sustainability

MDPI

Article

Assessment of the Greek National Plan of Energy and Climate Change—Critical Remarks

Efthimios Zervas [1,*], Leonidas Vatikiotis [1], Zoe Gareiou [1], Stella Manika [1] and Ruth Herrero-Martin [2]

[1] School of Applied Arts and Sustainable Design, Hellenic Open University, 263 35 Patra, Greece; leonidas.vatikiotis@gmail.com (L.V.); gareiou@latpee.eap.gr (Z.G.); manika.stella@ac.eap.gr (S.M.)
[2] Department of Thermal and Fluid Engineering, School of Industrial Engineering, Universidad Politecnica de Cartagena, 30202 Cartagena, Spain; Ruth.Herrero@upct.es
* Correspondence: zervas@eap.gr; Tel.: +30-2610-367-566

Abstract: The Greek National Energy and Climate Plan was validated by the Greek Governmental Committee of Economic Policy on 23 December 2019. The decisions included in this plan will have a significant impact on the Greek energy mix as the production of electricity from lignite combustion ceases in 2028, when lignite will be replaced by natural gas (NG) and renewable energy sources (RES). This work presents an assessment of the Greek National Energy and Climate Plan by analyzing its pros and cons. The main critiques made are focused on the absence of risk analysis and alternative scenarios, the proposed energy mix, the absence of other alternatives on the energy mix and energy storage, the low attention given to energy savings (transport, buildings), the future energy prices, and the economic and social impacts. This analysis shows that delaying this transition for some years, to better prepare it by taking into consideration the most sustainable paths for that transition, such as using more alternatives, is the best available option today.

Keywords: climate change; energy and climate plan; energy price; energy transition; Greece; lignite; natural gas; RES

check for updates

Citation: Zervas, E.; Vatikiotis, L.; Gareiou, Z.; Manika, S.; Herrero-Martin, R. Assessment of the Greek National Plan of Energy and Climate Change—Critical Remarks. *Sustainability* **2021**, *13*, 13143. https://doi.org/10.3390/su132313143

Academic Editors: Georgios Tsantopoulos and Evangelia Karasmanaki

Received: 30 September 2021
Accepted: 22 November 2021
Published: 27 November 2021

1. Introduction

Climate change is one of the main current environmental problems [1] and its mitigation requires a great effort from scientists to find adapted solutions, from policy makers to find adapted policy measures, and from different stakeholders to apply them. One of these measures is the transition from the production of electricity via coal combustion to more efficient or renewable energy sources.

Coal was and is still today one of the major sources for electricity production in Europe, as it accounts for 22.9% of the total final energy production in EE27 in 2017 [2]. However, the target set by the European Green Deal is to decrease greenhouse gas emissions by 40% in EE27 in 2030, compared to the 1990 emissions [3], and to reach climate neutrality (80–95%) in the EE countries in 2050 [4]. In that sense, coal's participation in the EE energy mix has to decrease to 12% by 2050, with the complete elimination of oil as a power-generating source [5]. To achieve these goals, several countries set up measures to decrease coal's participation in their energy mix. Greece is one of them, as electrical energy production from lignite was 29.3% in 2019 [6].

All EU countries recently released National Energy and Climate Plans [7]. The Greek plan [8] sets the goal of greenhouse gas emissions in Greece for 2030 and the main actions proposed to achieve this goal. It is an important milestone for the current national policy on energy and climate, as it sets out climate goals at the heart of development policy in Greece and actions to protect the environment. This plan sets several very ambitious goals. However, the Greek NECP is one of the most critical for several reasons: Greece was heavily impacted by the recent economic crisis, and for this reason both economic growth and available funds are limited; also, Greece is very dependent on local lignite production and imported oil; thus, the radical change of the energy mix in just a few years is very challenging.

The aim of this work is to address the points of this plan that could pose some issues for the future, and to serve as a guideline for other European NECPs in the cases of similar issues. This work follows the general structure of several similar policy works on energy regulations, policies, or research agendas that can be found in the literature [9–13]. It should be noted that this work assesses some major points in a high-level critique of this plan and that this work is clearly of an application nature. For each one of these points, a specific analysis will be conducted to precisely quantify the economic, social, and environmental pros and cons. These detailed analyses will be presented in future dedicated works.

2. Presentation of the Mains Points of the Greek National Energy and Climate Change Plan

The purpose of the NECP is described in detail in the introduction of the plan (published on the website for the Greek Ministry of Environment and Energy [14]). More specifically, it is stated that the National Plan for Energy and Climate is, for the Greek government, a strategic plan for the issues of climate and energy. A detailed roadmap for the achievement of specific energy and climate objectives by 2030 is given. The NECP presents and analyzes policy priorities and measures in a wide range of development and economic activities for the benefit of Greek society, making this text a reference for the next decade.

It is noted that the NECP is a tool for national policy in the field of energy and for the mitigation of climate change, which highlights the priorities of, and development opportunities in, Greece. The aim of the NECP is to be the main tool for the establishment of national economic, energy, and climate policies over the next decade, taking into account the recommendations of the European Commission and the UN's Sustainable Development Goals. The strategic goals of the Greek government in the field of energy and climate are set until 2030, and they aim to contribute decisively to the necessary energy transition in the most competitive way for the national economy, achieving a drastic reduction in greenhouse gas emissions. In this way, Greece can emerge as one of the member states with the most ambitious climate and energy goals through a comprehensive and coherent program of measures and policies for both 2030 and 2050.

The NECP sets specific targets for greenhouse gas emissions from Greece in 2030 and determines the Greek energy mix until that year by increasing the participation of natural gas and renewable energy sources [8], as well as by increasing energy efficiency. At the same time, the NECP identifies the policies and measures that are necessary for achieving those goals, analyzes the evolution of the Greek energy system until 2030, and reports the investment needs and the different impacts on society, the economy, and the environment.

In summary, the objectives of this plan [8] are the following:

- Greece will cease the production of electricity from lignite combustion in 2023, except for the Ptolemaida V thermal plant, which will close in 2028;
- Lignite will be substituted with imported natural gas;
- The RES participation in the Greek energy mix will be 35% in 2030 (60% in the case of electricity production);
- For the year 2030, GHG emissions will be reduced by 43%, compared to the 1990 levels, and 56%, compared to the 2005 levels;
- The improvement of energy efficiency of the final energy consumption will be 38% by 2030.

3. Methodology

The Greek National Energy and Climate Plan is analyzed from two points of view: first, the general concept of this plan is analyzed; then, a specific analysis is conducted for each one of its parts. For every one of these points, the general methodological approaches are analyzed and the specific problematic points are revealed. Concrete proposals are formulated for these approaches and points. Then, an analysis of the specific parts of the plan is performed; as previously, the general methodological approaches are analyzed and the specific problematic points are revealed, followed by concrete proposals. In both cases, alternatives are suggested for several points, following a high level of argumentation.

More specifically, the critiques analyzed in this article concern the application of a single scenario and the absence of updating and alternatives, the de-lignification of energy production and the proposed future energy mix (natural gas and renewable energy sources), the absence of other alternatives for the energy mix/production (biomass, gasification of lignite, carbon storage, and energy storage), vehicle electrification and public transport, the energy savings in buildings, the local production of products and dietary habits, the cost of energy and its economic and social consequences, the impact on labor issues, employees education and training, the employees and citizen information, and the regional and sectoral plans.

Several proposals, based on the general needs of the Greek economy, the protection of the environment, and the mitigation of climate change are presented for the above issues. Their general feasibility is also shown. These proposals aim to address the economic development of Greece, the decrease of energy poverty, with the parallel respect of the environment and the mitigation of climate change. As mentioned above, only a high-level critique is addressed in this article; a specific and detailed study is necessary for each one of the proposals presented here, and these studies will be presented in the near future.

4. Results—Assessment of the Plan

4.1. Implementation of a Single Scenario and the Absence of Alternative Scenarios

The submitted National Energy and Climate Plan is, with a few exceptions, a linear implementation of a single scenario. However, it should be noted that the energy and climate sectors are highly unpredictable. Taking this high variability into consideration, the National Plan should include a risk assessment and multiple alternative scenarios. However, the possible cases of deviation from, or even the failure of, this linear implementation are not analyzed, and no alternative scenarios are given.

Obviously, scientific progress leads to better materials, more efficient technologies, and finally to a decrease in the cost of energy production. In the field of energy, many technological achievements have been developed in recent years, such as the extraction of marine shale gas [15] or new photovoltaic materials, such as the recent progress in chlorinated organic photovoltaic materials, the discovery of two-dimensional photovoltaic materials accelerated by machine learning, or their new applications, such as in highways for signal systems, for agricultural and livestock purposes due to the need for water during periods of intense sunshine, for charging car and boat batteries, etc. [16] However, while technology has a positive effect on energy production, either in terms of efficiency or price, geopolitical events can affect the price and availability of energy in the opposite direction. The price of natural gas, which will be one of the major components of the future Greek energy mix, can be very significantly affected by these events in the future. The relationship between the geopolitical situation and energy is interdependent, as geopolitical changes can affect energy markets and, conversely, energy trends can disrupt geopolitical dynamics [17].

The 1973 oil crisis is the easiest example. Geopolitically, the Middle East, an important oil-producing region, is a politically unstable region with two ongoing conflicts, one in Iraq and one in Syria. Additionally, the political and economic developments in China have a global impact. Libya is another hotbed of instability in the close-to-Greece region; moreover, the relationship between Greece and Turkey is often very tense. Other global tensions, however, especially those concerning oil-producing countries (such as Iran or Venezuela), have a significant impact on energy prices.

Figure 1 shows the change in the price of crude oil for the period of 1946–2021. This figure shows a course of sharp changes and alternating increases and decreases in crude oil price; this price shows a range of variations, from less than USD 20 to near USD 180 during this time period. This sharply changing picture is also reflected in Figure 2, which shows the changes in the price of crude oil during only the last two years (January 2020–October 2021).

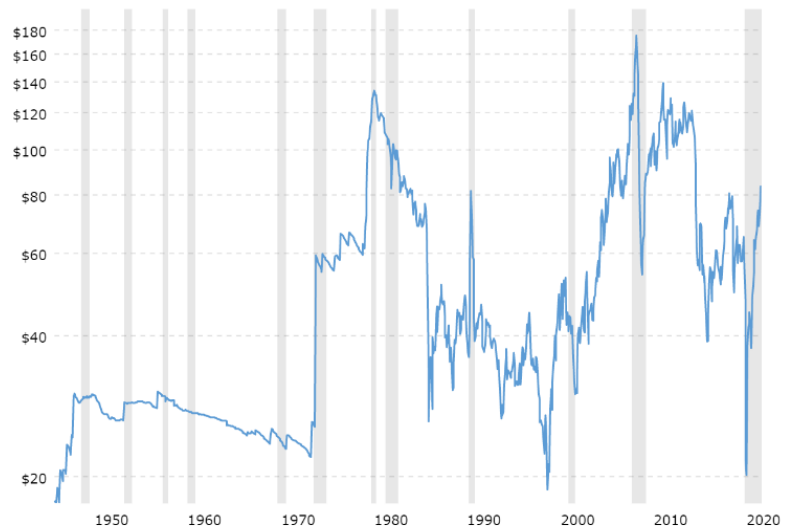

Figure 1. Change in the price of crude oil from 2010 to today (source: https://www.macrotrends.net/1369/crude-oil-price-history-chart, (accessed on 5 September 2021)).

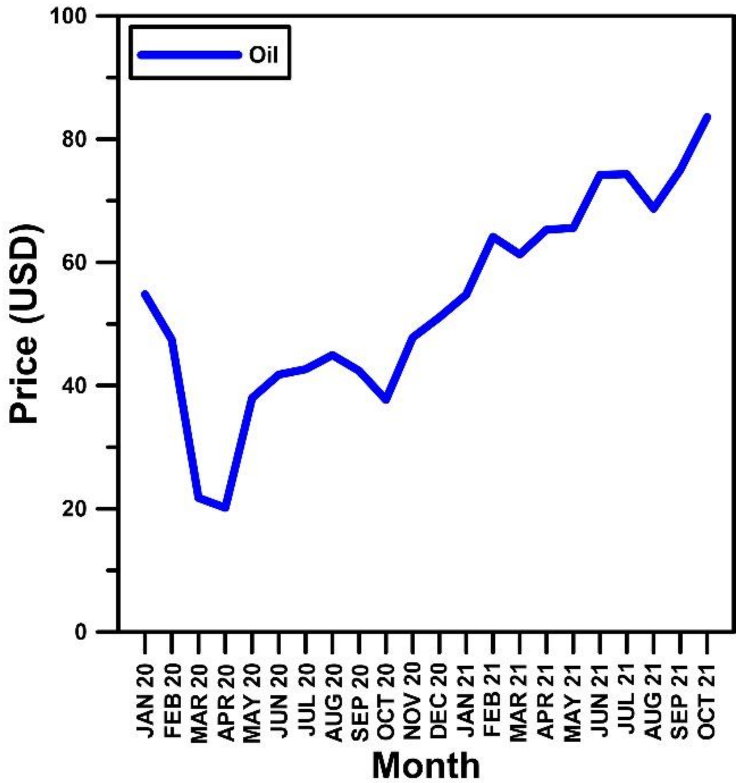

Figure 2. Change in the price of crude oil in the period January2020–October 2021 (Source of the data: https://www.macrotrends.net/1369/crude-oil-price-history-chart, (accessed on 5 September 2021).

While unexpected health crises, such as the current crisis of COVID-19, along with new technological advances and geopolitical developments play an important role in the global supply chain and the energy markets [18], it is a fact that the situation in the international market becomes even more unpredictable given the uncharted course of the coronavirus, the announcements about mutations, the preventive measures taken, as well as the course of vaccinations. These conditions directly determine consumption, which, in turn, affects the supply–demand balance and the course of prices.

Figure 3 shows a well-known figure of the evolution of crude oil prices the last 20 years, indicating some major global political events [19]. This figure shows the great impact of these events on the price of crude oil.

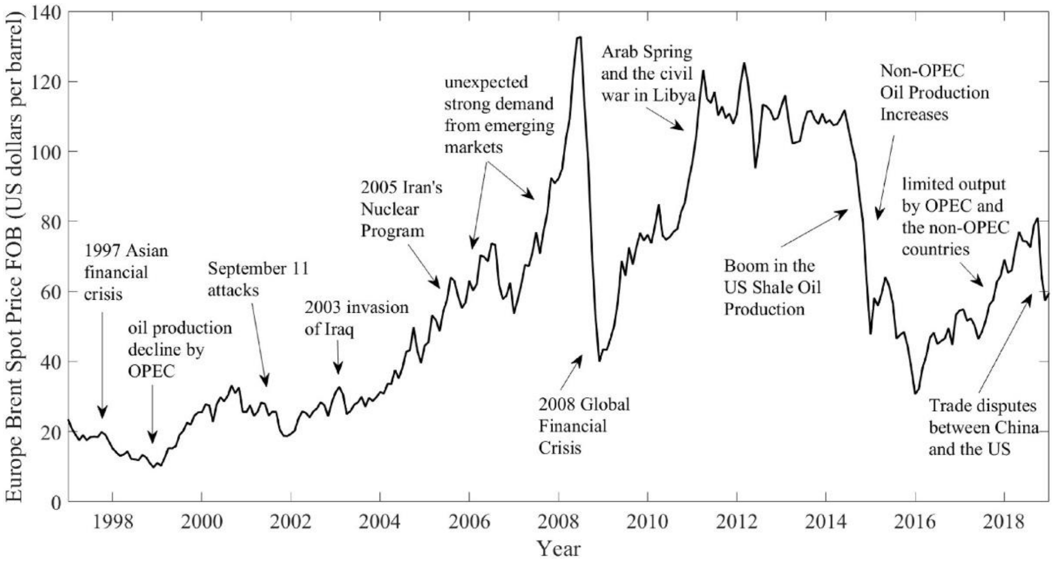

Figure 3. Evolution of crude oil price during the last 20 years. The major political events are indicated (source: [https://doi.org/10.1016/j.ribaf.2020.101357], (accessed on 24 November 2021)).

Recent research has shown the correlation between daily new cases or total number of deaths due to communicable diseases and adverse stock returns in the Chinese equity market [20] and presented the negative, direct, and indirect effects of COVID-19 on global markets [21]. Meanwhile, even the way that COVID-19 is covered by the media, or that panic is caused by them, seems to affect stock market volatility [22].

In addition to the previous figures, Figure 4 shows the index of prices for the three fossil fuels.

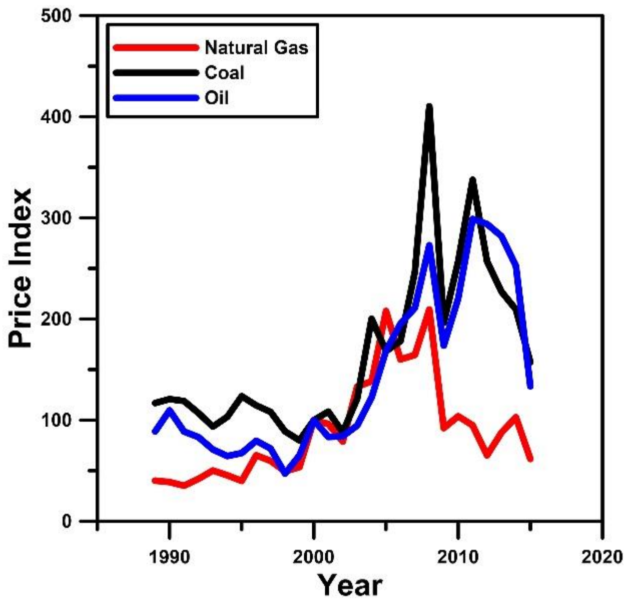

Figure 4. Price index for the three fossil fuels (source of data: https://ourworldindata.org/fossil-fuels, (accessed on 5 September 2021)).

The above figures show the instability and uncertainty of the price of fuels; however, the linear application of only one scenario cannot take into consideration these changes.

At the same time, the Intergovernmental Panel on Climate Change (IPCC) has recognized that many parameters affect the emissions of greenhouse gas and, therefore, there is considerable uncertainty for the prediction of future emissions. For this reason, six groups of greenhouse gas emission scenarios have been proposed (A1T, A1B, A1F1, A2, B1, and B2) with a total of 40 scenarios, the implementation of which give different future temperatures in the Earth's atmosphere (Figure 5) [23].

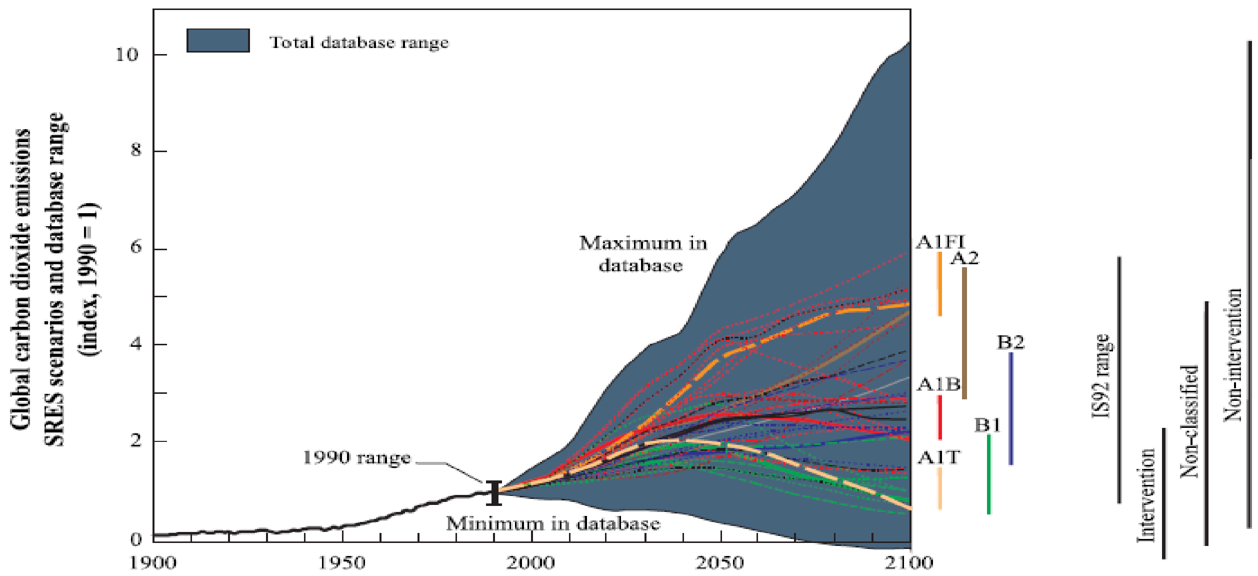

Figure 5. Index of carbon dioxide emissions produced by energy and industry for the various IPCC scenarios (1990 = 1) (source: [23]).

Based on the previous analysis, two additional works must be conducted to complement the NECP. The first one concerns the inclusion of alternative scenarios to cover the probability that unpredictable factors inhibit the implementation of the initial planning. The alternative scenarios should take into account both the positive and negative eventualities, such as:

- The technological developments that will improve the efficiency and effectiveness of technology and reduce the price of energy produced;
- Economic issues, such as the evolution of the country's GDP, the price of gas, of RES, of electricity, etc.;
- Possible schedule delays due to unexpected factors and events (such as a new pandemic or a major natural disaster in Greece, e.g., an earthquake), changes in institutional, economic, or social parameters, etc.;
- Geopolitical issues that may affect the availability of an uninterrupted gas supply in Greece, or a great change in energy prices, etc.

The second necessary work is to have a specific provision for the regular reporting of the progress of the plan's actions and, based on this reporting, the establishment of an annual update of the objectives of the plan, of the policies to be set, and of the actions to be implemented. It should be noted that this regular reporting and the regular update of the objectives of the plan are not mentioned in the current plan.

4.2. De-Lignification and Energy Mix

The plan proposes the complete de-lignification of the country in 2028 and the increase of the participation of natural gas and RES in Greece's energy mix. This option has some positive and some negative points. The main positive point is the reduction of greenhouse gas production. However, this advantage is not so obvious. Natural gas produces 201.96 kg of CO_2/MWh, compared to 363.6 kg of lignite [24]; or, put differently, natural gas produces 55% of the GHG produced by lignite. However, methane has a 100-year global warming potential, 25 times that of CO_2, or 72 times for a 20-year period [25], and leaks of methane from the production, transport, and consumption of NG are significant [26]. For the above reasons, the gain in GHG emissions will be much smaller than initially estimated, as already reported [27,28]. The additional risk of accidents in the natural gas circuit also decreases this difference. In conclusion, leaks of 5% of methane can completely cancel this difference.

Aside from the previous statement, there are also some other issues about the proposed energy mix. The first one is the deterioration of the country's trade balance, both from the import of raw materials for the installation of RES and natural gas installations and also from imports of natural gas to replace a domestic product, lignite. The other negative point is the energy dependence of Greece on an imported fuel instead of a locally produced one, leading to higher risks of national energy autonomy.

It is clear that the deterioration of the country's trade balance will affect the entire Greek economy, and heavy actions should be proposed to mitigate this. However, the analysis of these actions and/or of alternative scenarios is not performed in this plan.

It should be also noted that countries that use natural gas to a large extent in their energy mix, such as the Netherlands, have decided to become independent of it in the coming years [29]. Taking this into consideration, natural gas can be considered only as a transition solution, and the cost of replacing lignite with natural gas, which will be also replaced in two or three decades, is not examined in the NECP.

The proposed energy mix also has several uncertain elements, such as the final price of the energy, which can be much higher than the current one, or the uncertainty of finding domestic hydrocarbon reservoirs, as the NECP estimates that the domestic fuel production will increase from 281ktoe in 2020 to 536ktoe in 2030. However, this last estimation is not consolidated, and no alternatives are examined in case of failure.

Even if a close economic analysis of the substitution of lignite by natural gas is out of the scope of this work, some elements are given here. The current cost of electricity production from lignite is EUR 105/MWh (EUR 35 is the direct cost and EUR 70 is the emission price) [30], while the corresponding cost for natural gas is EUR 75/MWh, and for RES is EUR 135.6/MWh [31].

However, these values, and the great instability of prices shown in Figures 1–4, indicate that the complete abandonment of domestic energy sources (lignite) and the use of only imported fossil fuels (oil and natural gas) can have a very high cost for the energy in Greece and, as a consequence, for the entire Greek economy.

Therefore, a more detailed examination of the possibility of continuing to exploit lignite, an available domestic fuel, for a longer time, instead of completely substituting it for imported natural gas (at least until the cost of energy produced from RES decreases significantly) is proposed. This can be done by using modern, more environmentally efficient technologies, by combining lignite combustion with biomass combustion or gasification technology, and using synthetic gas and, in addition, carbon storage technology, as will be exposed here.

4.3. Biomass Combustion

The development of more renewable energy sources started in a more systematic manner after the oil crisis of 1973. During this period, scientists adopted a systematic approach to energy and coined the term biomass [32]. Biomass is a renewable energy source because the CO_2 released from its combustion is bound to the plants for their development. Therefore, its use as a fuel can have a positive impact on the overall GHG balance. Due to this positive impact, the use of biomass as fuel has increased during the last years. In addition, biomass is abundant, which is why biomass energy has become the world's fourth largest energy source today, following coal, oil, and natural gas, indicating its significant economic, societal, and environmental potential [33].

In several countries affected by the economic crisis after 2008, or even in the case of citizens with economic hardship in economically developed countries, the shift in the use of biomass as a heating fuel is mainly due to its lower price, or to the ability to burn materials that had not previously found a suitable route of exploitation through domestic combustion. Several citizens of low economic status have used pruning or even organic waste as heating fuel during the last years [34,35].

However, the combustion of biomass has a significant negative impact: the high emission of pollutants, mainly of particulate matter (PM) [36]. The increased use of biomass for domestic heating in recent years has led to a very poor air quality in Greek and many European cities, especially in winter. This poor air quality has serious consequences for both quality of life and human health, and these consequences will strongly appear in the next years. The European Respiratory Society has already highlighted the serious effects of biomass-burning on human health in cities in developed countries, and recommends limiting its use [37]. However, the poor air quality comes from the domestic combustion of biomass, where no pollution control system exists. Central power plants using biomass and equipped with pollution-control systems are widely available. Biomass co-firing has already received wide acceptance in many European countries, mostly in the northern and central parts of Europe, such as the United Kingdom, Germany, and the Nordic countries [38]. From this point of view, the use of biomass combustion to produce electrical energy for central power plants can be a very serious alternative to lignite combustion. This alternative is not proposed in this plan. Very roughly, the following data can show the feasibility of this alternative.

The consumption of lignite in Greece is 4.5 million tons of oil equivalent [39] or 46 million tons of lignite [40]. The typical thermal power of wood is quite similar to that of lignite, of course depending on the wood type [41]. The total timber production in Greece was almost 1.1 million m^3 in 2013 [42]; considering an average density of wood of 600 kg/m^3 [41], almost 0.7 million tons of wood was produced in Greece in 2013. However, in other neighboring or European countries with an equivalent or smaller surface area than Greece, the production is several times higher: 6.1 million m^3 in Bulgaria, 5.5 in Croatia, 15.3 in the Czech Republic, 7.6 in Estonia, 7.0 in Lithuania, 6.0 in Hungary, 17.4 in Austria, 8.0 in Slovakia, etc. [42]. Moreover, the forest cover of Greece is about 3.9 million hectares, with 3.5 million available for wood production [43]. In addition to the previous data, 52 thousand acres of forests were burned in Greece in 2018. Considering a wood density of about 10 $m^3/acre$ (although, depending on the tree species, it can reach up to 40 $m^3/acre$), the total volume of burned forests corresponds to 0.5–4 times the annual timber production in Greece [44,45]. The data for the forest fires of 2021 are even worse, as 1.55 million acres of the total forest area was burned in Greece [46], which corresponds to 4.2% of the total forest area (of 36.8 million acres) [47].

It is important to mention that funds allocated in 2021 for fire protection was only EUR 1,700,000, which corresponds to only 10% of the costs requested by the relevant institutions [48]. This indicates that, with a very small increase of this fund, a significantly decreased amount of forest fires will occur in the future, allowing for the better exploitation of forests for timber to be used as fuel, rather than being devastated by fires.

The above data and calculations are approximate and, of course, a more detailed analysis is necessary. However, the above data show that a ten-times increase in the total timber production in Greece in the coming years could be an achievable goal. This production could be specifically focused on the mountainous areas of Western Macedonia, where the majority of the lignite mines are found today, but also on the many mountainous/semi-mountainous areas of Greece that are currently bare of forests and could accommodate special fast-growing tree plantations. This amount could replace about 15% of the current lignite consumption and will have several advantages, such as:

- Zero contribution to the emission of CO_2, because the CO_2 produced from biomass combustion is absorbed by the plants for their development;

- For equal energy production, natural gas produces about 55% of the emissions of CO_2 from lignite; however, the replacement of 15% of the quantity of lignite with wood corresponds to the net production of carbon dioxide equal to 85% of the original production. This decrease can be achieved with less effort than the complete transition to natural gas (the disadvantages of this transition were shown previously);
- Biomass will be a domestic product and, thus, the dependence on energy imports will be lower;
- The stimulation of jobs in Greece, and especially in the province, instead of the current decrease in the number of jobs due to the closure of the existing thermal plants;
- The development of a cutting-edge technology and the creation of a Greek know-how that can be exported; this will have multiple benefits for Greek society and economy;
- The possible co-combustion of waste will be another option;
- The protection and upgrade of Greece's rural and mountainous environment by stimulating ecosystems, reducing erosion, changing microclimate areas to less-warm, etc.

The decentralized electricity production, i.e., the creation of plants in many areas, e.g., 1–2 per county, will be more efficient due to the shorter transportation distance of biomass. This will also have a positive impact on the control of particles emissions, as the pollution will not be emitted in the same area.

The above (approximate) analysis shows that this route, albeit complementary to the import of natural gas, should be better exploited. In this case, the future use of lignite, combined with carbon capture technologies, may be more advantageous for the Greek economy than the transition to natural gas. A comprehensive study is necessary to take into account all the pros and cons of this alternative. Of course, a comprehensive technical and economic study should be carried out, including the external costs of this alternative, ensuring that there are no major environmental nuisances or degradations [49].

The above analysis shows that the further exploitation of biomass, a domestic product, can replace lignite to a certain extent with zero-equivalent CO_2 emissions, and it is therefore proposed that this is taken into consideration.

4.4. Gasification of Lignite

The gasification of lignite and the production of fuel gas is another alternative; however, this alternative is not considered by this plan. This technology, used in several parts of the world in the past, is found in recession after the mid-20th century due to the high competitiveness of oil and gas prices, but is again on the rise because of the necessity to reduce greenhouse gas emissions [50].

It is therefore proposed that the use of this alternative technology is explored in more technological, economic, and environmental detail. The gaseous fuel could be used for electricity generation or in large central plants (industry, hot water production, etc.), or even be considered as an addition to the domestic natural gas network.

The above process could continue the use of lignite, in combination with the use of biomass and carbon capture technologies, and continue to produce energy with domestic raw materials, lower costs for the Greek economy, and lower CO_2 emissions. A comprehensive technical, economic, and environmental study is again necessary to take into consideration all the pros and cons of this alternative.

4.5. CO_2 Storage

The use of CO_2 storage technology is not mentioned in this plan and is proposed only at one point, concerning future research actions.

It is true that this technology has, so far, been used worldwide in a limited number of facilities [51]. However, many countries, such as Canada, or the Netherlands in the port of Amsterdam [52], invest significantly in this technology. The plan proposes a research action for this technology, but only after the end of lignite production. In this case, the implementation of carbon storage technology will be of very limited value.

An immediate examination of the technological and economic uses of this technology, in combination with the continued use of lignite and in biomass combustion, is proposed here. This alternative can possibly have lower CO_2 emissions than the use of natural gas combustion [53]. In addition, a combination of an existing domestic source (lignite) with a new one (biomass), and a combination of a mature technology and infrastructure (lignite combustion) with a new one (biomass combustion and carbon storage) will be used.

4.6. Energy Storage

It is well known that the production of electricity from RES does not necessarily go hand-in-hand with consumption. The highest production of energy from photovoltaics occurs during the sunshine hours of the day, falling to zero during evening hours, when a peak in consumption occurs. The energy produced by wind turbines is quite unstable, as it depends on the windy hours. Moreover, the distribution of winds in the year and in space is also of high variability. In contrast to that, energy production from thermal plants, using fossil fuels or biomass combustion, and from hydropower plants, can be adapted to energy consumption.

Therefore, in order to efficiently use the energy produced from certain RES, such as wind turbines and photovoltaics, it is necessary to store the energy produced during the low consumption hours in order to use it during the high consumption hours. The main available energy storage techniques are pumped storage hydropower (using the pumping of water from a reservoir of low elevation to one of high elevation during low consumption hours and then allowing the flow of water from the high to low reservoir for the production of electric energy during peak hours), batteries, and hydrogen [54].

This plan mentions storage in batteries or in gas production (e.g., hydrogen), without giving specific data, but pumped storage hydropower is not included. However, pump storage could be an efficient way of storing energy. In addition, the creation of new water reserves could be very beneficial for agricultural purposes. The storage of energy in batteries on the level of an entire country can be quite problematic, as the cost of these batteries may be too high. Moreover, the environmental consequences of this very high amount of necessary batteries are not negligible [55,56].

Therefore, it is proposed that the alternative of pumped storage hydropower, instead of the battery storage that is proposed in this plan, is developed.

4.7. Vehicle Electrification

One of the actions of the NECP to reduce the use of fossil fuels is to increase the electrification of vehicles. The plan presents an estimation for the development of electric mobility in Greece until 2030. However, the estimated numbers are rather high.

The total market for new passenger cars is projected to increase from 103,431 units in 2018 (reference year) to 275,133 units in 2030, which corresponds to an annual increase of 8–11%, which is rather high. It should be noted that sales of 280–320,000 units/year took place in Greece during the period of 2000–2006.

However, the economic development of that past period cannot be compared to the current economic situation of Greek households. In addition, the plan estimates that Greece's GDP will be approximately the same as in 2008, when the economic crisis started, only by 2030. It should be noted that the rest of the European countries will have recovered much earlier from this economic crisis and will be at much higher corresponding levels of GDP in 2030. Having gone through a severe economic crisis, with declining incomes, high unemployment, and a large exodus abroad, especially of young scientists, it is probably very difficult to have such a large increase in the market for new passenger cars. Additional components that support this argument are:

- The market of passenger cars is much more saturated than in the period of 2000–2006;
- The implementation of sustainable mobility should lead to an increase in the use of public transport, so the needs for passenger cars will be lower in the future;

- This plan estimates an additional reduction in the country's population, as a result of either a decrease in births or migration abroad. It should be noted that the number of births per woman in Greece was only 1.4 in 2017, a value that is one of the lowest not only in Europe, but also worldwide. Low birth rates and migration of the Greek population abroad are both signs of economic recession and not of high economic growth;
- A high increase in the prices of residences (both for acquisition and rent) has occurred since 2017. Is should be noted that the index of the prices of dwellings constantly increased from 1997 to 2008 and then constantly decreased until 2017, due to the economic crisis. It is estimated that this increase will continue in the coming years [57]. This increase absorbs a higher and higher percentage of the income of households, and is rather competitive to the automobile markets, as it reduces disposable income for the purchase of a passenger car.

Moreover, the estimated rate of electric vehicle penetration (24–30% by 2030) may be overestimated. Electric vehicles, from almost non-existent today, are projected to have a quite-high penetration in 2030. Given the current available technology for electric cars (such as the number of kilometers that an electric vehicle can travel, sufficient for urban travel but not always for long-distance, or battery life, etc.), the necessary infrastructure to be created to recharge a car's battery, especially in public places, and the higher prices of electric cars compared to conventional vehicles, the above objective for the penetration of these cars may not be met so early. Several researchers already expressed their reservations about the announced rapid introduction of electric cars to the market [58]. It should also be noted that, as an additional difficulty, the battery-charging infrastructure of electric cars in public places is quite problematic in Greek cities, due to the general insufficient width of sidewalks and, moreover, to the high lack of parking availability in all Greek cities.

Due to the higher price of electric vehicles compared to conventional ones, high financial incentives for their purchase will probably be required, and this will be another additional charge for the Greek national budget and the Greek National Balance, as all these vehicles are imported.

For the above reasons, the existence of several scenarios with alternatives is more than necessary.

4.8. Public Transportation

Although there is a specific chapter in this plan on the electrification of passenger cars, the increase of public transportation in Greece is not taken into consideration. It is well known that the use of public transportation emits lower CO_2 emissions than the use of passenger cars [59], and this difference is even higher in a complete product life-cycle analysis, with all the external costs taken into consideration, since the total impact of policies or measures in the long term are unclear [60].

Greece has one of the lowest percentages of train-passenger kilometers, and the second lowest percentage of railways for the transportation of goods in the EU [61,62]. Moreover, Greece showed a very high decrease in the share of public transport in total passenger traffic, from 28% in 2000 to 18% in 2018 [62].

The shift to public transport is therefore of paramount importance, and this action should be immediately taken into consideration in this plan.

4.9. Energy Savings

The remarks concerning the energy savings are analyzed as a function of the type of the building: public administration buildings or residential buildings.

4.9.1. Energy Savings in Public Administration Buildings

The plan provides an annual energy upgrade of 3% of the total surface of the buildings of the central public administration. Some facts should be mentioned here. The first is that the ages of Greek public administration buildings are quite high [63]. In addition, many of them are listed; therefore, they require a specific process for their restoration and the targeted energy results cannot be achieved easily. Moreover, the procedures for such upgrades in the public sector are very time-consuming. These facts show that the target of the energy upgrade of 3% of the total surface each year is very probably unattainable, at least during the first years. On the other hand, there is an urgent need to upgrade much more than one-third of the total buildings' area by 2030.

The above shows that it is initially necessary to radically review and accelerate the current procedures for the energy upgrade of public buildings, of course with the necessary protection of listed buildings, and set a more ambitious target. The energy-saving measures must be first implemented, as saving energy is one of the most efficient measures to decrease CO_2 emissions.

4.9.2. Energy Savings in Residential Buildings

In Greece, there were about 3 million households and more than 6 million residences in 2019 [63]. More than 55% of these residences were built before 1980, i.e., they have very poor energy performance [63]. The plan proposes the energy upgrade of 60,000 residences per year, a number that corresponds to less than 10% of all residences by 2030. This percentage is obviously very small.

If the estimated economic growth is taken into account (the country's GDP will be by 2030 equal to that of 2008), it seems that the disposable income of citizens for energy upgrades will not be very high. This statement indicates that either there will be financial difficulty in upgrading many buildings, or that large public funds will be required for subsidizing this upgrade. For an estimated cost of EUR 10,000–15,000 for a residence of 80–100m^2 (depending on the climatic zone, the age of the residence, the exposure, etc.), the total cost will be more than EUR 60 billion. For comparison, the public revenues, spending, and the Program of Public Investment of the Greek state was, in 2019, EUR 53.02, 57.79, and 6.75 billion, respectively, and the GDP of Greece was EUR 192.75 billion in 2020 [64].

The plan also proposes an increase of the use of domestic natural gas. Taking into consideration the current coverage of Greece in the use of natural gas (only 5.4% of the residences used natural gas from 2011–2012 [65]) and the large and time-consuming projects required to increase the natural gas network, there are high reservations for the rapid penetration of the use of natural gas. Therefore, it is necessary to change the priorities and practices followed so far in order to achieve this goal. At this point, we can again express the previous comment concerning the choice to use domestic natural gas while other countries choose to abandon it.

4.10. Local Production of Products, Dietary Habits

There are several additional measures to decrease the emission of greenhouse gases. One of them is local/global production/consumption. The large penetration of globalization led to the high increase of the transportation of products on a global scale. However, a very effective action to decrease CO_2 emissions is to enhance the local production/consumption of products, as their transportation is significantly decreased. This policy has proven to be one of the most effective policies/actions to reduce greenhouse gas emissions from product transport (e.g., "food-kilometers") in the case of food transport [66].

However, this action is completely missing from this plan. In addition, this policy can strengthen the Greek economy and Greek businesses, and help with the creation of new jobs, especially in small cities or suburban areas. The dynamic integration of this policy is proposed in this plan. Specific policies and actions must be implemented immediately, as this policy will bring only positive results.

The food sector is responsible for a large proportion of greenhouse gas emissions, stemming from the production of primary food products, their process, transport, etc. [67]. Greece has an average consumption of 3353 kcal/cap/day calories in 2017, against the 2000 calories a day for women and 2500 for men that is recommended by the WHO [68]. Meat consumption in Greece is 76.7 Kg/cap/year [69], compared to 63.12 Kg/cap/year in

Europe in 2013 [70]. The decrease in extra calories and meat consumption can be two very efficient methods for the decrease in the greenhouse gas emissions of a country [67], with a very low cost and, moreover, with several other significant health advantages. However, there is no mention in this plan about these, or similar, alternative and low-cost measures for the decrease of greenhouse gases emissions.

4.11. Energy Price, Social Impact, Energy Poverty

The causes of energy poverty are low incomes, high fuel prices, and the poor thermal conditions of houses [71,72]. A total of 35% of Greeks have debts to energy bills (first place among the member countries of the European Union) and the percentage of Greeks who cannot keep their home warm is very high, ranking Greece in third place among the member states of the European Union [73].

It is, therefore, absolutely necessary that the actions of the plan should focus on mitigating energy poverty. However, there are some reservations about the effectiveness of the proposed actions. Reducing energy poverty requires either a high increase in income or a high decrease in the price of energy. However, the plan does not foresee either of those two options. Based on projected GDP growth in Greece, the Greek GDP will reach that of 2008, i.e., before the economic crisis, only in 2030.

The plan estimates a decrease in the price of RES in the coming years without providing more information about the final prices or about how this decrease will take place. It should be noted that it is very difficult to obtain the real cost of energy production of RES from official sources and, thus, this point cannot be verified.

It should be noted that the complete de-lignification and change of the energy mix of Greece in such a short period of time carries the risk of a significant increase in the final price of electricity. In recent years, from 2006 to 2017, there has been an increase of 28% in the price of electricity for medium-sized industries and 177% for households [74]. The current worldwide increases in fuel and energy prices are another example. Therefore, several reservations can be expressed about the announced decrease of energy prices in the coming years. In addition, the plan does not present alternative scenarios if the projected final energy price does not occur, nor possible actions or legal shields in case of speculative trends from the liberalized energy market.

Therefore, the decrease of energy poverty mentioned in the plan seems to be very difficult to achieve. It is proposed here that more generous, but also more specific measures to deal with this phenomenon are adopted. The control of household energy prices is the first of those measures.

Is should be noted that the environmental and social impacts from the energy transition to the main lignite area of Greece, that of Western Macedonia, are analyzed in another work [75].

4.12. Education, Public Awareness

The change of the energy mix of Greece with the shift to RES and natural gas, the gradual change of the fleet of vehicles to electric cars, and the actions of energy-upgrading buildings, etc., will bring significant changes in many technical professions directly related to the above issues.

It is obvious that not only these professions must be protected from any downgrading, but also that a substantial improvement of their role as well as their working conditions should take place. To upgrade these professions, the role of education and training should be enhanced, in addition to institutional and legislative upgrading. Education and training, both conventional and lifelong, and both in presence and distance, need to be upgraded to issues related to energy, the environment, and climate change. These issues need to be more strongly integrated at all levels of education, starting from the lowest, even that of primary school. However, in Greece, during the last years, there is a severe lack of technical workers to face the necessary technical works of the energy transition, and this is not taken into consideration in this plan.

Additionally, it is already known that well-informed and sensitized citizens can implement environmental protection actions much better than those who are not properly or fully informed [76,77]. Several points of the plan refer to citizens/consumers' actions on energy and climate change; however, these points are quite unclear. A specification of the increase of public information and awareness on issues of the safe and proper use of energy, energy savings, environmental protection, and climate change is proposed.

4.13. Regional and Sectoral Plans

The plan proposes individual regional plans to better implement the objectives of the project in the regions of Greece. According to the National Statistical Authority of Greece, the regions of Greece have an imbalanced contribution to the country's GDP [78]. Special mention should be given to regions with a small contribution, so as not to exclude these regions or to have them find themselves at second speed from the actions to be developed.

However, in addition to regional targeting, a sectoral dimension of this plan is missing. The establishment of a sectoral plan is probably more important than those of regional plans and should be established very soon.

5. Discussion

The main pillars of a National Energy and Climate Plan should first take into consideration the future energy mix of the country to mitigate climate change. However, energy is one of the main pillars of society and economy. For this reason, available energy, for example, without power interruptions or blackouts, and energy at an affordable price must be ensured so that the economy can function efficiently, but also to protect the disposable income of citizens and small enterprises. The high price of energy is the main reason for energy poverty, a very significant social problem in Greece, but also in many other countries in Europe or worldwide.

As a first step, a policy maker should guarantee that his proposal is efficient. If, for some reason, this proposal cannot be implemented, efficient alternatives should be applied. It is very strange that the Greek NECP lacks a risk analysis and proposes no alternatives to cover the probable cases of failure. This is a major shortcoming of this plan and should be restored as soon as possible, especially taking the very high increase of energy prices during 2020 into consideration. Greece, especially, is characterized as the most expensive wholesale electricity market in Europe, with the wholesale price at EUR 157 per MWh, a 70% increase since the beginning of the year [79].

Energy mixes and alternative technologies are the other critical points of this plan. The very rapid de-lignification of the country and the transition to natural gas can lead to a very problematic situation. The first point is that the decrease in greenhouse gas emissions will not be as high as is expected, mainly due to leaks of natural gas and its high global warming potential [26–28]. Additionally, the deterioration of the country's trade balance from the transition to natural gas is not taken into consideration in this plan. However, this is a major point, as the trade balance of Greece is, generally, highly negative. For example, the trade balance of Greece reached its highest point in 2015 (EUR -1.8 billion), during the debt crisis due to the collapse of aggregate demand, while it reached its lowest point on 2020 (EUR -12.52 billion) because of the collapse of tourism. Moreover, the trade balance of Greece becomes more negative when the GDP increases [80].

The energy dependence of Greece is also not taken into consideration, as a local product, lignite, is substitute with an imported one. A very specific analysis, using several scenarios of energy prices, should have been conducted to prove the advantages of this transition. However, this analysis is not shown in this plan. It is also clear that natural gas will be used only for some decades, and this statement adds a supplementary cost for the replacement of the infrastructure created only for a limited period of time.

More sustainable alternatives, such as the combustion of biomass, the gasification of lignite, or carbon storage, are not considered in this plan. However, the precise economic, environmental, and social evaluation of these alternatives, using different scenarios, should have been completed first. The same is valid in the case of energy storage, which is necessary due to the high future penetration of RES, where no comparative analysis, with different scenarios, is provided. Pumped storage hydropower, one of the established techniques for energy storage, is not compared with the other techniques to prove that storage in batteries has a lower cost, is more efficient, and more environmentally friendly.

The plan proposes a gradual shift to electric passenger cars. However, the targets set are overestimated and cannot be reached very easily. Moreover, the increase in the use of public transportation, one of the most efficient methods for decreasing CO_2 emissions from the transport sector, is not taken into consideration in this plan.

Energy saving is one of the most efficient ways to decrease greenhouse gas emissions. However, the proposed energy savings in public buildings and private residencies are too low and, moreover, will not be achieved very easily. Energy-saving measures must be first implemented before examining a radical change to an energy mix, which will probably not be adequate for the new consumption of energy.

Other alternatives for the mitigation of greenhouse gas emissions, such as the enhancement of local production/consumption, or the very low action of changing dietary habits, which also have several other advantages for human health, are not taken into consideration in this plan. In addition, the establishment of a circular economy is not strong enough in this plan.

The social impacts of this energy transition are weakly taken into consideration in this plan. Some examples are the provision for technical workers, and their education/training, or the social awareness and information of citizens.

The absence of sectoral plans is another shortcoming of this plan; these plans should be established as soon as possible.

Finishing the list of main shortcomings, the future low energy price is not guaranteed in this plan. It is mentioned that future energy prices will be lower than the current ones without providing, however, a precise analysis. Even if there are some actions to tackle energy poverty, achieving this with a low economic growth, high energy prices, and a low percentage of dwellings renovated each year is impossible.

From the previous analysis, a more detailed examination of the possibility of continuing to exploit lignite, an available domestic product, for a longer time, instead of its complete substitution with imported natural gas, (at least until the cost of energy produced from RES decreases significantly) is therefore proposed. This can be done by using modern, more environmentally efficient technologies, by combining lignite combustion with biomass combustion or gasification technology, and by using synthetic gas and, in addition, carbon storage technology, as is exposed here.

There is also a very strong necessity to ensure the availability of all forms of energy at an affordable price. It is proposed that special care is taken to verify the projected reduction in the prices of energy and that actions, institutional initiatives, and other arrangements are taken so that the final price of energy does not increase and, additionally, so that any speculative trends are avoided.

6. Conclusions

The Greek National Energy and Climate Plan set the priorities of the Greece in the terms of Energy and Climate. A complete de-lignification by 2028 is proposed. The future energy mix will be mainly composed of natural gas and RES.

This plan has several shortcomings: there is no risk analysis and no alternative scenarios are proposed; the participation of other energy sources, such as biomass or the gasification of lignite, is not considered; energy storage is mainly focused on batteries and hydrogen, while pump energy storage is not considered; the targets set for the electrification of the passenger car fleet are too difficult to achieve, and at the same time, there is no provision for the enhancement of sustainable mobility by increasing the participation of public transportation; energy savings in buildings are not so ambitious; the tackling of energy poverty is almost impossible; and the same goes for the control of energy prices.

It is suggested that this transition be delayed for some years, taking into consideration the most sustainable paths for transitioning, such as using more alternatives.

Author Contributions: Conceptualization, E.Z.; methodology, E.Z. and L.V.; investigation, L.V., Z.G. and S.M.; resources, L.V., Z.G., S.M. and R.H.-M.; data curation, Z.G. and S.M.; writing—original draft preparation, Z.G. and S.M.; writing—review and editing, E.Z., L.V. and R.H.-M.; supervision, E.Z. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. IPCC. Available online: https://www.ipcc.ch/ (accessed on 8 September 2021).
2. DCD. Available online: https://www.datacenterdynamics.com/en/opinions/what-fuel-is-used-by-power-stations-in-europe-and-the-us-today/ (accessed on 8 September 2021).
3. IEA. Available online: https://www.iea.org/reports/european-union-2020 (accessed on 5 September 2021).
4. European Commission. *Energy Roadmap 2050*; Publications Office of the European Union: Luxembourg, 2012; pp. 1–24.
5. IISD. Available online: https://sdg.iisd.org/news/wind-and-solar-will-provide-50-of-electricity-in-2050-bnef-report-finds/ (accessed on 10 September 2021).
6. Energypedia. Available online: https://energypedia.info/wiki/Greece_Energy_Situation#Electricity (accessed on 7 September 2021).
7. European Commission. Available online: https://ec.europa.eu/info/energy-climate-change-environment/implementation-eu-countries/energy-and-climate-governance-and-reporting/national-energy-and-climate-plans_en (accessed on 24 October 2021).
8. Ministry of Environment and Energy. *National Energy and Climate Plan (NECP)*; Ministry of Environment and Energy: Athens, Greece, 2019. Available online: https://ypen.gov.gr/energeia/esek/ (accessed on 5 September 2021).
9. Bampatsou, C.; Zervas, E. Critique of the Regulatory Limitations of Exhaust CO_2 Emissions from Passenger Cars in European Union. *Energy Policy* **2011**, *39*, 7794–7802. [CrossRef]
10. Martin, N.; Bishop, J.; Choudhary, R.; Boies, A. Can UK passenger vehicles be designed to meet 2020 emissions targets? A novel methodology to forecast fuel consumption with uncertainty analysis. *Appl. Energy* **2015**, *157*, 929–939. [CrossRef]
11. Liu, Y.; Liu, Y.; Chen, J. The impact of the Chinese automotive industry: Scenarios based on the national environmental goals. *J. Clean. Prod.* **2015**, *96*, 102–109. [CrossRef]
12. Palm, J. The Transposition of Energy Communities into Swedish Regulations: Overview and Critique of Emerging Regulations. *Energies* **2021**, *14*, 4982. [CrossRef]
13. Jain, M.; Sharma, G.D.; Mahendru, M. Can I Sustain My Happiness? A Review, Critique and Research Agenda for Economics of Happiness. *Sustainability* **2019**, *11*, 6375. [CrossRef]
14. Official Journal of Greek Government. Available online: https://ypen.gov.gr/wp-content/uploads/2020/11/%CE%A6%CE%95%CE%9A-%CE%92-4893.2019.pdf (accessed on 8 September 2021).
15. Wei, Y.; Jia, A.; Wang, J.; Qi, Y.; Jia, C. Current Technologies and Prospects of Shale Gas Development in China. In *Shale Gas. New Aspects and Technologies*; Al-Juboury, A., Ed.; Intechopen: London, UK, 2018. [CrossRef]
16. Sacco, A.; Bella, F.; Bianco, S.; Bongiovanni, R. Photocured Polymer Electrolyte Membranes for Dye-Sensitized Solar Cells. In *Photovoltaics: Synthesis, Applications and Emerging Technologies*; Gill, M., Ed.; Nova Science Publishers: Hauppauge, NY, USA, 2014; pp. 53–72.
17. Ladislaw, S.; Leed, M.; Watlon, M. *New Energy, New Geopolitics: Balancing Stability and Leverage*; CSIS: Washington, DC, USA, 2014; ISBN 978-1-4422-2835-1.
18. Shaikh, I. Impact of COVID-19 pandemic on the energy markets. *Econ Chang. Restruct* **2021**, 1–52. [CrossRef]
19. Lin, B.; Bai, B. Oil prices and economic policy uncertainty: Evidence from global, oil importers, and exporters' perspective. *Res. Int. Bus. Financ.* **2021**, *56*, 101357. [CrossRef]
20. Al-Awadhi, A.M.; Alsaifi, K.; Al-Awadhi, A.; Alhammadi, S. Death and contagious infectious diseases: Impact of the COVID-19 virus on stock market returns. *J. Behav. Exp. Financ.* **2020**, *27*, 100326. [CrossRef] [PubMed]
21. Papadamou, S.A.F.; Kenourgios, D.; Dimitriou, D. Direct and Indirect Effects of COVID-19 Pandemic on Implied Stock Market Volatility: Evidence from Panel Data Analysis. *MPRA* **2020**. Available online: https://mpra.ub.uni-muenchen.de/id/eprint/100020 (accessed on 9 May 2021).
22. Haroon, O.; Rizvi, S.A.R. COVID-19: Media coverage and financial markets behavior—A sectoral inquiry. *J. Behav. Exp. Financ.* **2020**, *27*, 100343. [CrossRef] [PubMed]

23. Nakicenovic, N.; Swart, R. *Emission Scenarios, IPCC*; Cambridge University Press: Cambridge, UK, 2000; p. 6.
24. Our Word in Data. Available online: https://ourworldindata.org/grapher/carbon-dioxide-emissions-factor (accessed on 23 September 2021).
25. Forster, P.; Ramaswamy, V.; Artaxo, P.; Berntsen, T.; Betts, R.; Fahey, D.W.; Haywood, J.; Lean, J.; Lowe, D.C.; Myhre, G.; et al. Changes in Atmospheric Constituents and in Radiative Forcing. In *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*; Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K.B., Tignor, M., Miller, H.L., Eds.; Cambridge University Press: Cambridge, UK; New York, NY, USA, 2007.
26. Oliveira, B.T.; Schulz, R.; McGlade, C.; Gould, T. *Methane Emissions from Oil and Gas*; IEA: Paris, France, 2019.
27. Our Word in Data. Available online: https://ourworldindata.org/fossil-fuels (accessed on 16 September 2021).
28. UNFCCC. Available online: https://unfccc.int/process/transparency-and-reporting/greenhouse-gas-data/greenhouse-gas-data-unfccc/global-warming-potentials (accessed on 18 September 2021).
29. Potter, P. The Netherlands to go completely gas-free in the future. *The Holland Times*, 28 June 2018.
30. Energypress. Available online: https://energypress.gr/news/sta-1356-eyro-meso-kostos-kathe-paragomenis-mwh-ape-2020-poso-syneisferei-kathe-pigi-eisrois (accessed on 10 September 2021).
31. Kathimerini. Available online: https://www.kathimerini.gr/economy/561503764/oi-lignitikes-monades-einai-aparaitites/ (accessed on 10 September 2021).
32. Cablevey. Available online: https://cablevey.com/the-history-of-biomass-as-a-renewable-energy-source/ (accessed on 12 September 2021).
33. Demirbas, A. Progress and recent trends in biofuels. *Progr. Energy Combust. Sci.* **2007**, *33*, 1–18. [CrossRef]
34. Zervas, E.; Drimili, E.; Gareiou, Z. Annoyance from winter atmospheric pollution created from wood burning for heating. In Proceedings of the ERS International Congress 2019, Vienna, Austria, 7–9 September 2019.
35. Drimili, E.; Zervas, E. Opinions of the residents of Athens on the heating of their homes in the winters since the beginning of the crisis. In Proceedings of the 1st Online Conference on Energy Poverty, Athens, Greece, 11 November 2020.
36. Chen, J.; Li, C.; Ristovski, Z.; Milic, A.; Gu, Y.; Islam, M.S.; Wang, S.; Hao, J.; Zhang, H.; He, C.; et al. A review of biomass burning: Emissions and impacts on air quality, health and climate in China. *Sci. Total Environ.* **2018**, *579*, 1000–1034. [CrossRef] [PubMed]
37. Sigsgaard, T.; Forsberg, B.; Annesi-Maesano, I.; Blomberg, A.; Bølling, A.; Boman, C.; Bønløkke, J.; Brauer, M.; Bruce, N.; Héroux, M.E.; et al. Health impacts of anthropogenic biomass burning in the developed world. *Eur. Resp. J.* **2015**, *46*, 1577–1588. [CrossRef] [PubMed]
38. Tzelepi, V.; Zeneli, M.; Kourkoumpas, D.-S.; Karampinis, E.; Gypakis, A.; Nikolopoulos, N.; Grammelis, P. Biomass Availability in Europe as an Alternative Fuel for Full Conversion of Lignite Power Plants: A Critical Review. *Energies* **2020**, *13*, 3390. [CrossRef]
39. Eurostat. Available online: https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Tonnes_of_oil_equivalent_%28toe%29 (accessed on 15 September 2021).
40. EURACOAL. Available online: https://euracoal.eu/info/country-profiles/greece/ (accessed on 17 September 2021).
41. Francescato, V.; Bergomi, L.Z.; Metschina, C.; Schneld, C.; Krajnc, N.; Koscik, K.; Nocentini, G.; Stranieri, S. *Wood Fuel Manual*; Biomass Trade Cent; AIEL—Italian Agroforestry Energy Association: Legnaro, Italy, 2008.
42. Eurostat. Available online: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Wood_production,_2000%E2%80%932015_(thousand_m%C2%B3)_YB17.png (accessed on 17 September 2021).
43. Eurostat. Available online: https://ec.europa.eu/commission/presscorner/detail/en/STAT_08_146 (accessed on 18 September 2021).
44. FAO. Available online: http://www.fao.org/3/y1997e/y1997e07.htm (accessed on 16 September 2021).
45. NRCAN. Available online: https://www.nrcan.gc.ca/our-natural-resources/forests-forestry/state-canadas-forests-report/howmuch-forest-does-canada-have/indicator-wood-volume/16399 (accessed on 14 September 2021).
46. Dasarxeio. Available online: https://dasarxeio.com/2021/08/27/101205/comment-page-1/ (accessed on 12 September 2021).
47. To Vima. Available online: https://www.tovima.gr/2021/03/05/society/dasiko-to-60-tis-ellinikis-epikrateias/ (accessed on 8 September 2021).
48. Dasarxeio. Available online: https://dasarxeio.com/2021/04/19/96134/ (accessed on 12 September 2021).
49. Greek Fireservice. Available online: https://www.fireservice.gr/el_GR/synola-dedomenon (accessed on 12 September 2021).
50. Globalsyngas. Available online: https://www.globalsyngas.org/resources/the-gasification-industry/ (accessed on 11 September 2021).
51. NRCAN. Available online: https://www.nrcan.gc.ca/energy/publications/16226 (accessed on 14 September 2021).
52. Port of Rotterdam. Available online: https://www.portofrotterdam.com/en/news-and-press-releases/port-authority-gasunie-and-ebn-studying-feasibility-of-ccs-in-rotterdam (accessed on 3 September 2021).
53. Rhodes, J.S.; Keith, D.W. Biomass with capture: Negative emissions within social and environmental constraints: An editorial comment. *Clim. Chang.* **2008**, *87*, 321–328. [CrossRef]
54. Energy.gov. Available online: https://www.energy.gov/eere/water/pumped-storage-hydropower (accessed on 21 September 2021).
55. Dehghani-Sanij, A.R.; Tharumalingam, E.; Dusseault, M.B.; Fraser, R. Study of energy storage systems and environmental challenges of batteries. *Renew. Sustain. Energy Rev.* **2019**, *104*, 192–208. [CrossRef]

56. McManus, M. Environmental consequences of the use of batteries in sustainable systems: Battery production. In Proceedings of the 2nd International Conference on Microgeneration and Related Technologies, Glasgow, UK, 4–6 April 2011; pp. 4–6.
57. Bank of Greece, Index of Prices of Dwellings (Historical Series). Available online: https://www.bankofgreece.gr/en/statistics/real-estate-market/residential-and-commercial-property-price-indices-and-other-short-term-indices (accessed on 19 September 2021).
58. Temple, J. Why the Electric-Car Revolution May Take a Lot Longer Than Expected. MIT Technology Review. Available online: https://www.technologyreview.com/2019/11/19/65048/why-the-electric-car-revolution-may-take-a-lot-longer-than-expected (accessed on 19 September 2019).
59. Shapiro, R.J.; Hassett, K.A.; Arnold, F.S. *Conserving Energy and Preserving the Environment: The Role of Public Transportation*; American Public Transportation Association: Washington, DC, USA, 2002.
60. Kii, M. Reductions in CO_2 emissions from passenger cars under demography and technology scenarios in Japan by 2050. *Sustainability* **2020**, *12*, 6919. [CrossRef]
61. Sipotra. Available online: https://www.sipotra.it/wp-content/uploads/2019/06/Passenger-transport-statistics.pdf (accessed on 22 September 2021).
62. Odyssee-mure. Available online: https://www.odyssee-mure.eu/publications/efficiency-by-sector/transport/transport-eu.pdf (accessed on 22 September 2021).
63. ELSTAT, 2019, Greece with Numbers, ELSTAT. Available online: https://www.statistics.gr/ (accessed on 27 September 2021).
64. Ministry of Finances of Greece. Available online: https://www.minfin.gr/documents/20182/7655501/%CE%95%CE%99%CE%A3%CE%97%CE%93%CE%97%CE%A4%CE%99%CE%9A%CE%97+%CE%95%CE%9A%CE%98%CE%95%CE%A3%CE%97.pdf/d100d4de-02c3-4651-be19-58020e917e84 (accessed on 20 September 2021).
65. European Commission. Available online: https://ec.europa.eu/energy/sites/ener/files/documents/20142207.78-93.pdf (accessed on 14 September 2021).
66. Weber, C.; Matthews, S. Food-Miles and the Relative Climate Impacts of Food Choices in the United States. *Environ. Sci. Technol.* **2008**, *42*, 3508–3513. [CrossRef] [PubMed]
67. Salamaliki, C.; Matsouki, N.; Drimili, E.; Vatikiotis, L.; Zervas, E. CO_2 benefits from the change of the Greek dietary habits. In Proceedings of the 1st International Conference on Environmental Design, Athens, Greece (Virtual), 24–25 October 2020.
68. NHS. Available online: https://www.nhs.uk/common-health-questions/food-and-diet/what-should-my-daily-intake-of-calories-be/ (accessed on 18 September 2021).
69. Euronews. Available online: https://www.euronews.com/2019/02/10/which-european-countries-eat-the-most-meat (accessed on 17 September 2021).
70. Our Word in Data. Available online: https://ourworldindata.org/meat-production/ (accessed on 17 September 2021).
71. Csiba, K. Overview. In *Energy Poverty Handbook*; Csiba, K., Ed.; European Union: Brussels, Belgium, 2016.
72. Energy Poverty. Available online: https://www.energypoverty.eu/publication/measuring-energy-poverty-greece (accessed on 19 September 2021).
73. Eurostat, 2019, Ageing Europe, Eurostat. Available online: https://ec.europa.eu/eurostat/web/products-statistical-books/-/KS-02-19-681 (accessed on 27 September 2021).
74. Vatikiotis, L. *Energy Poverty in Small and Medium Enterprises*; Research Texts; IME GSEVEE: Athens, Greece, 2019; p. 64.
75. Zervas, E.; Vatikiotis, L.; Gareiou, Z. Proposals for an environmental and social just transition for the post-lignite era in Western Macedonia, Greece. In Proceedings of the 2nd International Conference on Environmental Design, Athens, Greece (Virtual), 23–24 October 2021.
76. Gilg, A.; Barr, S. Behavioural Attitudes Towards Water Saving? Evidence from a Study of Environmental Actions. *Ecol. Econ.* **2006**, *57*, 400–414. [CrossRef]
77. Drimili, E.; Gareiou, Z.; Vranna, A.; Poulopoulos, S.; Zervas, E. An integrated approach to public's perception of urban water use and ownership of water companies during a period of economic crisis. Case study in Athens, Greece. *Urban Water J.* **2019**, *16*, 334–342. [CrossRef]
78. ELSTAT, 2020, Regional Accounts: Gross Value Added for the Year 2017, Press Release. Available online: https://www.statistics.gr/documents/20181/a3067d2d-82fd-703b-a600-8c2ad811885b (accessed on 29 September 2021).
79. Kathimerini. Available online: https://www.ekathimerini.com/economy/1167134/steep-hikes-in-electricity-bills/ (accessed on 18 September 2021).
80. ELSTAT. Available online: https://www.statistics.gr/en/statistics/-/publication/SEL30/- (accessed on 18 September 2021).