Competitiveness between Energy Crop and Food in Biofuel Production Assessment in Austria and Czech Republic Case

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Abstract:

The rapid development of biofuel usage gives the chance to mitigate the worrisome situation regarding the GHG increment, which is made by the high usage of fossil fuel. This will lead to alleviating climate change. However, this may increase food prices and food insecurity, especially for low-income communities. This research focuses on the competitiveness between the Energy crops used in both biofuel production and the food industry and discussion the impact of biofuel production on increasing food prices and its influential parameters.

Keywords: Biofuel, Food Price, Food Insecurity Fossil fuel, Austria, Czech Republic

1. Introduction:

The world's economies are gradually shifting their policies and strategies toward a transformation from a food economy to a bio-economy due to the high demand for food, energy, and fuel.[1] The instant trade-off between natural resource use, food security, renewable energy, waste management, and other biobased production and resource management goals becomes a key policy concern, because these objectives frequently compete for the same resources, such as land, labor, water, and other investments, in this process of shifting from a food economy to a bioeconomy.[2], [3].

On the one hand, the use of fossil fuel-based resources more quickly than they can be replenished. Furthermore, using fossil fuels has significant negative effects on the ecosystem. Therefore, it is crucial to replace fossil fuels with renewable energy sources. Biomass is regarded as one of the most promising forms of renewable energy, making up 59% of all renewable energy sources in the European Union in 2015. The world's overall energy needs are thought to be 8 times greater than the same amount of biomass that is generated globally.[4]

Crops such as (Wheat, Maize, Sugar beet, Rapeseed, Soybean, palm oil, rapeseed oil, etc) are considered sources of biomass in bioenergy production. Figure 1 indicated the share of the consumption of main crops in the production of bioenergy in EU28 in 2015, which accounts for wheat, Maize, sugar beet, and vegetable oil around 4.05%,7.51%,12.48%, and 43.39%, respectively. However, Solid biofuels (for residential use, industry use, and use for transformation to power and/or heat) represent almost 70% of the biomass energy supply. Liquid biofuels, biogas, and renewable waste each represent around 10%.[5]–[7].

Diesel is the dominating fuel in the EU transport system, meanwhile, on average, biodiesel represented 6.4% by energy of EU28 diesel consumption in 2019. Bioethanol on average represented 3.7% of the energy of gasoline consumption. Moreover, about 30% of biofuels consumed in the EU28 in 2019 are qualified as ‘advanced biofuels’, meaning that they are produced from residues and waste (particularly used oils for biodiesel). [4], [6].

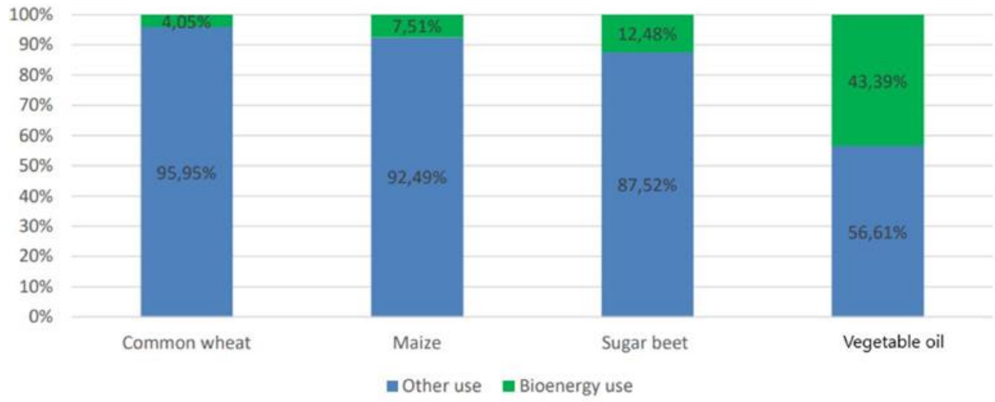


Fig1- share of the consumption of the main crops at the production of bioenergy in EU28 in 2015 [7]

Some of the world's biggest biodiesel producers are in the EU. France, Germany, Spain, and the United Kingdom are among the continent's top four producers, although biodiesel's importance is expected to fall as it is connected to the first-generation biomass, The feedstock inputs you need for biodiesel are more expensive than petroleum.[8]

For this aim significant technological challenges need to be overcome for fermentation to be commercially viable. Also, it should remember that bioethanol is quite a controversial type of biofuel because the increased use of biofuels puts increasing pressure on water resources in at least two ways: water use for the irrigation of crops used as feedstocks for its production; and water use in the production of biofuels in refineries, mostly for boiling and cooling.[9]

Until 2050, it is predicted that the EU could open an excess of 0 to 6.5 Mha of agricultural land (0-15.0 Mha if fallow land is included). This concludes the article on the significant EU biomass potential from surplus land that has been released (7-48 Mha), primarily as a result of increased crop yields.[6]

It is therefore widely accepted that rising demand for bioenergy may indirectly influence how land is used to promote domestic production of plant-based biomass. This could potentially have negative effects on the environment, such as soil degradation, nitrate fertilizer pollution, a deterioration of the greenhouse effect, a decrease in the amount of area used to grow food crops, and rising costs.[10] The main goal of this study is to find the relationship between the crop as food and energy crops, including the production of biofuels, land use, and feedstock price.

1.1 Biofuel Production Pathways

Many organizations and countries utilize different definitions and categorizations of biofuels. These variations are not minor. They serve as the foundation for certifications in international trade in addition to reflecting the objectives outlined in a particular national biofuel strategy. Therefore, different companies that are significant players in the biofuel industry have diverse perspectives on identical products. There is no classification system that everyone agrees on. The legalization of biodiesel in European and American legislation may be one of the most alarming examples. Figure 2 indicates the different pathways for biofuel production with different feedstocks and with different products in the next section, we will give in more detailed information.[11]

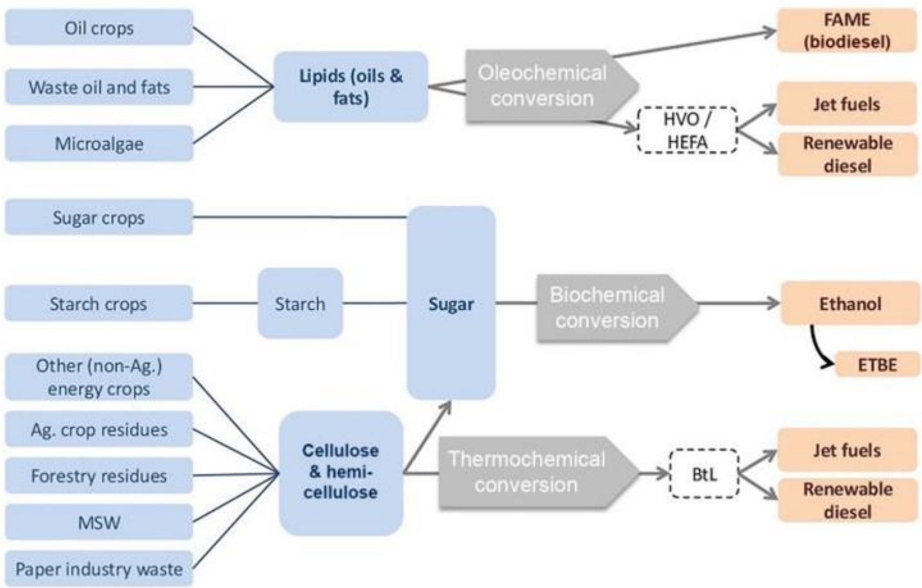


Fig2-Overview of the main biofuel pathways[11]

2. Methodology of Approach

To evaluate the impact of biofuel production on the food price two types of approaches have been chosen:

a) the underlying connection between production volumes, costs, and subsequent market prices.

b) a summary of the most significant literary works on the food and fuel debate

3. Results

In this work, the most influential parameters like the economic efficiency of food-based biofuel, Production of Biofuel in Austria and the Czech Republic, Feed Stock Prices in Austria and the Czech Republic and the volatility of their price of them, and finally some overview regarding the available land and agricultural potential in Austria and Czech Republic will be discussed.

3.1 Biofuel Production in Austria and the Czech Republic

In total, 30 % of primary energy production in Austria in 2019 had made from Renewable sources, and from this amount, 55% of them comes from biomass. The usage of biofuel in the transport section in Austria is makeup around 5%. It should remember that Austria is a country that moving toward a climate-neutral use of energy up to 2050. In the transportation section also, these policies have been inserted. For the case of biofuel production using 7% of biodiesel with diesel and 5% bioethanol with petrol has been done. Therefore, it is interesting to look over the share of each kind of energy source in the total energy supply of Austria. Figure 3 compares the development of energy supply from bioenergy in Austria from 2000 to 2018. [12]

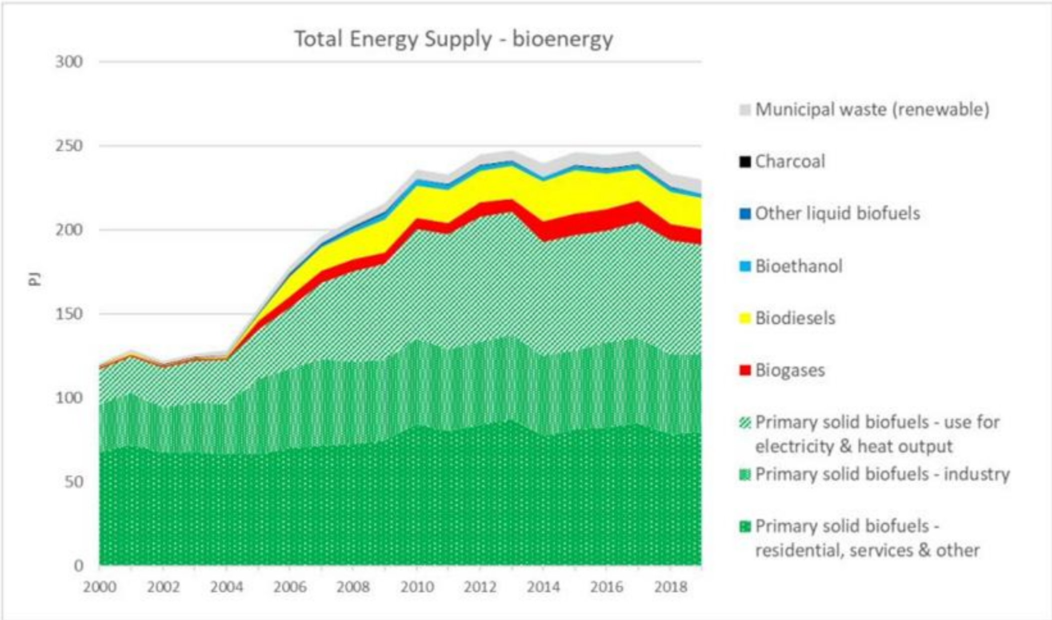


Fig3- Energy supply with a focus on bioenergy in Austria 2000 – 2018[12]

As indicated in Figure 6, solid biofuels make up (>80%) of bioenergy in Austria, which is fuel wood, wood chips, wood pellets, bark, and sawmill by-products. The share of other kinds of bio-energies is biodiesel (8%), biogas (4%), renewable MSW (3%), and bioethanol (1%).

Biodiesels means here the biodiesel (FAME) and HVO which FAME production increased from 1PJ in 2005 to 19 PJ in 2010. Because of imports of HVO, the total amount of FAME and HVO indicates a peak of 26 PJ in 2015. However, Biodiesel supply levels decreased to 19 PJ in recent years.

Bioethanol consumption was also enhanced. Moreover, a reduction in the consumption of gasoline has been experienced in recent years. To have a framework regarding the percentage of biofuels in the transportation sector fig 4 indicated the share of each type of energy in the transport sector in Austria from 2000-2019.[12]

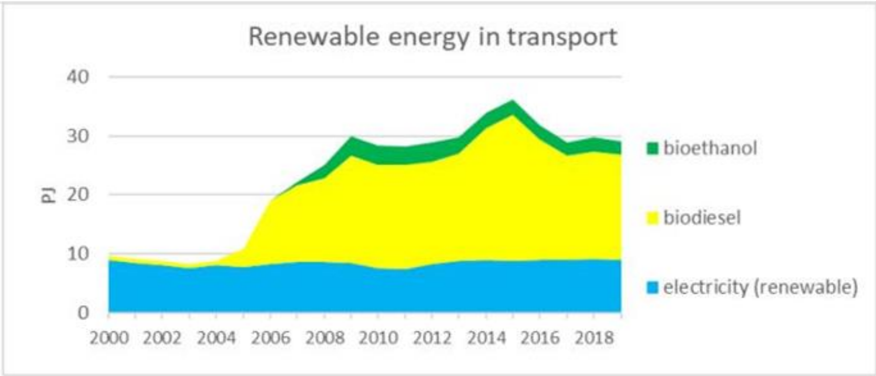


Fig4- Evolution of transport fuels in Austria 2000 – 2019[12]

From years 2005-2009 in Austria, there is a significant increase in the usage of biofuel, however, this amount rather stays constant at around 5-6% of overall transport energy consumption. As already mentioned, biodiesel is involved in the majority of diesel in practice, which is the basic biofuel in Austria. From a general point of view, biodiesel makes up for 6.3% of diesel consumption, which is involved with a combination use of B7 and some HVO.

Bioethanol also experienced the same trend, increasing from 2010, however, its level decreased because of a reduction in the usage of gasoline. In total bioethanol indicates 3.3% of the energy of gasoline. [12]

Turning to the Czech Republic's usage of Bioenergy (Biofuel). As depicted in Fig 5 a small amount of fuel for transportation in the Czech Republic is made of biofuels around 5%, and 91% of them are covered by oil. Only 2% of the energy supply in transportation is from electricity. As Figure 8 indicates the biofuel consumption in the transportation section before 2008 is very low. Since 2009, the share of biofuel in transportation is considerable. [13]

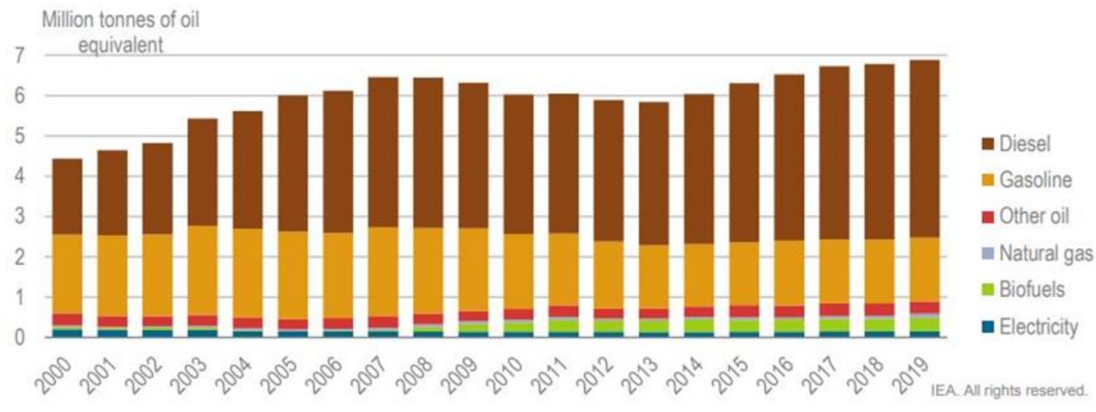


Fig5- Total final consumption in transport in the Czech Republic by source, 2000-19[13]

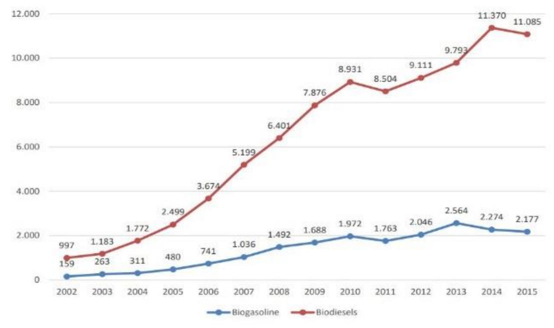
The NECP (national energy and climate plan) of the Czech Republic involves the usage of 14% of the total amount of fuels from renewable resources (RES in the gross final consumption) up to 2030. With a closer look at that, it is expected the second-generation biofuel share will be 6.2% and 7% for the first generation which is the maximum amount based on the EU legislation.

The biofuel blending Czech Republic for petrol and diesel is about 6% and 4.1% respectively. Also, in the case of first-generation biofuel in the Czech Republic is based on raw materials such as. rapeseed, cereals, and sugar beet and processing all types of them locally, the only exception is biodiesel, which is imported. [13]

After looking at using usage number of biofuels, will have a look at the production amount of biofuel in Austria, the Czech Republic, and the EU. Table 1 compares the primary biofuel production and net import of liquid biofuels in Austria, the Czech Republic, and the EU in 2015. The primary production of total liquid biofuel in Austria is around two times higher than the Czech Republic, while the net import of total liquid biofuel for Austria 3 times higher than the Czech Republic which means Austria has 35% dependency on biofuel import and the Czech Republic 25%, therefore Austria is more dependent on biofuel import, which is aligned on the climate-neutral usage of energy. Also, for the EU the primary production is 13.660(Ktoe), and the net import is 930 (Ktoe). To have a better comparison, figure 6 indicates the evolution of the primary production of liquid biofuels in EU28 (ktoe) (left) and; Evolution of final energy use of liquid biofuels in transport in EU28 (ktoe) (right) from 2002 to 2015. As it is obvious the production amount and final energy usage (biogasoline and biodiesel) from 2002 to 2015 experienced an increasing trend although the number for the usage is slightly lower than production which indicates the biofuels import in the EU in this duration. Moreover, it should mention that the production number and using amount of Biodiesel are significantly higher than biogasoline. [7]

Table 1-Primary production and net imports of liquid biofuels in the EU28 Member States in 2015 (ktoe) [7]

	Total liquid biofuel			Biodiese		Biogasoline	
	Primary production	Net import	Biofuel import dependency*	Primary production	Net import	Primary productior	Net import
EU28	13.660	930	6%	11.085	391	2.177	539
AT	445	236	35%	304	317	140	-80
CZ	216	75	25%	148	85	68	-11



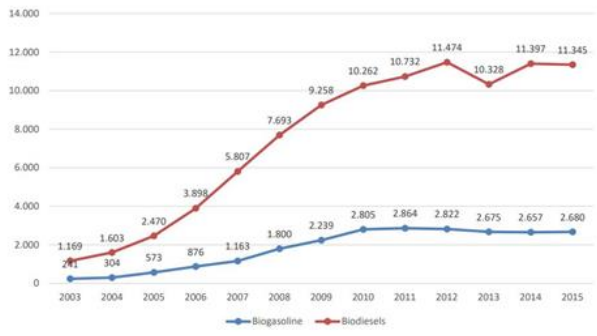


Fig6-Evolution of primary production of liquid biofuels in EU28 (ktoe) (left); Evolution of final energy use of liquid biofuels in transport in EU28 (ktoe) (right) [7]

3.2 Feed Stock Price in Austria and Czech Republic

Between 2005 and 2015, the amount of biodiesel produced worldwide increased on average by 28% per year. The surge in biodiesel production also coincided with a time when crude oil prices rose quickly Figure 7. Figure 7 indicated the real prices of crude oil and major biodiesel feedstocks, 2000–2017. (Notes: Crude oil price is an equally weighted average of Brent, Dubai, and West Texas Intermediate spot price monthly averages. Palm oil price is the Malaysian bulk price, 5% FFA, C.I.F. N.W. European ports monthly average. Soybean oil price is the F.O.B. ex-mill Netherlands monthly average. Rapeseed oil price is the F.O.B. Rotterdam monthly average. One can examine either crude oil or diesel about biodiesel, as the correlation between crude (European Brent) and diesel (LA Ultra Low Sulfur) prices was 0.989 between 2000 and 2015). [14]

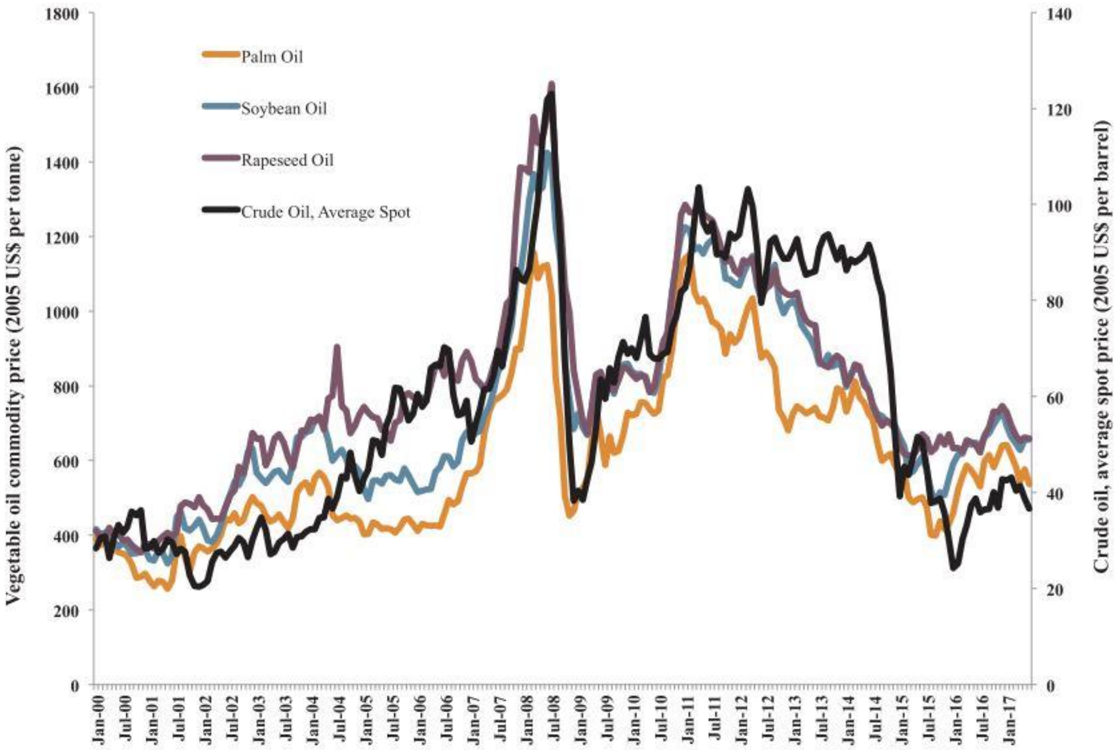


Fig7 -Real prices of crude oil and major biodiesel feedstocks, 2000–2017 [15]

Since the business has rarely been successful without extra financial support, even when feedstock costs have been low, these policies have nearly always been combined with other incentives for producers of biodiesel, such as tax credits and subsidies. [16]Palm oil is the only one of the three main agricultural feedstocks for biodiesel—soy, rapeseed, and—that has been cost-effective without subsidies for portions of the past decade, but only when factoring in variable costs. In the absence of additional subsidies, biodiesel has rarely been economical under a system of mandates or targets when fixed costs are taken into account .

The observed flexibility of requirements suggests that the upward pressure that biodiesel policy exerts on vegetable oil prices may be less intense than expected—and more constrained—than what quantitative models employing policy as an exogenous variable may suggest. [17]

Markets for oil crop by-products and substitutability of demand among vegetable oils are two additional elements that are crucial for determining the effects of biodiesel policy on vegetable oil pricing. Food, high-protein animal feed, industrial goods, and biodiesel are only a few of the uses for oil crops, and the meal-to-oil ratios vary from crop to crop. The demand for feed (meal) for food and fuel (oil) will affect price dynamics, depending on the co-product balance. For example, soy is 80% meal while oil palm is virtually exclusively oil. Instead of only maximizing the value of either meal or oil, oil crop growers often aim for optimal utilization of all co-products .[18]

It is considerable that global vegetable oil prices tend to move together. This means if in one country the biodiesel demand stimulates by biodiesel policy change (for example in EU rapeseed oil) this effect is answered by the high amount of substitution of multiple other types of vegetable oils in global markets. However, in practice, this is not completely influential and the cost of vegetable oil largely increased, so general changes in macroscale and regulation outside of the energy crop sectors also put changes in the general economic conditions. [16]

With the expansion of biodiesel production, food security with consumer prices for vegetable oils will change. About 75% of global vegetable oil demand is for food. [16]The high price of vegetable oil results in the deterioration of food security, especially for the net consumer from poor communities whose main diet is based on fats and oils, and also yet the price elasticity for them is large. This means with biodiesel price increments the vegetable price also pushes up which leads to these people losing 15-20% of their needed calories. Based on the structure of production and supply chains for the crops in question food security results vary.[19]

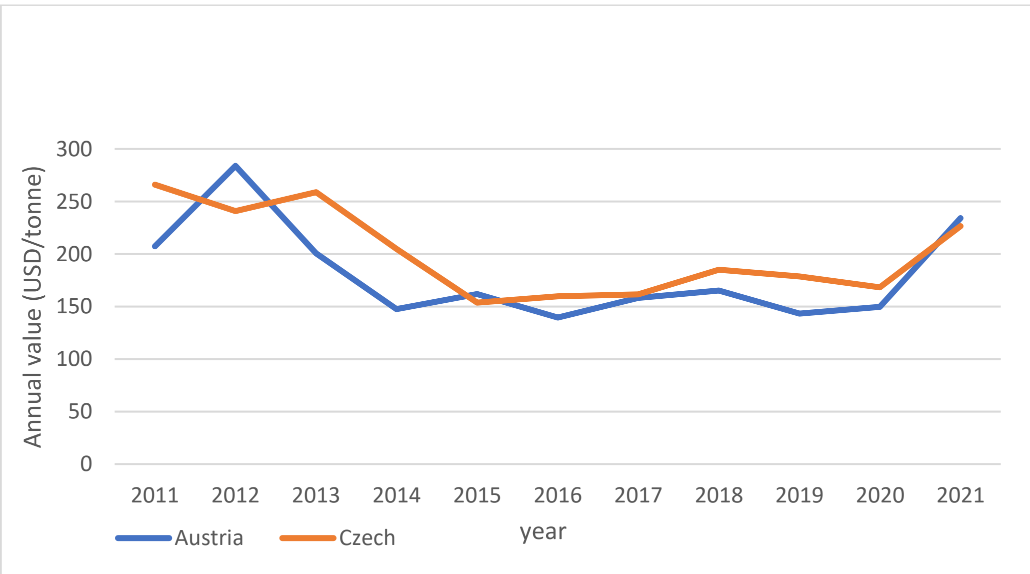


Fig8-average price of the commodity- Maize (USD/Tonne) from 2011 to 2021 for the Czech Republic and Austria [20]

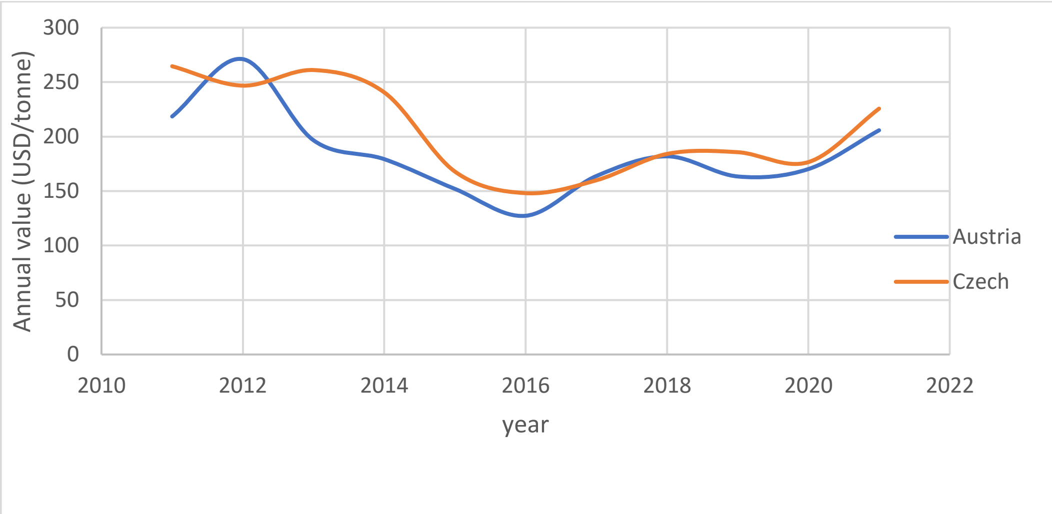


Fig9- the average price of the commodity- Wheat (USD/Tonne) from 2011 to 2021 for the Czech Republic and Austria [20]

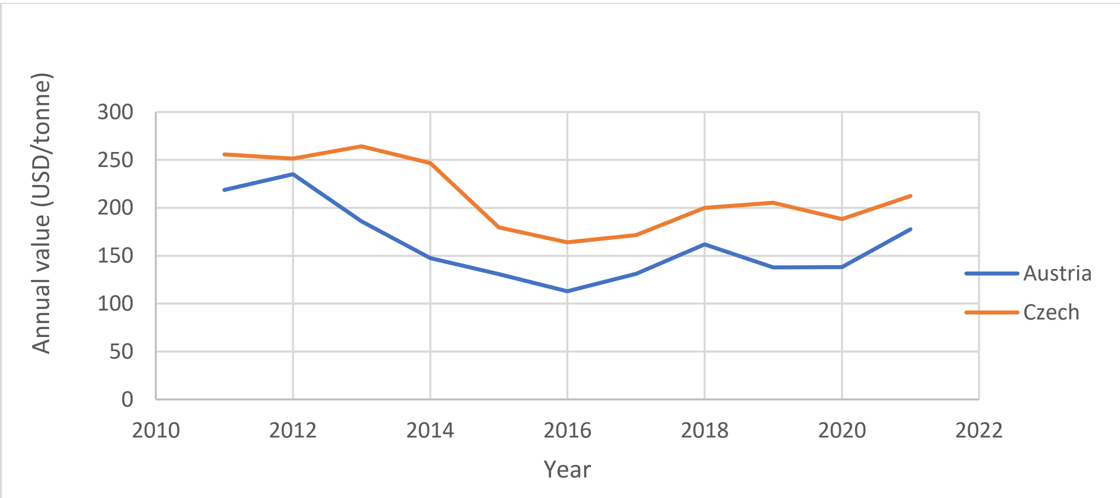


Fig10- the average price of the commodity- Barley (USD/Tonne) from 2011 to 2021 for the Czech Republic and Austria [20]

Fig 11-price of fuel in EU from 2018 to 2022 [21]

Based on the literature, feedstock (energy crop) prices are changing with the amount of biofuel production.[22]The sugar price change is the factor for shifting the price of agricultural products, which is the largest feedstock for ethanol production . Also, it behaves like the leader of economic indicators. [23]

It should be considered that the land for sustainable food production is in an alarming condition, but mostly in the country with food insecurity biofuel production has been chosen as a way for rural development.[24] In the case of biofuel production, corn, and wheat are playing a crucial role, and the biofuel production in the EU and (Austria, Czech Republic) increased significantly. (See section 3.1)

However, with slight fluctuation, the energy crop´s price remained stable in Figures 8-10 from 2011 to 2022.Should mention that after 2019 prices again increased which could be linked to the Covid-2019 pandemic and followed by the Ukraine-Russia War 2022 Figure 11. Also, the same trends and changes in price for Austria and Czech Republic have been seen. We should not forget to have to look at Figure 7, the direct link between the increasing price of fossil fuel and the price of feedstocks. The reason for this link is that the fossil fuel increase will lead to an increase in the expense of transporting feedstocks and also fertilizer. Also, the comparison of main crop production change from 2011 to 2021 for Austria and the Czech Republic, in which the production number of energy crops(for biofuel production) more or less stayed unchanged. [20]

3.4 Land Resources, yield, and water demand

Austria is a member of the European Union and is mostly a mountainous nation in central Europe. Its population is around 9 million, it has an overall land area of 82,500 km2. This equals a 109-person population density.

The majority of the land is made up of forests, 23% of which are protected. 30% of the area is used for agriculture, with an equal number of permanent pastures and meadows. Figure 12 indicates the land use in Austria. [12]

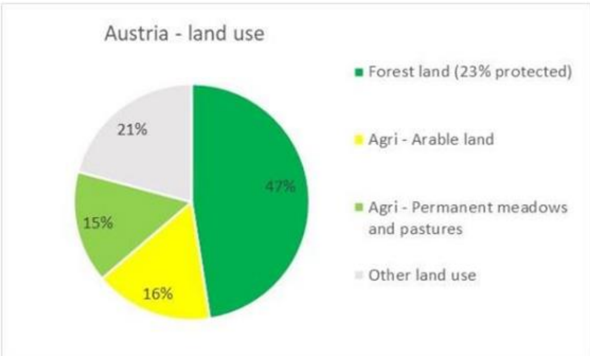


Fig12- Land use in Austria 2018 [12]

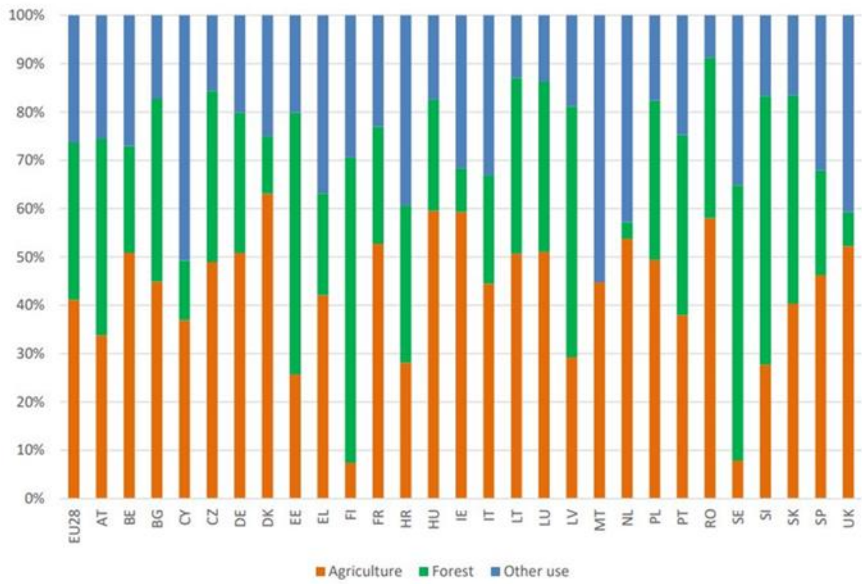


Fig13-Land Use by Type in EU28 2015 [7]

As Figure 13 indicates the share of agricultural land for the Czech Republic is around 50%,30% is the share of the forest, which in EU28 is about 40% Agriculture,30 % forest, and the rest other. [7]

The Czech Republic is in central Europe and is a member of the European Union. Its population is around 10,5 million, it has an overall land area of 78,8666KM^2. This equal a 133-person population density.

If we look at Austria and the Czech Republic from aerial images, the difference in the size of the individual land blocks is noticeable at first glance. While on the side of the Czech Republic, we see large blocks of land on which the same crop is grown, on the Austrian side these blocks are smaller. Spatial heterogeneity, and thus also soil quality, are connected with the size of land blocks. The size of land blocks is linked to the size of farms. In the Czech Republic, the average farm size is about 130 ha, while in Austria it is about 20 ha.[25]

Turning in more details, in the case of land utilization, it is beyond a shadow of a doubt important how much land is used, in this case, for growing energy crops. If only for the reason that the amount of land on which it is possible to grow crops (agricultural land), not only energy ones, is limited. But it is not only the case of land. Other resources that are necessary for growing energy crops are also limited. Thus, it can be assumed that competition will naturally arise between the cultivation of energy and conventional crops. There are concerns that due to the growing demand for biofuels, their cultivation will be, one might say, reckless toward the environment. The danger is that the demand for land will mean the destruction of natural grassland and forests. In addition, there is a fear that unsustainable agriculture will be used, part of which is the abundant use of chemicals (such as pesticides or fertilizers). Moreover, there is a risk of pollution of water resources, excessive use of water resources, soil erosion, degradation or a total loss of biodiversity, and more [26]. Figures 14 and 15 indicate the Arable land availability in Austria and the Czech Republic from 2000 to 2020. As we can see the Arable land in both Austria and Czech Republic has decreased significantly over two decays (2000-2020), which could be the result of the population increase and urbanization development in these countries. However, the decreasing rate in the Czech Republic was much higher. Compared to other nearby countries, this occurrence is unusual. The residual arable land in the forage areas steadily disappeared, particularly around 2000 when several sections were subsidiarily converted to grassland. In places with more intense agriculture (potato and cereal production zones), they remain steady. However, a consistent trend towards a decrease in the amount of intensively farmed arable land has also been seen here. The drop is caused by the area's growing urbanization, the stabilization of some of the higher regions through the growth of forest cover, as well as water areas, such as those created to battle drought. [27], [28]

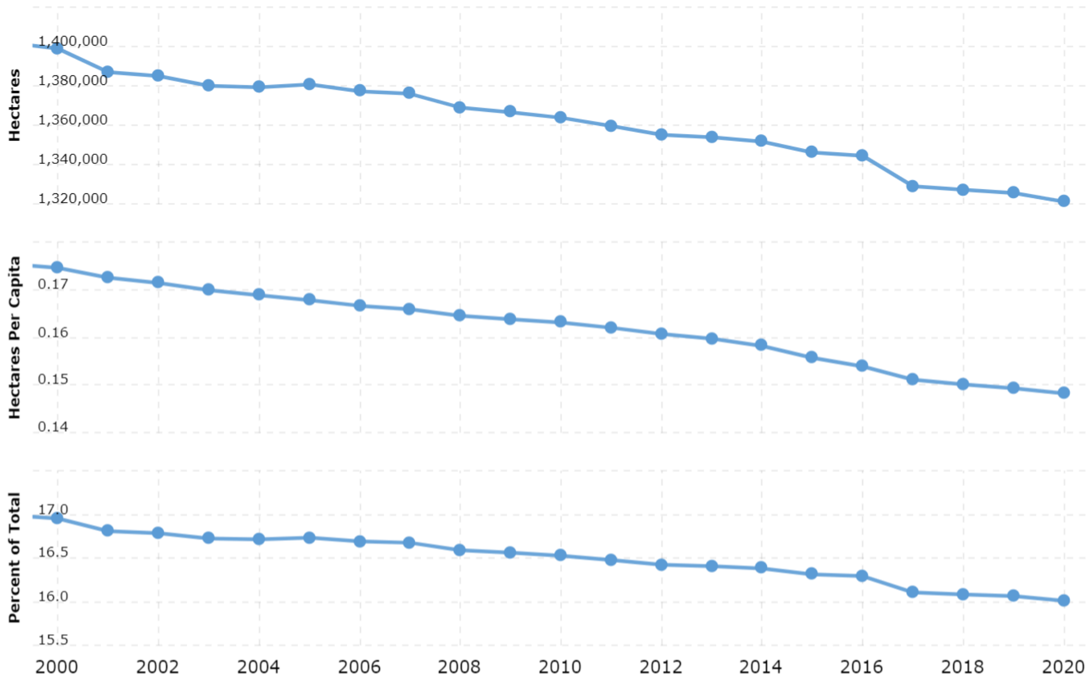


Figure 14-Arable land availability in Austria 2000-2020 [29]

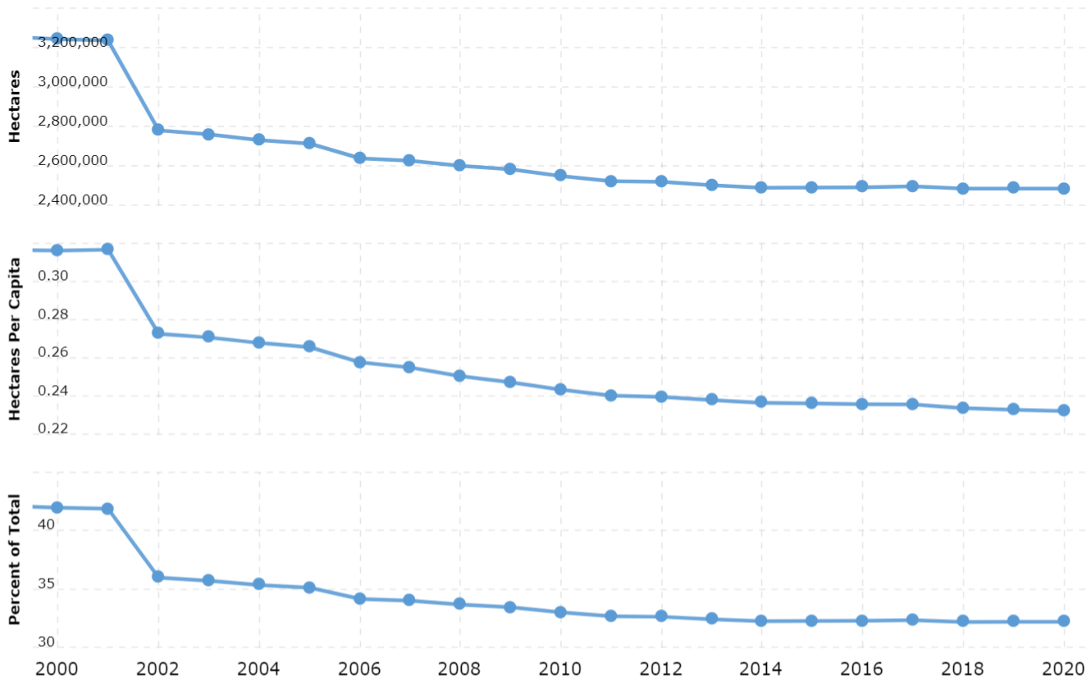
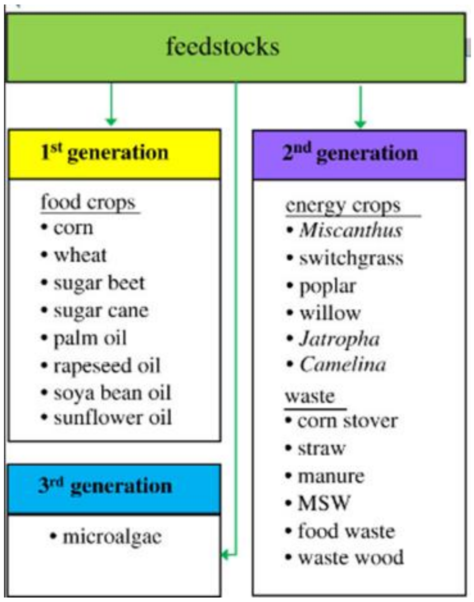


Figure 15- Arable land availability in Austria 2000-2020 Czech Republic [30]

But that alone is not a sufficiently comprehensive understanding of the given issue. We must not forget how important the type of selected land is, and also how the selected land is subsequently managed. As stated by Souza[31] , according to available data, with proper land management, it is possible to ensure sufficient production of bioenergy even without competition between the production of energy crops and conventional crops. In this process, it is very important to ensure that the land is managed in a sustainable manner.

In the case of growing energy crops, the category of energy crops matters. For example, the division into first, second, and third generations is commonly used (Fig 16). A fourth generation is expected in the future, but its importance is currently negligible for the purposes of this work.

Fig 16 - Three generations of energy crop [26]



First-generation biofuels are produced from food or animal feed crops. Second-generation biofuels are produced from non-food feedstock (in Figure 16 they are referred to as energy crops). Third-generation biofuels are produced from microalgae. It also depends on the specific species and how it affects its surroundings. Some types of energy crops are beneficial for their surroundings, they provide so-called ecosystem services (perennial energy crops). Of course, this cannot be applied to all of them (annual energy crop) . And for this reason, among others, it is necessary to appropriately allocate a certain energy crop to a certain type of soil. Therefore, it is possible to reverse the process of soil degradation by growing energy crops on less fertile soils (these soils are not suitable for the successful cultivation of conventional crops) [26]. Furthermore, energy crops can help with water management and so on. As a result, even conventional crops benefit from this, as it is possible to grow them again on previously unsuitable land. Other positive effects of energy crops are mentioned in the following paragraphs.

Among other things, the strategy of using agricultural land is exceptionally important. For example, according to Dauber and Miyake [32], there are several strategies, as can be seen in Figure 16:

- *"A1: First-generation energy crop production on productive agricultural land*
- *A2: Combination of first-generation and dedicated energy crops on productive agricultural land.*
- *A3: Strips of dedicated energy crops on productive agricultural land*
- *B1: First-generation energy crop production on economically marginal land*
- *B2: Combination of first-generation and dedicated energy crops on economically marginal land*
- *B3: Strips of dedicated energy crops on economically marginal land*
- *C1 and 2: Woody perennial crops on low-grade land*
- *C3: Biomass from (semi-)natural vegetation"*

First-generation energy crop production on productive agricultural land. In this case, they are annual crops of the first generation. Rapeseed and corn are among the most used in this category in Europe. The problem here is that these plants do not improve soil biodiversity. On the contrary, it can make it worse. And at the same time, they are not beneficial for pollinating insects all year round but only seasonally [32]. Their advantage is that their cultivation does not mean additional investment costs for the farmer in terms of technology [33].

Combination of first-generation and dedicated energy crops on productive agricultural land. They are already a more suitable combination due to the biological diversity of the soil. And at the same time, in this case, we are dealing with more permanent crops, not just annual crops. It is also related to the fact that, compared to the previous strategy, they can better ensure soil regeneration. They also have an anti-erosion effect and use fewer inputs like fertilization .[32], [33]

Strips of dedicated energy crops on productive agricultural land. Thanks to strips of trees (fast-growing woody species), wind erosion of the soil is limited. The combination of agricultural-forestry systems has many positive effects on the landscape and soil, and at the same time, it can counteract many of the negative impacts of agriculture. *"Perennial buffer strips adjacent to annual crops can reduce soil sediment and nutrient inputs into surface waters, increase carbon storage, improve farmland biodiversity, and reduce pesticide drift into natural habitats"* . Thanks to strips of herbaceous crops, the strengthening of natural pest control and positive effects on pollinating insects were observed .[32] This type, in particular, could be a very beneficial solution for large monoculture fields in the Czech Republic.

First-generation energy crop production on economically marginal land. "*This scenario resembles A1 but on lower-grade soils and/or under stronger climatic limitations to crop cultivation. Different crop varieties or species may be grown in comparison to A1"*[32]

Combination of first-generation and dedicated energy crops on economically marginal land. For this scenario, it is appropriate to use perennial lignocellulosic crops, as they have a positive effect on biodiversity and soil. But it is necessary to pay attention to sustainable agriculture when cultivating them .

Strips of dedicated energy crops on economically marginal land. This scenario has similar advantages to agricultural-forestry systems as was described in A3. At the same time, this scenario "improved habitat connectivity and ecosystem services" .[32]

Woody perennial crops on low-grade land. By its parameters, this soil is not intended for the cultivation of ordinary (food) crops. However, energy crops can be successfully grown on it, whether it is pastoral systems or agricultural-forestry systems. This scenario has similar advantages to agricultural-forestry systems as was described in A3.

Biomass from (semi-)natural vegetation. "*Biodiversity impacts of this utilization are largely unknown"*.[32]

Scenarios A1 and A2 are not the most suitable choice, either due to the above-mentioned reasons or taking into account that water consumption, especially for energy crops of the first generation, is relatively high. Scenarios A2, A3, B2, and B3 promote synergy between energy and conventional crops due to their characteristics.

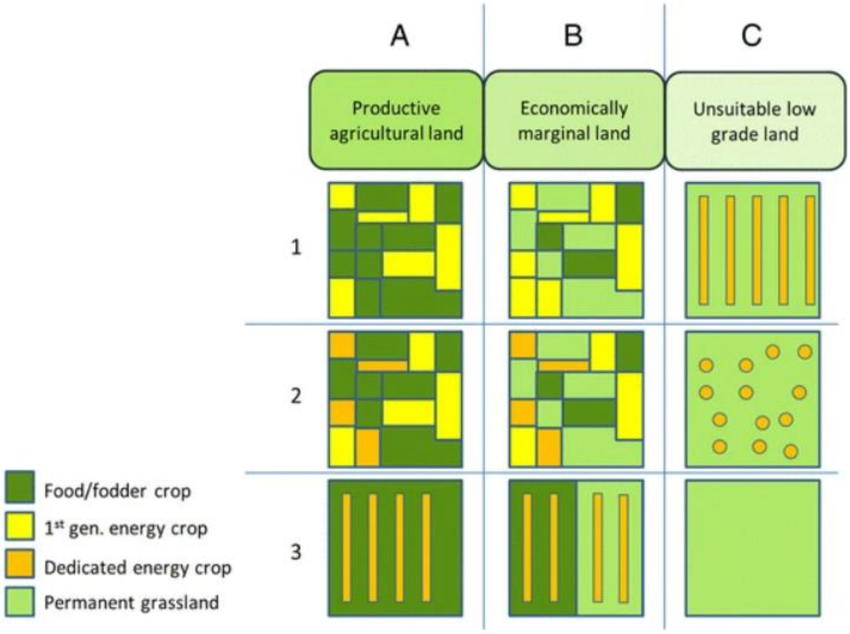


Fig 17 - Scenarios of integrating energy crop cultivation in open land varying in suitability for food production [32]

3. Conclusion

Austria has made significant progress in the production and use of biofuels, particularly biodiesel and bioethanol. In 2019, 30% of Austria's primary energy production came from renewable sources, with biomass accounting for 55% of that. The share of biofuels in the transport sector was around 5%. Solid biofuels, such as fuel wood and wood chips, constituted the majority (>80%) of bioenergy in Austria. Biodiesel and bioethanol showed increasing trends but experienced fluctuations due to changes in gasoline and diesel consumption.

The Czech Republic has also seen an increase in the usage of biofuels in the transportation sector. Biofuels accounted for around 5% of the total fuel consumption, with the majority (91%) still covered by oil. The national energy and climate plan aims to achieve 14% of total fuel consumption from renewable resources by 2030, with both first and second-generation biofuels playing a role. The Czech Republic has a lower dependency on biofuel imports compared to Austria.

The prices of feedstocks for biofuel production, have shown volatility over the years. Biodiesel production has increased despite fluctuations in fossil fuel prices, indicating the role of regulatory incentives. Subsidies and tax credits have been essential in supporting biodiesel producers. The price of vegetable oils, a key feedstock, is influenced by biodiesel policy changes, market dynamics, and the substitutability of different vegetable oils.

The utilization of land for biofuel production raises concerns about competition with conventional crops and potential environmental impacts. There is a risk of land degradation, deforestation, water pollution, and biodiversity loss. Austria has limited agricultural land, and the availability of arable land has decreased over time, which may pose challenges for expanding biofuel production. The Czech Republic also faces a decrease in arable land, which has declined at a higher rate compared to Austria.

Both Austria and the Czech Republic are moving towards climate-neutral energy use. The countries have set targets for increasing the share of renewable energy sources, including biofuels, in their energy mix. Future prospects involve further investments and advancements in biofuel production technologies, along with supportive policies and incentives to achieve these targets.

The Czech Republic's national energy and climate plan includes a significant share of second-generation biofuels. This indicates the potential for technological advancements and the use of non-food feedstocks, such as agricultural residues and dedicated energy crops, in biofuel production. Research and development efforts may focus on improving the efficiency and sustainability of second-generation biofuels. Also, ensuring the sustainability of feedstock production is crucial for biofuel development. Efforts should be made to avoid deforestation, land degradation, and negative environmental impacts. Promoting sustainable agricultural practices, such as efficient water use, reduced chemical inputs, and protection of natural habitats, can contribute to the sustainable production of biofuels.

Finally, Biofuel production and consumption are influenced by global market dynamics and international trade. Collaboration between countries, sharing best practices, and establishing common standards can contribute to the sustainable growth of the biofuel industry. International trade agreements and policies may impact the import and export of biofuels, affecting the energy security and market competitiveness of individual countries. Overall, the future prospects for biofuel production in Austria and the Czech Republic involve a combination of technological advancements, sustainable feed.

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