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Environmental Management and Power Generation in Czech Republic

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Abstract: **Purpose:** This article emphasizes the urgent claim for a sustainable approach embedded in the efforts of economic theory for spurring long run growth. The recent approach in the field of economic modelling and climate change estimates the impacts of unfettered economic activity on the atmosphere and on the climate. In such terms, this article presents the most relevant findings linking sustainability and economic growth in order to encompass the current situation of the Czech power generation sector.
Methodology: A descriptive narrative intended to unfold the main theoretical developments of economic theory and climate change based on the contribution of the 2018 Nobel Prize Nordhaus and the main results of the climate change modelling. There, the emphasis marks the interaction between technological change and the preservation of natural resources, encompassed in an international effort for engaging the main contaminant countries in an effort of abatement. This theoretical bedrock provides us with the set of criteria to assess the method and the technology for generating power in the Czech Republic in a sustainable way.
Findings: The blatant threat coming from global warming and climate change requires the involvement of the most contaminant countries. The article demonstrates that a game based on non-cooperative rules is not an incentive for complying the environmental goals. With no effective sanctions for the contaminant countries there is no incentive to comply with the rules. From the point of the economic theory, the first step for punishing the carbon emissions and contamination is the assignment of an economic value to the emissions, and to the extent that it makes up a negative externality, the contaminant agent must pay a cost due to an unsustainable production process and technology.
Originality: The new sectorial and macroeconomic approaches involve the participation of private sector, the government and supranational spheres for ruling and implementing sustainable production practices and goals. Europe has been an example of concern for the definition of ambitious environmental goals, and the Czech Republic echoes the collective guidelines intended to make the economy more environmentally friendly.

Keywords: energy; strategic management; sustainability; Czech Republic.

JEL Classification: Q42; Q51; Q01; R11.

Introduction

Humanity has arrived to a non-return point in terms of the climatic threaten, due to accumulative processes of carbon emissions and consumer patterns and production intensive in a such carbon emission, which have demonstrated to be deadly disrupting for the life. These long-lasting practices provoke global externalities which induces strong damages to humans a life all round the world.

In all corners of the world, proliferates severe effects: high temperature, precipitation patterns, storm abundance and frequency, snowpacks, river runoff, water scarcity, surface warming of the land and oceans, and ice sheets. Glaciers quickly have been disappearing evaporating pure water supplies. The rising temperature of the oceans and tropical storms become more severe.

The increase in the ocean level threatens the existence of several geographical spots. Keeping the same situation within 50 years, or according the Nordhaus (2018b) definition, replicating more the Business as Usual Trajectory (BUT), Maldives will disappear beneath the ocean, Manhattan could be under water, and the Bangladesh territory will be submerged, driving to internal migrations whose final effect is to plummet even more

the current subsistence level of income (Stiglitz 2006) and Nordhaus (2018a). Precisely, is spite of the worldwide harmful effects, the low-income countries become the most vulnerable to its effects, despite contributing least to climate change.

This unsustainable development concentrated green-houses gases at the atmosphere. This long-lasting process is the consequence of liberation of carbon dioxide (CO2) through the intensive use of fossil (or carbon-based) fuels namely: coal, oil, and natural gas. The human activities account for most of the emissions, considering that the source of 65% of the gases is the use of energy; the remainder arises from waste, agriculture, and land use (Arrow 2006).

The process has expanded uncontrolled with the human intervention and the economic activity. Rigorous models and analysis estimates that in 1750 the CO2 concentrations in the atmosphere were 280 parts per million (ppm), evolving dramatically until 2018 accounting for more than 413 ppm of CO2. Under the same scenario of business-as-usual trajectory, the projections forecast a range of concentration spanning 700–900 ppm by 2100, if no efforts are made in terms of curbing the fossil fuel use. In such time horizon, it looms an increase in the average global warming reaching 3 - 5°C in 2100 (Nordhaus 2018a). The most plausible computation predicts concentrations of 550 ppm, driving a rise in temperature of at least 2°C.

The catastrophic impact hits the economic activity as agriculture, tourism, forestry and the models' outcomes impart about the effect on GDP. Howard and Sterner (2017) estimate models intended to gauge the potential damage of global warming, and account for a wide range of possible affectations. An increase in the global surface temperature by 3°C, conveys a disparate range of potential damage tantamount to 1.9% to 17.3% of GDP.

Despite the development of a myriad of models, the environmental future scenarios end up being full of uncertainty (Shelling 2007). The current dimension of the damage already caused is so large that all models focused on the economic or the climatic forecast are mostly unpredictable, and accordingly, the ranges of uncertainty for future emissions, concentrations, temperature, and damages broaden slackly.

The forecasts generally depend on the current base lines, and the results impart that even under the most optimistic assumptions, the global temperature increases markedly, and in any case, the results accounts for substantial damages (Nordhaus 2018). On the other hand, Lemoine and Rudik (2017) apply a set of recursive models at analysing sources of uncertainty, in the context of the Nordhaus integrated assessment models, intended to quantify the complete effects of climate change.

Facing a such challenge, this article analyses the plausibility of the approaches suggesting the measurement of the environmental costs. Likewise, this article discusses the urgency of implementing an international cooperative approach, intended to gather the international will to reduce the emissions, in the context of international agreements designed to be complied by country members. After this introduction, next part points out the justification for making up an international effective common task for reducing the emissions. Last part of this article describes the degree of sustainability in the production of energy in the Czech Republic.

1. Research Background

During decades, the international community have unfolded several efforts for curbing the carbon emissions through the activation of international framework convention. Kyoto (1997) and Paris (2018) are palmary examples of institutional intends to attain and international consensus of de-carbonization, although the results have been scarce. The global goal is to get an international commitment regarding the abatement (the reduction of emissions). The Kyoto Protocol in 1997 was the first convention intended to achieve an agreement for reducing the emission of green-house gases. However, the United States refused to join early, and there was absence of developing countries. Neatly, the protocol became a failure. The American government brandishing the interest of national companies to use a cheap fuel without environmental tax, but while they harness the economic expansion, the world has to undergo the global warming. Actually, in the international realm, there was no mechanism to stimulate the compliance with the climate goals. The environmental international conventions have to face the challenge of free riders (Nordhaus 2018a).

The failure of the international consensus become glaring under the international governance, but the frustration is based on the absence of any law in force by which the international community can summon the more responsible contaminant countries. The inaction and ineffectiveness of international efforts for taming the most contaminant countries stems from the free riding, expecting the outcomes of active policies implemented by other counterparts, but keeping the individual business as usual trajectory. Besides, in general the national environmental policies tend to be more effective than the commitments of the international consensus (Nordhaus 2018a). At this point, the optimal environmental consensus must be derived from cooperative games with

common engagements. The agreements derived from non-cooperative games turn out to be cheated because the members are unable to appropriate the full benefits of the game. To the extent that the individual efforts become as spillovers to others members, there is no incentive to participate in cooperative games, and even less to comply the engagements.

In such terms the dominant strategy is the free riding because there is no incentive to participate in a cooperative game. As long as the free rider gets the same result when complying, or when cheating the engagements, he can enjoy the positive externality with no cost. The free riding conveys failure for the global goals because the few compliant countries has limited capacity to achieve ambitious objectives. This is the glaring reason explaining the scarce results in the current international policy environment (Nordhaus 2018a).

The most harmful effect of the inaction in the main contaminants countries will impact the developing world. In spite of their marginal blame for contamination, poor countries are mostly unprepared and vulnerable to the catastrophes derived from the global warming and the contamination. The threaten externalities will take the form of rain-fed agriculture, seasonal snow packs, coastal communities impacted by sea-level rise, river runoffs, forest erosion and fires, and natural ecosystems. As a matter of fact, when the countries did not yield any economic advantage to make the necessary emissions reductions, withdraw quickly. However, the solution of non-cooperative games, in which predominate the nationalist interests and make countries more closed, leads to outcomes where nations are worse off (Nordhaus 2018a).

Here appears the necessity to foster an economic approach to valuate externalities not priced. In such terms, the costs or benefits spreads outside the market, and there is no economic valuation, to the extent that market prices fails to capture such externalities (Nordhaus 2018a). In fact, the excessive consumption of intensive in emission fuels, accounts for the insufficient social cost ascribed to the prices of fuels. As Tol (2009) asserts, it is not possible have cheap energy without carbon dioxide emissions, and the cheap contaminant energy delays the transition to cleaner sources.

Some methodologies have been proposed to gauge for each country the degree of transition away from carbon-intensive energy practices. The Idiosyncratic path of each country is connected with the industrial evolution and the energy sources used (Ye et al. 2024). In Nordhaus (2015) appears a coordinated approach designed to overcome the environmental free riding. The argument asserts that it finds that in absence of sanctions against non-participants, there are no optimal results, other than goals engaged with minimal abatement. However, other mechanism is proposed brandishing small trade penalties on non-participants, as a mechanism for inducing the achievement of more ambitious goals.

Stiglitz (2006) also Howard and Sterner (2017) refer to the Social Cost of Carbon (SCC) as modelling methodology composed by various steps in order to translate a marginal unit of CO2 emissions into a measurement of economic damage. More formally, SCC gauges the economic cost derived from an additional ton of carbon dioxide emissions or its equivalent. According a more sophisticated concept, it can be defined as the change in the discounted value of economic welfare per an additional unit of CO2 - equivalent emissions (Nordhaus 2017). Stiglitz (2006) proposes the levy of environmental tax on emissions as an economic character intended to make pay for the social cost incurred by the responsible of the emissions, bringing up the microeconomic concept of marginal cost. Pricing the emissions offsets the underpricing of the negative externality of pollution. When increasing the prices, a limit is established on the amount of allowable emissions or by levying a tax on carbon emissions (the “carbon tax”) (Nordhaus 2018a).

The carbon tax, should be an effective measure for inducing radical changes in the human behavior. This burden must be sufficiently high, that necessary raises the fossil fuel and other prices leading the industries and consumers to substitute away from technologies intensive in emissions (Nordhaus 1992). In such terms, the policy measures based of the fair pricing of contaminant technologies, should be so deterring as to provoke a change in the consumption patterns. This alteration in the human behavior in response to climate change must respond to the policy’ s incentives, whose effects, in turn, must be embedded in the models of prediction (Tol 2009).

Other direct levies can be imposed. In an empirical work for Ecuador, Terneus Paéz *et al.* (2022) demonstrated that when levying a tax on engine displacement of vehicles, the final effect deters the acquisition of large vehicles, conveying a drop in the fuel consumptions and a lower emission of greenhouse gases. The economic theory trumpets the principle of “there is no free lunch”. Each producer must to pay by the factor he demands, optimally at the market price. This is possible because the production factors are prices, and there is a social valuation for it. This solution must start by pricing the cost in which incur the industries for contamination. It involves the assessment of the magnitude of the social cost of emissions. Otherwise, the contaminant companies would be receiving a subsidy. The subsidy is defined in terms of a firm who is unable to pay the full cost of

production, including the environmental damages. Not paying by emissions is tantamount to don't pay other production factor (Stiglitz 2006). The pricing policy has to be deterring, as it must make expensive the generation of CO2 and other greenhouse gases.

The valuation of environmental effects is based on a cost-benefit analysis, intended to gauge the balancing costs-benefits, with the exception that some impacts are hard to measure. This methodology is a plausible strategy to develop climate policy which includes obviously the abatement costs (Stiglitz 2006). It poses the principle of uniformity of price whose implementation involves the equalization of carbon prices according the sector and country (Nordhaus 2018a). The economic valuation of the carbon emissions can provide several aspects for making appear as costly the carbon production. It makes up an indicator for the consumers about the content of produced carbon of each good and service, giving rise to rationalize the consumption of more contaminant goods. On the other hand, the producers can detect how highly expensive the production be, inducing them to adopt clean technologies. Finally, the social valuation of contamination can spur the innovations process for producing low-carbon new products (Nordhaus 2018a). In such process of valuation, the market signals will make their work. It is the market mechanism through affordable taxes, valuation of subsidies and rationing, the force in charge of transmitting the information about the necessity of cleaner production. It is the price system the mechanism in charge of signaling how deadly costly can be production based on fossil fuels and in carbon emissions (Schelling 2007). Other recent approaches, are developing risk modeling taking in consideration the climate change and biodiversity, a task on charge of central banks and financial supervisors who joined the group of stakeholders interested in quantitative measurement of environmental issues (Hugues 2024).

Regarding the necessary scientific task intended to wrap up the set of innovations which make cleaner the production, Shelling (2007) points that the market mechanism perhaps does not suffice for provide powerful incentives. Other sources must emerge to the extent that R & D activity must be financed. Governments must come up for funding the innovative environmental activities whose yields are not sufficient for remunerating a such investment. Other sustainable procedure for reducing the role of fossil sources is the full exploitation of biofuel, mainly supplied by developing countries. However, the collateral damage is made by the diversion from staple food crops, to biofuel production with the subsequent effect on food prices (Nakamya 2022). In the context of smart cities, other innovations have been proposed as home energy management incentivizing the use of renewable energy sources mainly solar panels and energy storage units. This technology conveys several advantages as more stable prices, more flexible sources for the households (Ghanavati *et al.* 2024). Other participative initiatives to decarbonize the manufacturing production entail shared infrastructures, the creation of local zero-carbon hubs, the application of innovations into abatement technologies and the local participation in designing energy plans (Rattle *et al.* 2024).

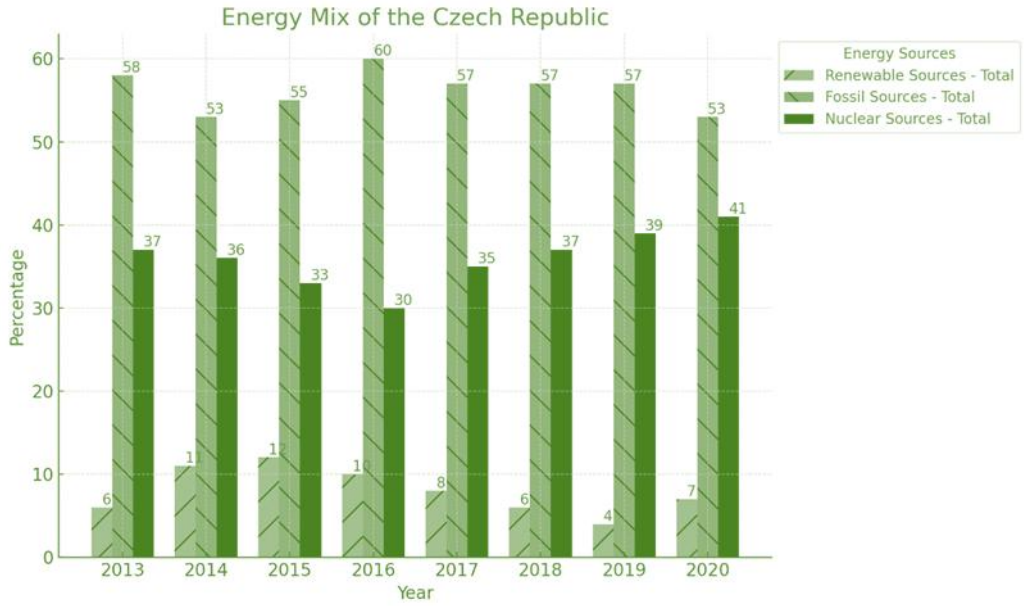
2. Sustainability in the Energy Generation in Czech Republic

After the previous overview dealing with the international consensus on environmental issues, we proceed to describe the main traits dealing with the energy sector in the Czech Republic, a discussion fully encompassed in the European context, marked by the compliance with the Green Deal. Accordingly, the Czech Republic is obliged to implement policies related to energy efficiency in particular, which is why the Czech transmission system is interconnected with all neighboring states (Ministry of Trade and Industry 2021).

The development of the Czech energy sector has gone through an incredible transformation. At the end of the 19th century, coal was an important energy, raw material, in the 20th century, oil, natural gas and hydropower, and since the middle of the 20th century, nuclear energy has taken its place of importance. In the 21st century, the following resources are used: oil, coal, natural gas, combustible waste, nuclear energy, hydropower and other resources (Matyášek *et al.* 2009).

Alongside this descriptive overview, this analysis separates energy sources into primary and secondary sources. It includes primary resources freely accessible into nature without recourse to human intervention for their transformation. The main trait of secondary resources is that they are reused as a result of energy and technology processes. The diversity of resources in the Czech Republic is quit disparate. Resources used in the Czech Republic are black and brown coal, natural gas, oil incl. petroleum products, nuclear fuel, electricity, renewable energy sources and other fuels.

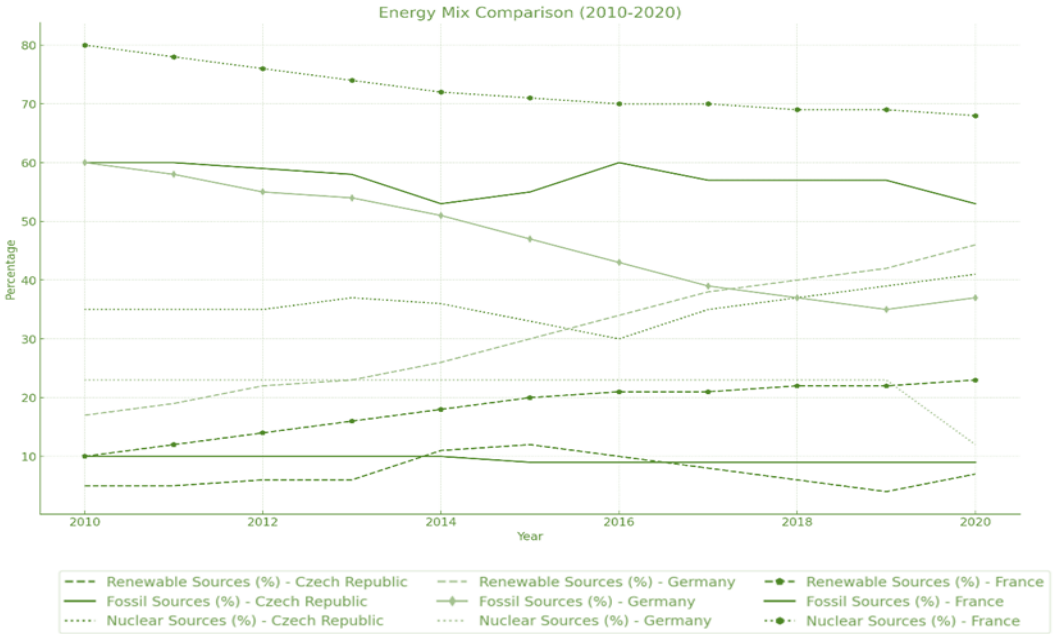
Graph 1. Energy mix in the Czech Republic



Source: Own elaboration according to the Ministry of Trade and Industry, 2021.

The ratio of the consumed energy is shown in graph no. 1, where the percentage of energy production in the area of fossil energy, renewable sources and the core is shown. Almost 50% of the consumption of primary energy sources in the Czech Republic is covered by domestic sources. The import dependence of the Czech Republic accounts for almost 50% of total, being one of the smallest in the entire EU (Ministry of Trade and Industry 2021).

Graph 2. Energy mix comparison of the Czech Republic, Germany and France in the last decade



Source: Own elaboration according to the International Energy Agency (2023), Eurostat (2023), World Bank (2023), Energetický regulační úřad (ERÚ 2023), Federal Ministry for Economic Affairs and Energy (2023), Ministry for the Ecological Transition (France 2023) and BP (2023).

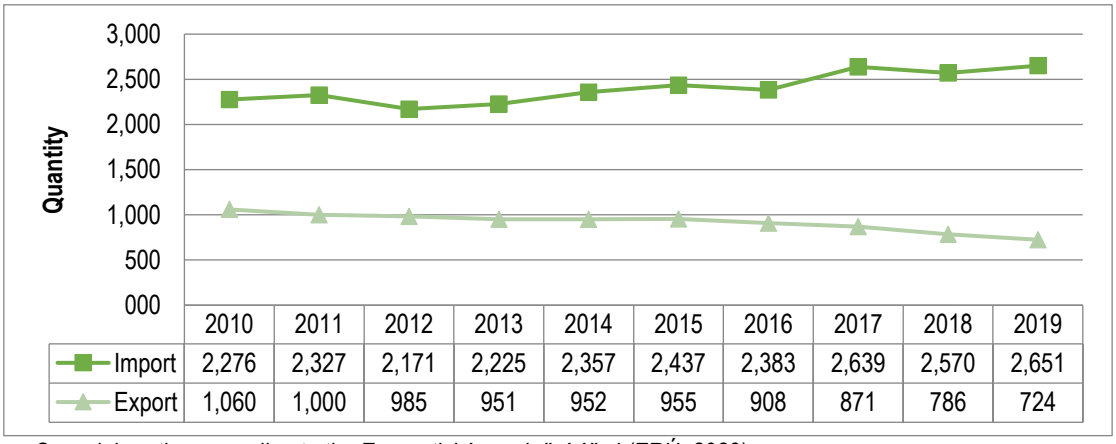
Czech Republic maintains a balanced energy mix with a significant share of nuclear energy, modest increases in renewables, and a gradual decrease in fossil fuels.

On the other hand, Germany demonstrates a strong shift towards renewable energy, significant reductions in fossil fuel dependency, and a clear move away from nuclear energy. France continues to rely heavily on nuclear energy, with gradual increases in renewables and minimal dependence on fossil fuels. This comparison

highlights the different strategies and progress made by these countries in transitioning to more sustainable energy systems. While Germany and France have made substantial strides in increasing renewable energy, the Czech Republic continues to rely heavily on nuclear power as a key component of its energy strategy. Since the Czech Republic does not have significant deposits of gas, oil and other energy sources, it is necessary to transfer these raw materials from countries to deposits that are richer and for the most part from not quite politically and militarily stable areas. That is why the development of nuclear energy in the Czech Republic helps to fulfil the energy and raw material security, which is caused by easier transportation and storage of nuclear fuel.

Graph 3 shows the balance of foreign energy trade in the Czech Republic, where we can observe a slight increase in imported energy commodities, and, on the contrary, a slight decrease in exported commodities.

Graph 3. Energy foreign trade in the Czech Republic



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Import	2,276	2,327	2,171	2,225	2,357	2,437	2,383	2,639	2,570	2,651
Export	1,060	1,000	985	951	952	955	908	871	786	724

Source: Own elaboration according to the Energetický regulační úřad (ERÚ, 2023).

The transport and storage of the various raw materials is linked to the safety requirements of each type of energy. Coal demands an enormous volume and, consequently, the problem of storage for future consumption is increasing. Oil is transported by pipelines and natural gas from gas pipelines, both of which are stored in special storage tanks. From the point of view of transportation and storage, nuclear energy has on the simplest way of transporting and storing nuclear fuel even for several years ahead (Ministry of Trade and Industry, 2021).

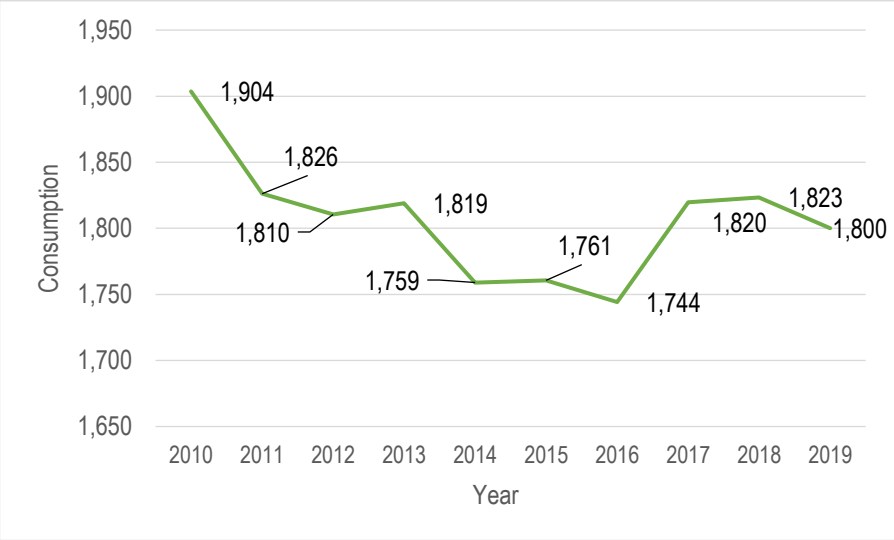
Currently, the issues of impact on the environment are widely discussed, when it is necessary to keep in mind the health of the population and the environment of the Czech Republic as a whole. In this sense, by reducing the impacts of energy and industrial production, the Czech Republic has made a lot of progress.

Among the key factors affecting the quality of the environment for residents are local airborne dust emissions, SO2 and NOx emissions. These emissions burden on the health of the inhabitants to a decisive extent, caused mainly by inefficient combustion of solid fuels, including biomass, and transport. On the contrary, CO2 emission is not a key indicator, but it is an obligation of the EU and subsequently also of the Czech Republic.

Gross household consumption shown in graph 4, accounts for a secular significant decrease, but describing a short-term increase in energy consumption in households. The decrease in energy is associated with better insulation of households and the replacement of energy equipment with newer, less energy-intensive equipment, thereby reducing the energy needed to produce heat.

Alongside this descriptive overview, this analysis separates energy sources into primary and secondary sources. It includes primary resources freely accessible into nature without recourse to human intervention for their transformation. The main trait of secondary resources is that they are reused as a result of energy and technology processes. The diversity of resources in the Czech Republic is quit disparate. Resources used in the Czech Republic are black and brown coal, natural gas, oil incl. petroleum products, nuclear fuel, electricity, renewable energy sources and other fuels.

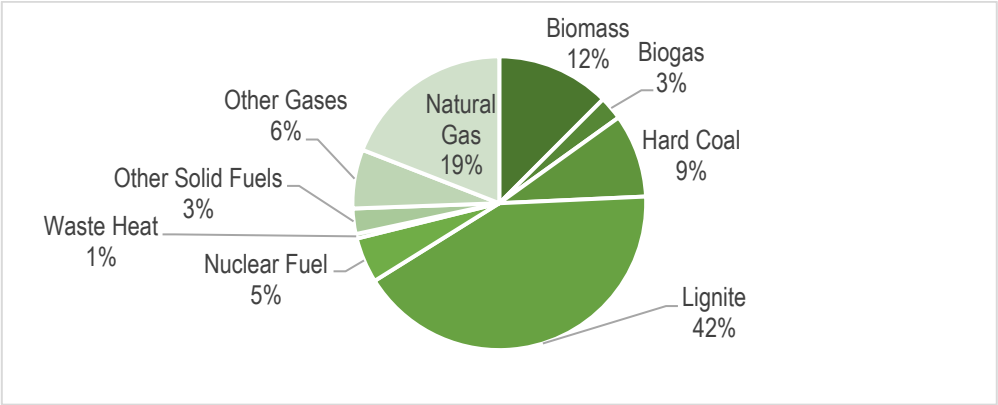
Graph 4. Gross household consumption in the Czech Republic



Source: Own elaboration according to the Energetický regulační úřad (ERÚ, 2023).

The total share of generation from large and medium-sized sources, amounts to almost 70% of the total gross heat production. The advantage of this production is the high level of fuel energy utilization, when 12-13% of gross electricity production is produced at the same time. The share of heat production from domestic fuels is around 60% and around heat supply it is more than 80%. Brown and black coal, natural gas, but also biomass is mostly used as fuel in heating plants to produce heat shown in graph 5 (Energy Regulatory Office 2021).

Graph 5. Energy source for production of heat in the Czech Republic, 2020



Source: Own elaboration according to the Energetický regulační úřad (ERÚ, 2023).

In the area of renewable sources, the Czech Republic aimed to achieve a share of gross final consumption around heat production of 13% for 2020 and a share of 22% of gross final consumption for 2030. The target for 2020 was exceeded (Energy Regulatory Office 2021).

2.1 Fossil Resources

Oil as an energy commodity is most used in the Czech Republic in the field of transport. This commodity is almost no longer used to produce heat in the form of heating oil. As part of the tightening emission limits, there is an effort to reduce its consumption, but in the field of transport, oil will still be the dominant raw material for many years to come. Mining within the Czech Republic covers less than 3% of the total annual consumption, which makes the Czech Republic completely dependent on imports of this commodity, especially from the Russian Federation. Czech refining companies have been privatized, which means that trade within this resource is fully controlled by the market and not by the state. Through legislation in the field of oil economy, the state only influences the amount and structure of emergency stocks of oil and oil products, which now prescribes a stock for 90 days. The state owns the company MERO ČR, a.s., which operates the Družba Ingolstadt-Kralupy-Litvínov oil pipelines in the territory of the Czech Republic, the central refuelling station and the storage of emergency oil reserves of the Czech Republic near Kralupy nad Vltavou. And the second state-owned company is ČEPRO, a.s.,

which owns and operates a domestic pipeline system connecting the company's warehouses and centres with refineries in Litvínov, Kralupy nad Vltavou and Slovakia, but also owns and operates significant fuel storage capacities. Coal sources make up the main share of primary sources, which are widely used in the production of heat through district heating and individual heating.

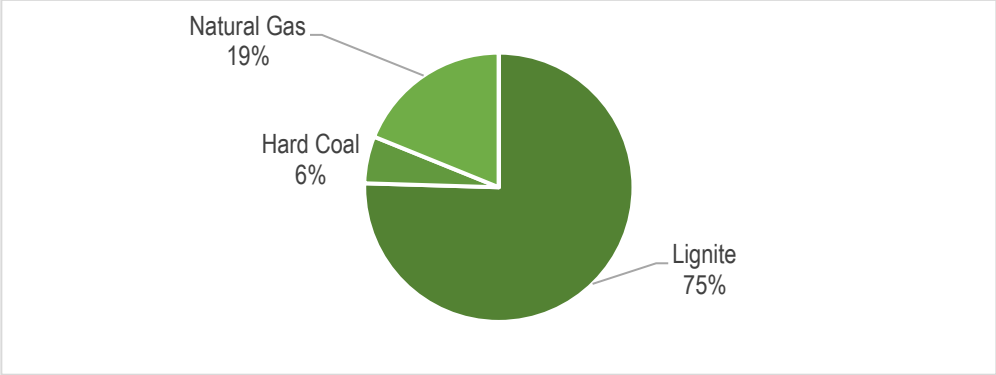
Even though coal resources are approaching the limit of their economic and physical lifetime, ecological aspects, this raw material is not completely replaceable. As part of the implemented measures and alternative methods used for heat production, the consumption of black and brown coal is expected to decrease. These measures lead to the most efficient and ecological way of consuming the remaining supply of coal raw material.

Natural gas is one of the important energy sources of the Czech Republic, but domestic consumption is almost entirely dependent on imports. The largest supplier of this commodity is the Russian Federation, followed by Norway. Recently, it has also been widely acquired by trading on markets within the EU. This resource is used for district and individual heating, but also for electricity generation. The ecological and technical properties of gas point to the appropriate use of the resource to produce electricity and heat, as well as the provision of supporting services in the electric power industry.

An equally important sector of natural gas use is in the field of transport, where it will serve to replace part of liquid fuels, and therefore its increased consumption is expected in the years to come. Natural gas consumption in 2020 increased by 1.87% compared to the previous year.

Graph 6 shows the percentage of energy from fossil sources of the total energy produced in 2020 in the Czech Republic. At first glance, it is obvious that brown coal with 40% is the most represented commodity, followed by natural gas, then black coal and a negligible part is made up of oil and oil products, secondary sources and others, when these commodities are at the 0% limit.

Graph 6. Energy source from fossil resources in the Czech Republic, 2020



Source: Own elaboration according to the Energetický regulační úřad (ERÚ, 2023).

2.2 Nuclear Fuel

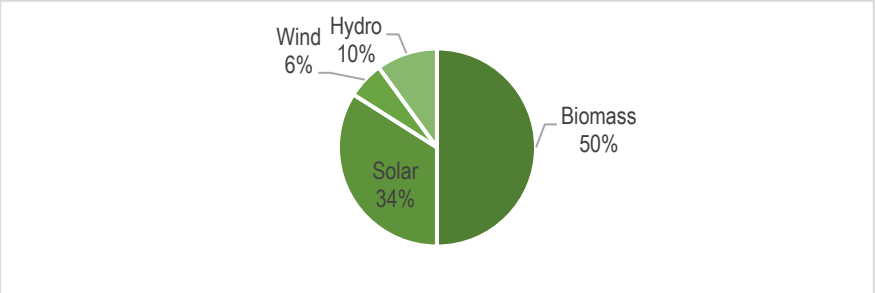
Nuclear fuel is the second largest energy resource in the Czech Republic. Nuclear sources use highly advanced technologies and are particularly used in power generation. Electricity production from this source accounted for 40.75% of the total electricity produced in 2020. The properties of the nuclear power source are particularly long service life, high utilization factor, reliability, but also cheap and predictable operation. The advantage of this resource is the high concentration of fuel, enabling the creation of strategic reserves for several years of operation. Currently, the Czech Republic has nuclear power in the Temelín and Dukovany power plants. The construction of a power plant based on the use of a nuclear source is very demanding in terms of technology, design, and personnel. An essential part is nuclear supervision overseeing nuclear safety focused on the risks of high concentration of energy in the nuclear source and the risk of radiation.

2.3 Renewable Energy

Non-fossil natural, renewable resources include the energy of water, wind, sunlight, solid biomass and biogas, environmental, energy used by heat pumps, geothermal energy and the energy of liquid biofuels (ČEZ 2021). At 2020, the share of renewable sources in domestic gross electricity consumption reached 6.75% (OTE 2021), but the commitment of the Czech Republic for gross final consumption of energy from renewable sources by 2020 was set at 13% (Ministry of Trade and Industry 2021).

In 2020, biomass had the largest share in energy production with a share of 3.4% of the total production, see graph 7, followed by solar energy with a ratio of 2.27%, followed by water and wind energy.

Graph 7. Energy source from renewable resources in the Czech republic, 2020



Source: Own elaboration according to the Energetický regulační úřad (ERÚ, 2023).

Among the renewable energy sources, biomass is the only and available systemic renewable energy source for the needs of the heating industry in the Czech Republic. Other energies classified as renewable sources are limited for heating purposes for technical and social-environmental reasons. The pro-growth biomass support measure produces greenhouse gas savings with the lowest cost per ton of CO2 saved. However, some sources also point to other types of emissions arising from the burning of biomass, which show higher values than from the burning of natural gas and coal. Therefore, it is necessary for the development of biomass burning to ensure technologies leading to the minimization of the emission load. The water resources used in the Czech Republic are currently almost exhausted, and their share in the national energy mix was 0.65% of the total production in 2020, and it is assumed that this share will not continue to increase. The advantage of pumped-storage power plants in the Czech Republic is their flexibility when they cover the fluctuations of intermittent sources.

Wind and solar energy have relatively limited possibilities of use in the Czech Republic regarding geographical and climatic conditions. Areas suitable for using wind to produce energy are in most cases in mountain natural protected areas. Solar energy used for energy production has seen rapid growth, but it is running into the limits of agricultural land protection.

The latest preliminary analyses speak of geothermal energy as an important commodity associated with high costs for the time being. The unproven potential of this commodity is in the field of heating, air conditioning and electricity generation.

The unused potential of a substitute for coal in terms of the production of electricity and heat is the energy use of waste, the energy use of which brings a non-negligible effect and at the same time solves the problem of removing the unused component of waste. Regarding the nuclear energy, it is considered as a non-renewable source with a sustainable process during the operation phase. On the other hand, this kind of energy gives rise to some concerns about the disposition of the waste, but it occurs at the end of the process of generation (Pienkowski 2024).

According to the previous overview, the main concern in the Czech Energy policy is to ensure a stable and fluent system of supply, able to guarantee the national self-sufficiency. Despite the lack of natural resources for generating certain kind of energy, the national system has arranged a matrix of supply based on imported energy whose tensions became a concern after the Russia-Ukraine conflict. The Czech Republic mainly depends on the fossil fuel for transport, and on the nuclear sources for residential and industrial purposes. On the other hand, renewable energy can increase its share in the national energy matrix.

In any case, the energy mix must be sufficiently flexible for incorporating the renewables, because the market conditions become challenging. When the system is strongly reliant on fossil-fuel to ensure the stability of the electric grid, the European Union (EU) ask for a systematic transition away from fossil-based fuels. So, when the grid becomes flexible, the planning of a medium- and long-term storage, it is possible to in insert the contribution of other sources as wind and solar energy (Sankaran 2023).

The diversification of the energy sources involves important changes in national regulations and markets. The goals of the diversification efforts must be based on the reliability of the electricity supply, the matching with consumer demand, the affordability in term of prices of end-users, and the fostering of economic development. The more decisive share of Renewable Energy Sources conveys several advantages, namely: the promotion of the renewable energy integration, the implementation of new technologies, the consumer participation, and the strengthening of the system resilience (Jingi *et al.* 2022).

3. Discussion and Conclusion

The harmful effects of global warming will hit badly poor countries for several reasons. This group of countries are lay in tropical zones closer to the Equator; accordingly, the countries are hotter, and higher temperatures will have a straightforward effect on agriculture. Furthermore, they are particularly weak to adapt to climate change due to the lack of resources and the institutional underdevelopment (Tol 2016).

There is a tendency for the current generation to ride free by pushing the costs of dealing with climate change onto future generations. Generational free riding occurs because most of the benefits of costly emissions reductions today would accrue many decades in the future. There are some explanations for the inaction or the climatic negationist. Nordhaus (2018b) defines the Business as Usual Trajectory (BUT) the reproduction of the actual inaction, in a set of countries engaged with minimal policies for reducing the emissions.

One of them is related with the intergenerational lack of solidarity, intended to transfer to future generations the cost of dealing with the climate change. It is quoted as “Generational free riding” (Nordhaus 2018a). However, if the time elapses more and more, the environmental damage becomes irreversible.

In this economic logic the cost should be so prohibitive that the force the implementation a cleaner technology. It could be a compensation to the current subsidies currently received. The subsidy is the tax not applied to contaminant production (Stiglitz 2007). The economic approach intended to price in market conditions the consequences of contamination looms as an effective strategy for mitigating the damages, and to force the producers to implement clean technologies. In a such context, policies raising the price of CO2 and other greenhouse gas emissions must be urgently implemented effectively for stopping emissions and promoting low-carbon technologies.

Penalty on carbon emissions becomes a convincing argument to migrate towards cleaner technologies and is the unique strategy for a quick transition to a low-carbon economy. The implementation of economical low-carbon technologies will reduce the cost of getting the goals.

The international community must promote a cooperative game, in which countries afford proportionally the share of costs, but can receive in return the benefits of a more sustainable environment. The comprehensive actions must be global to be effective and must convey a cooperative game with explicit commitments and proportional benefits for all. The isolated national actions normally have scarce results. In such terms a cooperative game the coalition of nations can gather nations engage with environmental goals, having the capacity to penalize the free riders.

The Czech Republic energetic stance is encompassed in the European engagement of reducing the carbon emissions, dealing with a small contaminant country with scarcity of oil, and with a supply of power based on nuclear plants. The search of green alternative sources faces strong geographical constraints given the relatively small territory and the lack of access to the sea.

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Credit Authorship Contribution Statement

Gabriela Antošová: Conceptualization, Investigation, Methodology, Project administration, Software, Formal analysis, Writing - original draft, Supervision, Data curation, Validation, Writing - review and editing, Visualization.

Declaration of Competing Interest

The author declares that she has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Use of Generative AI and AI-Assisted Technologies

This text was prepared based on an extensive review of scholarly sources (with the aid of the scite.ai tool for searching relevant literature) and contains structured information that has been processed and organized using AI-assisted tools (chatgpt.com). AI was primarily used as a means for efficient analysis and organization of available data, while all content was carefully reviewed, edited, and expanded by the author. The final literature review is therefore the result of expert work combined with modern technologies, enabling a faster and more systematic approach to processing information.

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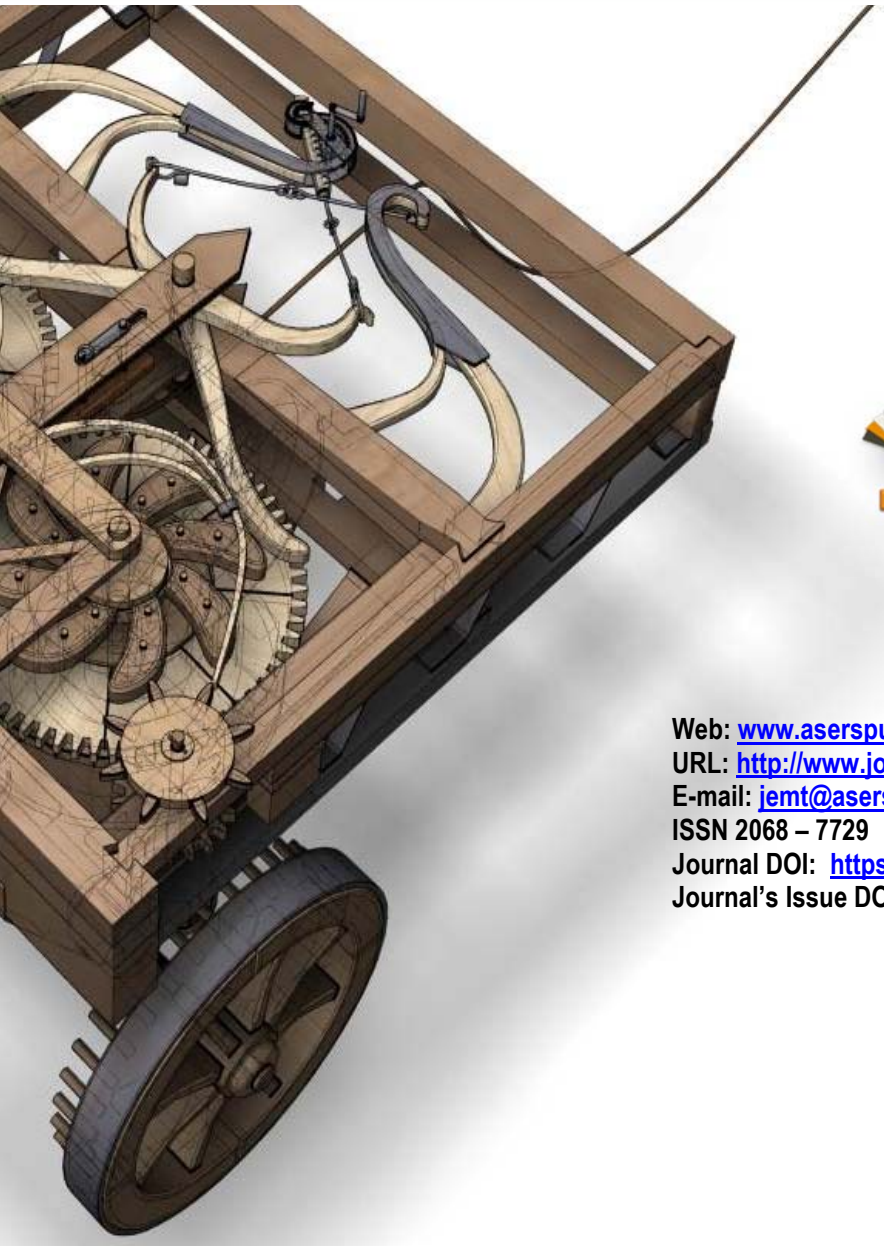

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