallel, the federal government is also investing in infrastructure development and the digitalization of services to make public transport more attractive [9].

3.3 Political Implementation

To achieve further given goals, the Austrian government has introduced several measures to reduce emissions and promote sustainable development. These measures include introducing a tax on businesses and enterprises emitting high amounts of CO_2, providing tax incentives for eco-friendly business models, and eliminating subsidies for environmentally damaging businesses [22]. Furthermore, regional governments will receive increased funding to accelerate the transition to sustainable energy and expand environmentally friendly public transport.

In addition to the measures mentioned above, Austria is also taking steps to promote sustainable development in other sectors. For example, the government is investing in renewable energy and energy efficiency to reduce emissions from the energy sector. The government is also promoting

sustainable transport by expanding public transport options and encouraging the use of low-emission vehicles. These measures are part of Austria’s broader efforts to reduce its carbon footprint and transition to a more sustainable economy.

4 Challenges for Czech Republic

In the following section, we will analyse some local specifics associated with the implementation of the Green Deal in the Czech Republic, such as the composition of the industry, the energy mix, and the adaptation of society to the obligations arising from the Green Deal.

4.1 Economic Challenges

The Czech Republic faces challenges in transitioning to cleaner energy and reducing emissions due to its heavy reliance on emission-based energies and the limitations of its economy and energy sector. The energy industries remain the primary source of greenhouse gas emissions across the economy. As of 2005, the energy sector accounted for 42% of the total emissions. However, there has been a significant reduction in emissions from the energy industry, with a decrease of nearly 20% between 2005 and 2019. This reduction has resulted in their share of total emissions decreasing by 8% [6] [7].

The manufacturing industries and construction sector have achieved the most substantial reduction in emissions. Over the same period, their share of total emissions has decreased from 12.6% to 7.8%, representing a 45% reduction since 2005 [7].

On the other hand, the waste and transport sectors have experienced the largest increases in emissions, with a rise of 24% and 23% respectively over the given period. Emissions related to industrial processes and product use have also increased by 10%. Consequently, the combined share of emissions from these sectors has grown from 24% in 2005 to 33% in 2018 [7].

According to the paper [7] this is an overall Czechia's greenhouse gas emissions divided by sector:

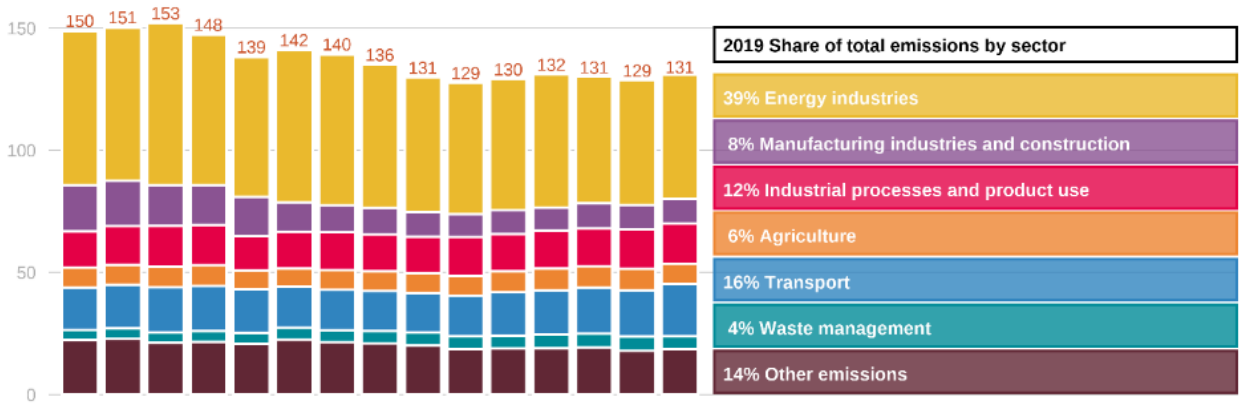

Figure 2: Greenhouse emissions by sector (2005-2019) [7]

Based on the data above the energy industries in Czechia constitute a significant and prominent component of the country's carbon dioxide emissions. In order to provide an understanding of the issue, it is crucial to consider the composition of power plants in Czechia (using data from 2019) [11]:

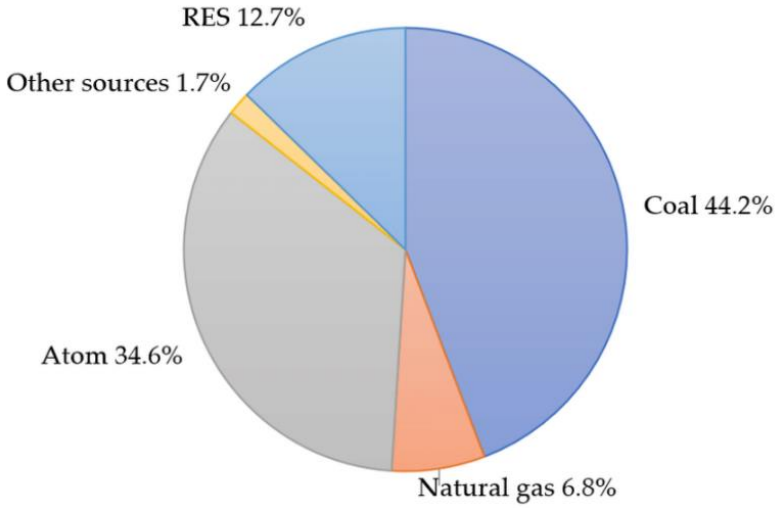

Figure 3: Net electricity generation structure in the Czech Republic in 2019 [11]

The country also has plans to phase out coal and lignite, which currently contribute to almost 50% of electricity production and 60% of heating. These efforts are expected to lead to further decreases in emissions from the energy industry in the future [7].

Not only the heavy reliance on coal is a problem, but potentially it is also a reliance on the nuclear energy. Two Czech nuclear power plants, Dukovany and Temelín, were commissioned between the years 1985 and 1987, and 2002 and 2003, respectively. Even though their operational lifespan has been recreantly increased up to 60 years, the planning of electricity generation structure must include a potential disruption in the production capacity after the lifespan of Dukovany, then Temelín. Dukovany Powerplant is older and plans for its replacement with newbuilds are necessary [20].

4.2 Political Implementation

In December 2019 the Czech Republic, along with other European Union member states, committed to achieving climate neutrality by 2050. The leaders expressed concerns about the proposed radical increase in climate-energy objectives by 2030, arguing that implementing such ambitious targets would be impractical and irresponsible, requiring careful long-term financial planning throughout the European Union [21].

4.2.1 The State Energy Concept of the Czech Republic 2015

In 2015 the Government of the Czech Republic approved of the Czech Energy Concept, that aimed to establish clear priorities and strategic intentions in the energy sector, ensuring reliable, secure, and environmentally friendly energy supplies at competitive prices. The policy also emphasized the need for uninterrupted energy provision during crisis situations to ensure the functioning of essential state components and the survival of the population [7] [22].

This document approved strategic plan for the energy mix in a year 2040 [10] [22]:

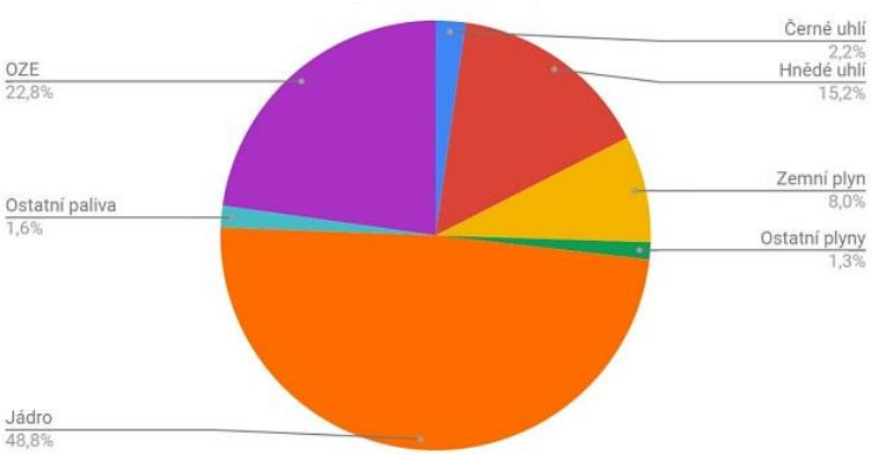

Figure 4: Planed energy mix in 2040 [22]

Based on this document the nuclear power's contribution (orange) to electricity generation is reaching up to 9% by 2040, while the share of coal-fired power plants (red and blue) is expected to decrease to 17.5%. Renewable sources (purple) are set to comprise approximately 23% of the energy mix, with a particular focus on biomass, biogas, and photovoltaic power plants due to the limited potential of hydroelectricity [10].

4.2.2 Update from the year 2023

Dated April 12, 2023, the Czech Republic government approved the guidelines for updating the State Energy Concept of the Czech Republic and related strategic documents. These updates are crucial considering the changes that have occurred since the concept's approval in 2015. The necessity for this update was highlighted in the Evaluation of the Implementation of the State Energy Concept of the Czech Republic, prepared earlier in 2021. Additionally, the Ministry of the Environment is responsible for preparing the update of the Climate Protection Policy in the Czech Republic and the update of the National Plan of the Czech Republic for Energy and Climate by 2030. The goals from category environmental sustainability are [12]:

- Reduce greenhouse gas emissions to align with the targets set in the Fit for 55 package and achieve climate neutrality by 2050 and continuously decrease emissions of air pollutants in accordance with the National Emission Reduction Program.
- Lower the per capita greenhouse gas emissions.
- Decrease the share of fossil fuels (used without carbon capture technology) in primary energy consumption to 50% by 2030 and eliminate their usage entirely by 2050. Phasing out coal for electricity and heat production should be completed by 2033.
- Achieve the share of renewable energy sources (OZE) in gross final energy consumption that corresponds to the EU targets by 2030 and further increase this share by 2050 to align with achieving climate neutrality.
- Maintain electricity consumption per capita below the average level of the EU.
- Decarbonize the district heating sector.
- Improve energy efficiency in district heating systems.
- Decarbonize the transportation sector and reduce reliance on fossil fuels in transportation.

4.2.3 Conclusion of Political Implementation

Based on the examination of documents from the Ministry of Industry and Trade, it is evident that there is a long-term effort to address energy-related challenges associated with the transition towards carbon neutrality. The Czech Republic has mapped its energy mix composition and possesses knowledge about the lifespan of individual facilities, enabling it to adequately anticipate future developments and plan legislative measures and strategies accordingly.

4.3 Social Aspect of the Implementation of the Green Deal

The study of Czech Perception of European Policy found that 62% of Czechs expressed their support for the Green Deal, despite having a limited understanding of its specifics. However, out of those who supported the policy, 34% believed that the Czech Republic should have the option to modify the plan according to its specific needs. The author of the study explains that this sentiment may stem from the Czech Republic's historical experience with communism and subsequent adoption of neoliberalism. The country has a general sensitivity towards policies that are perceived as being "imposed from above." Czech society typically requires a sense of tangible influence over European policies in order to fully accept them [19].

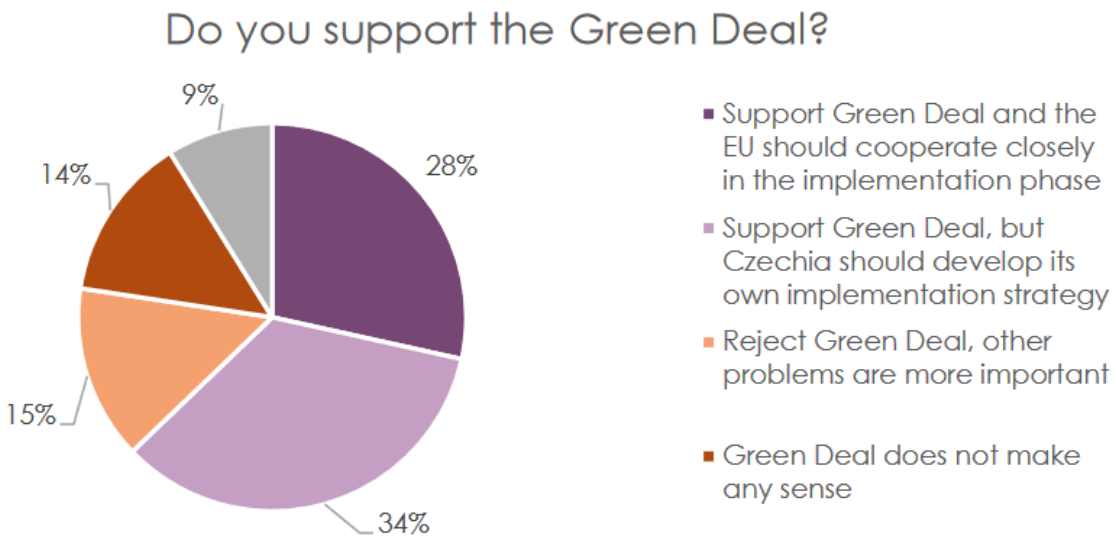

Figure 5: The support of the Green Deal [19]

To address this issue in the future, it will be crucial to convince the Czech population that they have an active role in shaping the final version of the Green Deal. Emphasizing their ability to influence the plan's content and highlighting the importance of tailoring it to suit Czech needs will be essential. By ensuring that Czech citizens feel empowered and involved in the decision-making process, it is more likely that they will embrace and support European policies like the Green Deal [19].

5 Comparison

In terms of climate neutrality, Austria tries to become climate-neutral by 2040, surpassing the EU target of 2050. The Czech Republic aims to achieve climate neutrality by 2050, in line with the EU target.

For implementing renewable energy systems Austria has favourable conditions for the expansion, such as hydropower and solar energy, due to its geographic location.

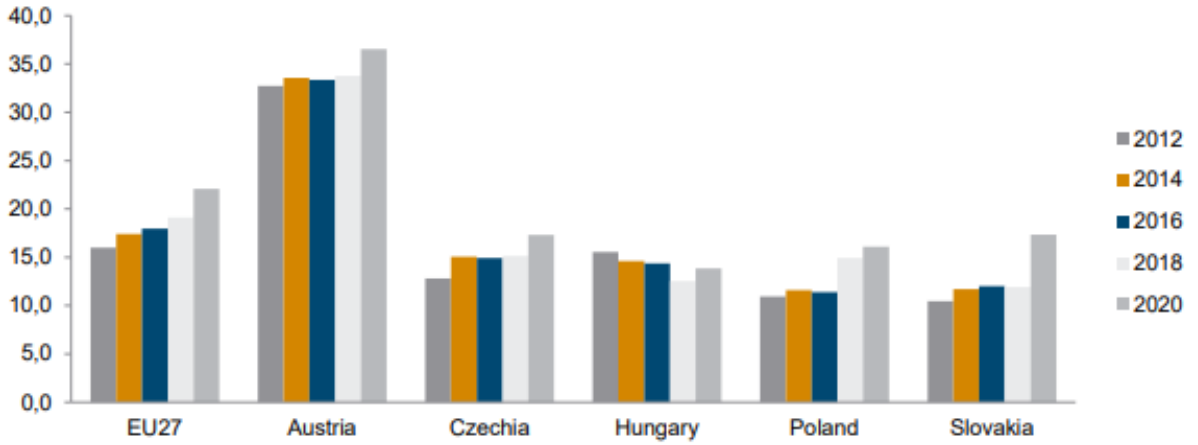

Figure 6: Share of renewable energy sources in energy mix [16]

In contrast, the Czech Republic has a higher dependence on coal and faces challenges in diversifying its energy mix. Also, the Czech Republic relies on nuclear energy, which plays a role in its energy transition strategy. Austria, on the other hand, has a long-standing anti-nuclear stance and does not utilize nuclear power. The following figure compares the electricity mix of both countries directly.

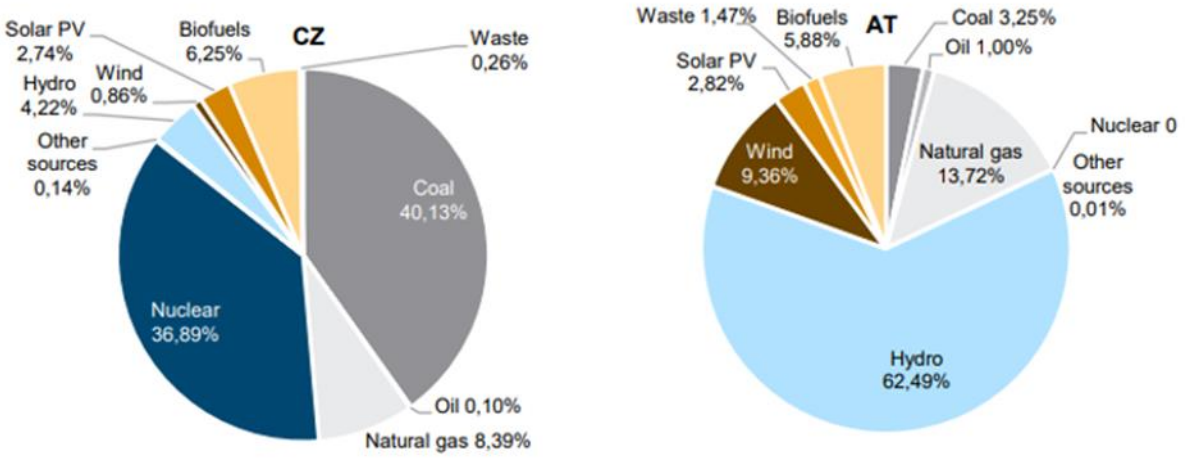

Figure 7: The electricity mix [16]

The CO_2 emissions by sector in Austria and the Czech Republic reflect the unique characteristics and energy profiles of each country as it can be seen in the following figure. In Austria, the largest contributor to CO_2 emissions is the transport sector, due to fossil fuel combustion from road vehicles. On the other hand, the Czech Republic has a higher share of emissions from the energy sector, with a reliance on coal-fired power plants. Additionally, the industrial sector, including manufacturing and heavy industries, contributes significantly to CO_2 emissions.

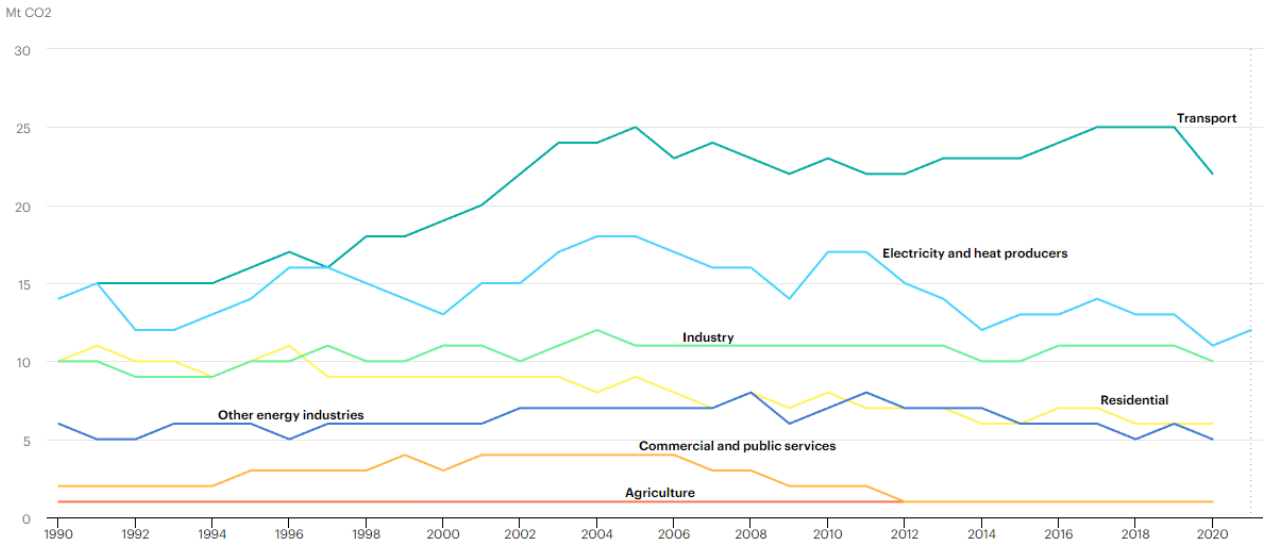

Figure 8: CO_2 emissions by sector, Austria 1990-2021 [14]

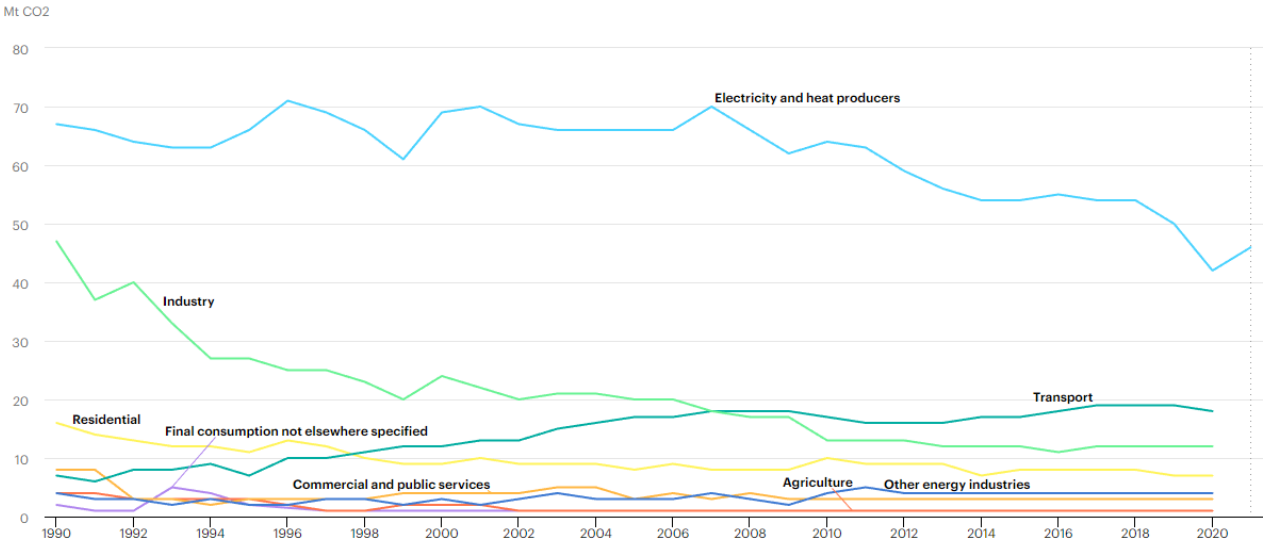

Figure 9: CO_2 emissions by sector, Czech 1990-2021 [15]

Comparing the CO_2 goals between the Czech Republic and Austria highlights the challenges that arise due to different starting points and geographical locations.

5.1 Difficulties Emerging from Using Renewable Energy

According to a draft EU document, Europe will require investments of over half a trillion euros in this decade to modernize its energy grid. These investments are necessary to achieve the goal of increasing wind and solar power, reducing greenhouse gas emissions by 55%, and reaching a 45% share of renewables by 2030. Upgrading the grid and implementing digital energy technologies will enhance flexibility in the system, enabling consumers to contribute excess power from solar panels back into the market and utilize stored electricity from electric vehicles to power their homes. This modernization is crucial to ensure the energy system is prepared for a higher proportion of renewable energy [24].

Those requirements are based on the problems with energy supply and demand in today's electrical grid and it is expected that with rising number of renewables the problems are only going to require more and more attention. As the electricity flows from windy Denmark through Germany and Czech Republic and the load in the grid increases with peaks of production. Many countries are fighting this with phase shifting transformers on their state borders [25]. Similarly, with growing number of PV systems there are peaks in the electricity production in the sunny summer, especially around noon. As a demonstration of this problem, look in the following picture with non-specified solar production and load curve. You can see the difference between solar power generation and demand. This needs to be addressed before adding more PV systems into the grid:

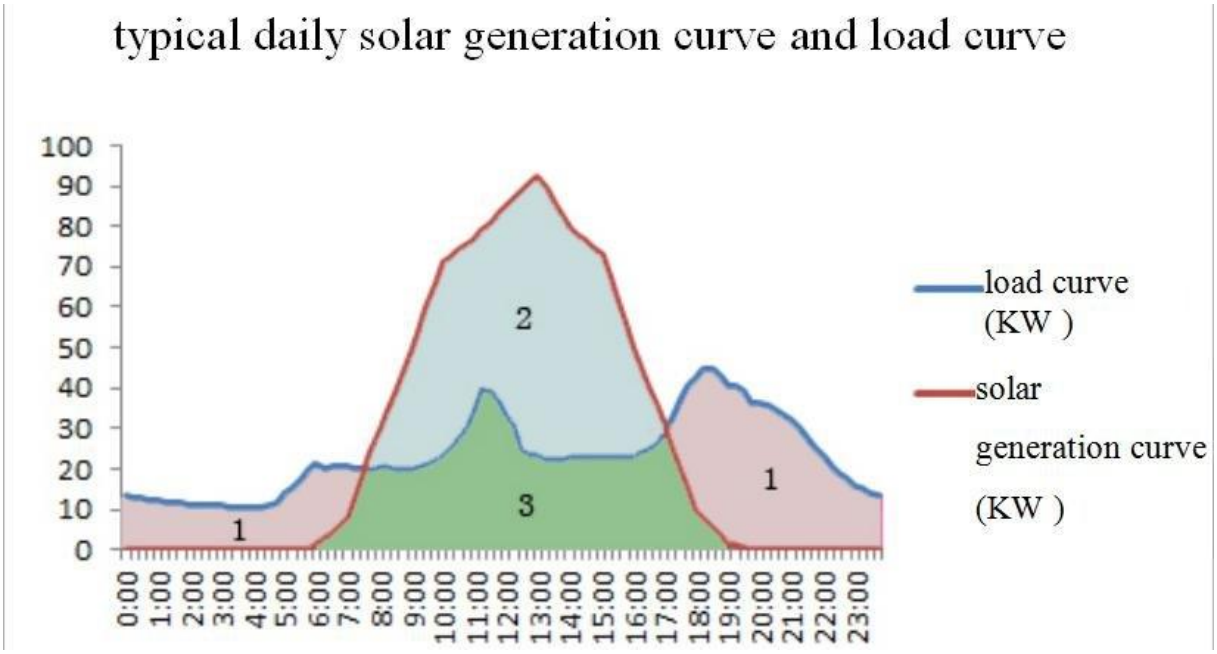

Figure 10: The non-specified curve of solar generation and load [26]

Based on above, the increasing integration of solar power into the electricity grid presents both opportunities and challenges for EU. It can be a local low-cost source of electrical energy. However, the variable and geographically dispersed nature of solar PV systems pose technical and economic challenges for the grid system. Achieving a balance between supply and demand calls for a high level of flexibility within the system, therefore gas power plants capable of rapidly generating electricity within minutes must be integrated. Energy storage solutions such as battery centres and power-to-gas implementations are an important part of evolution or prospects of the whole electrical grid [23].

Higer percentage of solar systems in the grid brings several technical challenges that need to be addressed [23]:

- The fluctuating power output of solar PV systems, particularly during cloud transients, can cause voltage fluctuations in the low voltage grid. This becomes more significant as the penetration of PV systems increases. These fluctuations can violate power quality standards, potentially damaging electrical appliances and causing annoyance and health problems due to light flickering.
- Integrating PV systems into the utility grid increases the contribution of short circuits. Faults in voltage channels can lead to short circuit interference, posing risks to human safety, power supply disruptions, and equipment damage.

- Unintentional islanding is the situation where a portion of the distribution system continues to operate independently despite the larger power system being disconnected. While this might seem desirable, unintentional islands can lead to equipment damage and safety concerns. PV inverters connected to the grid have anti-islanding features to detect and disconnect from islands, but there are concerns about their effectiveness, especially when combined with other distributed generation sources. This poses risks to equipment and safety.
- The frequency of a power system needs to be maintained close to its nominal. Frequency deviations occur when there is a mismatch between generation and load. Fluctuations in PV output due to weather changes can be mitigated by adjusting conventional generators, affecting their economic operation. However, with increased PV penetration, the system's inertia decreases, posing a threat to frequency stability.
- Reactive power is crucial for maintaining voltage stability in a power system, as it is directly related to voltage. Grid code requirements mandate that every new PV plant installed in the grid comply with reactive power control and voltage support. As PV penetration increases, challenges arise in managing reactive power and ensuring stable and reliable electricity supply.

The addition of renewable recourses such as wind and solar power are bringing volatility not only into the grid system itself, but it is also going to be reflected in the electricity pricing. Even nowadays we can see that the price of electricity can go into negative numbers, which encourages higher consumption in those moments. We can expect more flexible pricing in the future; therefore, it is expected that consumer behaviour is going to change: The companies can adapt their operation hours following patterns of lower electricity cost which follows high supply peaks.

In the future we will need a lot more energy storages. The increasing use of renewable energy sources requires more energy storage systems due to their intermittent nature. Energy storage helps stabilize the grid, balance energy supply and demand, maximize renewable energy utilization, ensure reliability during emergencies, enable decentralization, and facilitate the integration of electric vehicles.

To summarise, the grid needs many improvements and investments in the future. The share of renewable sources is expected to grow; therefore, volatility of electricity production can increase. This means changes in pricing and consumer behaviour are expected. Based on the documents following Fit for 55, the EU is aware of these problems and the investments are planned as well as research of new technologies of electricity transportation and conservation.

6 Conclusion

The European Commission's funding initiatives and support aim to assist the country in achieving the goals set by the European Green Deal. The European Commission recognizes the varying capacities of member states to undertake drastic changes and acknowledges that not all countries are in a privileged position to afford the short-term economic impacts of the transition. In response, the Commission has evaluated each member state's progress in adopting the necessary regulations and directives. In the case of the Czech Republic, the European Commission has acknowledged that the country's existing policies align with the goals of the Deal, suggesting that it is on track to meet the targets. To support Czechia and other member states, the European Commission has allocated substantial funds to finance the EGD initiatives. The EU's budget sets aside approximately €1 trillion, and an additional €800 million is expected from NextGenerationEU, bringing the total budget to €1.8 trillion. These funds provide crucial support for the Czech Republic to facilitate the necessary investments in renewable energy, infrastructure renovation, and other measures to reduce emissions [6].

The goals and approaches towards renewable energy and decarbonization may differ based on each country's unique energy profiles and available resources. These disparities make it difficult to directly compare energy goals between the two countries. Nevertheless, both countries share a common objective of achieving sustainability and reducing carbon emissions. Collaborative efforts, knowledge sharing, and policy exchanges within the European Union can help address these challenges and support the collective transition towards a greener future.

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