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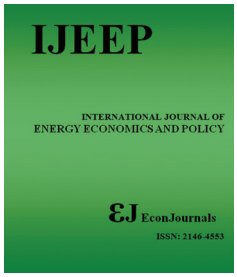

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Changing Primary Energy Consumption Due to COVID-19: The Study 20 European Economies

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ABSTRACT

With the outbreak of the coronavirus in countries around the world, governments have decided to impose restrictions and social distancing. Closures of businesses, and hence changes in supply and demand patterns during this period, have deepened concerns among policy makers. In this article, we investigate the change in primary energy consumption in the 20 European countries that have the highest GDP. To this end, 10 different shock scenarios and its limitations are considered. By implementing these shocks into input-output modelling, changes in primary energy consumption are calculated. The results show that according to the best scenario (rapid and complete economy restoration), Russia with 3.5% and Italy with 2.88% will have the largest decrease, and according to the worst case scenario (explosive exacerbation of disease and complete quarantine), Spain with 14% and Italy with 13% will have the largest reduction in energy consumption. In addition, considering the total changes in primary energy consumption of these 20 countries, according to the best scenario, it will decrease by 1.81% and according to the worst-case scenario, it will decrease by 10.46%. We discuss about possibilities that energy consumption permanently declines.

Keywords: Coronavirus, Input-output Modelling, Economy of Europe, Energy Economics
JEL Classifications: Q43, C67, D57, O13

1. INTRODUCTION

COVID-19 has become a global epidemic that has caused devastating economic effects around the world. As the first country to experience the virus, China is emerging from a state of crisis, with daily satellite data on NO_2 concentrations showing a relative improvement in economic activity in the country (Bluedorn et al., 2020). Although the state of epidemic in European countries is still worrisome, and hence the uncertainty is quite noticeable. According to Eurostat, the EU's industrial production index fell about 1.3% in the first 2 months of 2020 compared to the same period in 2019. Over the same period, the Malta industrial production index grew by about 12.9% to the highest growth rate and the Estonian index decreased by 6.23% to the lowest growth rate among the EU countries. The growth of the industrial production index during the first 2 months of 2020 has been positive for eight EU member states and negative for the remaining 19 countries. From February 2019 to February 2020 in the European Union, the production of capital goods decreased by 3.1%, energy by 1.7%, and intermediate goods by 0.2%.

According to the World Economic Forum, the world's average Effective Energy Transition index is 55.1%, the 1st time since 2015 that it has experienced negative annual growth. According to statistics, more than 55% of the world's countries surveyed in the report experienced a drop in the energy transition index. In 2020, the energy market has faced several challenges. In addition to uncertainties about the long-term consequences of COVID-19, a combination of disruptions, including a drop in global energy demand, delays or downtime in energy investments and projects, and uncertainty surrounding the employment prospects of millions of workers. With unprecedented oil price fluctuations

and subsequent geopolitical escalations, an unexpected volatility in the energy market can be seen.

Considering mentioned circumstances, we intend to examine changes in primary energy consumption in 20 major economies. For this purpose, input-output modelling is used to measure changes in energy consumption. Accommodating uncertainty conditions, ten different scenarios will be considered to reflect range of situations from complete restrictions to the complete elimination of restrictions.

In the next section, a review of theoretical literature and studies in this field will be done to examine the published works on this subject and discuss the innovations of this research. In addition, the OXCGRT index, which is used to measure the response of governments to the prevalence of COVID-19 and the application of restrictions in countries, is introduced to prepare the theoretical foundations for the construction of scenarios. In the third section, the methodology and data are presented. The fourth section describes the results for the 20 largest economies in Europe by GDP in 2019, followed by conclusions and policy implications.

2. FRAMEWORK

Epidemics and pandemics are one of the most stubborn, enduring, and deadly enemies of human history, and human society has faced many crises in the past. With COVID-19, for three billion people (more than a third of the world's 7.8 billion people), a forced quarantine has been imposed due to the spread of the coronavirus. Nonetheless, different countries have taken very different approaches: From India, which has banned people from leaving their homes for one and a half billion to US where the president has said that they must return to normal life. China has begun lifting restrictions on Wuhan and they hope to end the crisis.

2.1. Economic Impact

The failure of industries and enterprises will cause irreparable long-term damage to the economy and the population, especially the vulnerable population. The COVID-19 economic crisis began as a micro-economic problem, unlike the 2008 financial crisis. Supporting households and people in the form of existing employee-employer relationships will help to strengthen demand and maintain supply capacity by helping enterprises in situations where their performance has declined, or they have been temporarily shut down. The COVID-19 pandemic has unfavourable impact on public health, trade, tourism, food and agriculture industries, and retail sector, because of which governments, media, non-governmental organizations, health professionals, communities, and individuals are expected to have proactive approaches to address many health, social, educational, and political issues (Evans, 2020).

COVID-19 has three main channels to affect the economy (Boone et al., 2020). First, it impairs the supply of the economy by creating significant disruptions in the global supply chain, halting economic activity, and closing factories and stagnation in many of the activities of the service sector. On the other hand, because of mortality and reduction of manpower and the effect of disease on reducing the activity and productivity of the labour force, shock is created on the supply side. Consequences such as increased layoffs and unemployment are predictable results in this regard. Second, as a result of the outbreak of coronavirus, there is a significant reduction in business and tourism travel, a demand for transportation-related activities, a decrease in educational services, and a decrease in entertainment and recreational services. This change in demand is due to a change in consumer preferences due to fear and thus a change in consumption patterns. The huge result of this decline in demand is expected to be the slowdown in money supply. Third, COVID-19 will reduce investment in goods and services and delay investment-related decisions by creating uncertainty about the future of the economy. In other words, increasing global fears and uncertainty in the face of domestic and foreign investors are delaying investment decisions.

Considering the focus of this article on energy, we need to identify how we point to energy. There are different taxonomies for energy, one of which is its division into primary energy and secondary energy. Primary energy is energy that is not exposed to any conversion process. Such as crude oil extracted from oil fields or crude natural gas (untreated) from gas fields (Bhattacharyya, 2019). This type of energy can be used as input feed to industrial systems and factories, so this energy in the process is converted into more suitable forms of energy that can be used directly by the end consumer. In another definition, it is briefly stated that primary energy is a form of energy that is available in nature. In contrast, secondary energy refers to energy obtained through the process of converting primary energy. In this study, we will study the 9 primary energies:

- Natural Gas
- Coal
- Petroleum
- Nuclear Electricity
- Hydroelectric Electricity
- Geothermal Electricity
- Wind Electricity
- Solar, Tide and Wave Electricity
- Biomass and Waste Electricity.

2.2. Government Responses

Governments have taken extensive steps to combat the spread of COVID-19. Measuring the performance of governments around the world against the coronavirus greatly helps in analysing its economic impact. But this comparison requires a criterion by which policies and actions can be measured and ultimately judged. In this case, the University of Oxford (by OXCGRT) has introduced an indicator that can be used to measure a wide range of government policies (Hale et al., 2020). The authors indicate that COVID-19 stimulated a wide range of government responses to the virus and it is necessary to provide an indicator that measures responses. This indicator is called the Government Response Tracker, which provides a regular way to track governments' response to COVID-19 at any time. This index is used to describe the diversity of government responses, the effects of these responses on the level of spread, and the level of responsiveness. The common measures include school closures, travel restrictions, a ban on public gatherings, emergency investments in medical facilities, new forms of social welfare, tracking protocols and other interventions to control the spread of the virus, strengthen health

systems and manage economic consequences. The Government Response Tracker provides a systematic international and cross-cutting approach to understanding how the government is progressing during the full period of the outbreak. Data is collected from publicly available sources such as news articles, press releases and government meetings, and recorded according to a specific standard. The important point is that these indicators should not be interpreted as a criterion for the appropriateness or effectiveness of the government's response. They do not provide information on how policies are implemented, nor do they record demographic or cultural characteristics that may affect the spread of COVID-19. In addition, they are not comprehensive policy measures. In this study, we will use this indicator to represent economic shock intervals and to explain social constraints with varying degrees. Figure 1 shows the index till the end of June.

3. METHODOLOGY: INPUT-OUTPUT MODEL

In the input-output table we use in this article, the energy data is measured by the British Thermal Unit and the non-energy data is considered as dollar amount. To do this, first define the matrices required for this analysis. The Z matrix is an intermediate matrix that consists of two parts, energy carriers and non-energy materials. Total X production and total Y demand are defined in the energy input-output matrix. Matrix F also represents the sum of direct and indirect energy consumption. We now calculate the A^* matrix for the energy input-output matrix using the above definitions. In this case, we will have:

$$A^* = Z^* \left(\hat{X}^*\right)^{-1} \quad (1)$$

A matrix is a diagonal matrix in which each of the diameter elements is the total output of one of the sectors of the economy. For example, for a two-part economy, the Leontief coefficient matrix will be as follows:

$$A^* = \begin{bmatrix} \frac{Btu}{\$} & \frac{Btu}{\$} \\ \frac{\$}{Btu} & \frac{\$}{\$} \end{bmatrix}_{2\times 2} \quad (2)$$

But the properties of this matrix are different from the usual Leontief matrix. For example, the sum of each column in matrix A^* may not be <1. Direct energy consumption is the amount of energy input that each unit receives directly from the energy sector. The coefficients of direct energy consumption per unit of production can be obtained using the following equation:

$$\delta = F^*.(X^*)^{-1}.A^* \quad (3)$$

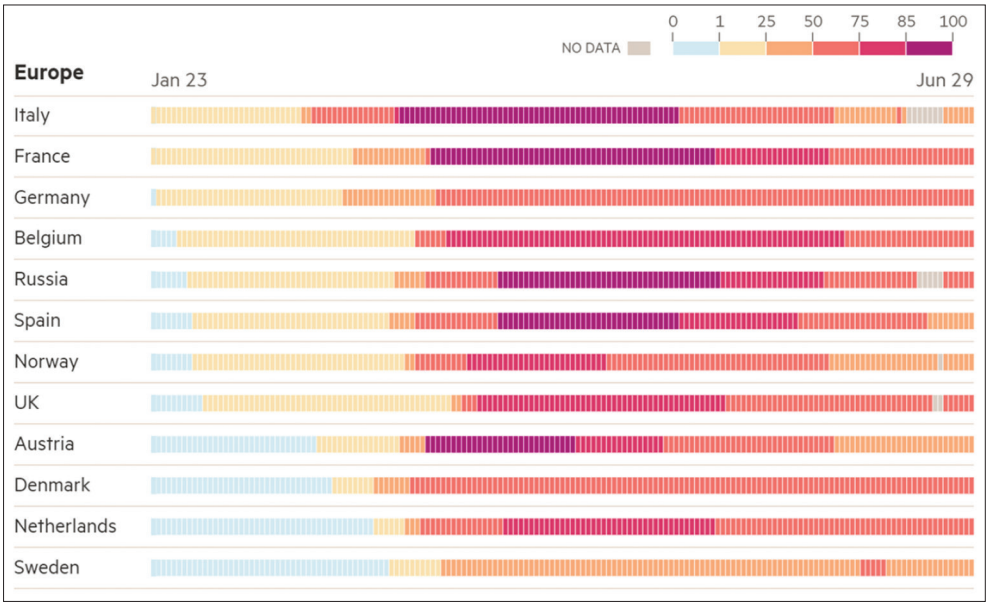
Total energy consumption coefficients, including direct and indirect uses, are:

$$\alpha = F^*.(X^*)^{-1}.(I - A^*)^{-1} \quad (4)$$

To investigate different types of energy consumption, we need to distinguish between factors that are used as inputs in the production process, such as primary energy, land and water, and factors that are produced in this process, such as pollution. This can be done by ecological-economic input-output analysis, in which environmental factors can be used as inputs and outputs. We consider a set of ecological inputs such as crude oil, gas, solar energy, wind, biomass, water, land, etc. Each element of the matrix $M=(m_{kj})$ reflects the amount of K-type environmental input that is used in the sector j.

We also consider a set of environmental products, such as the amount of air pollution caused by SO_2 and display it with a matrix $N=[n_{ik}]$. Each element of matrix N indicates the amount of ecological output type K, which is generated by the output of sector i. In this case, the table is generalized as follows (we have

Figure 1: Government Response Tracker index



Source: FT from Blavatnik School of Government, University of Oxford

assumed that the table has three sectors, two ecological inputs including oil, gas and land, and two ecological outputs):

		Transactions			Final demand	Total Production	Ecological output	
		Consumption						
		Agriculture	Mine	Industry			SO_2	HC
Production	Agriculture	a_{11}	a_{12}	a_{13}	f_1	x_1	n_{11}	n_{12}
	Mining	a_{21}	a_{22}	a_{23}	f_2	x_2	n_{21}	n_{22}
	Industry	a_{31}	a_{32}	a_{33}	f_3	x_3	n_{31}	n_{32}
Ecological goods	Oil and Gas Land	m_{11}	m_{12}	m_{13}				
		m_{21}	m_{22}	m_{23}				

Based on this table, Leontief's technical coefficient matrix can be defined:

$$A_{n\times n} = Z_{n\times n}\,\hat{X}_{n\times n}^{-1} \tag{5}$$

$Z_{n\times n}$ is the matrix of intermediate exchanges and $\hat{X}_{n\times n}$ is diagonal matrix whose diameter elements are the total production of each sector. We then define the matrix of the coefficients of ecological inputs. The matrix of ecological input coefficients $R=[r_{kj}]$ is the amount of ecological good k used for each dollar of production in sector j.

$$R_{k\times n} = M_{k\times n}(\hat{X}_{n\times n})^{-1} \tag{6}$$

In this example, the matrix $M_{2\times 3}$ shows the exchanges between the two ecological goods of land and oil and gas with the sectors of industry, agriculture and mining. The matrix of ecological coefficients is also defined by the same method. The elements of matrix $Q=[q_{kj}]$ (ecological output) represent the ecological output k, which is produced for one dollar of the output in sector j.

$$Q_{k\times n} = N'_{k\times n}(\hat{X}_{n\times n})^{-1} \tag{7}$$

In this case, the matrix $N_{n\times k}$ is the final output of the ecological goods that each sector of the economy produces. The matrix of the coefficients of the total inputs and outputs of the ecological goods is then calculated as a function of the final demand. First, we express the matrix of coefficients of total input effects:

$$Q^*_{k\times n} = Q_{k\times n}(I-A)_{n\times n}^{-1} \tag{8}$$

$$R^*_{k\times n} = R_{k\times n}(I-A_{n\times n})^{-1} \tag{9}$$

Matrix elements $Q^*=[q_{ij}]$ indicate the amount of pollution of the type i that is produced directly and indirectly for the supply of one dollar of the final demand of sector j. r^*_{ij} also as the element of matrix $R^*_{2\times 3}$ indicate how much direct and indirect ecological input is needed to produce 1 dollar of final demand in sector j (Miller and Blair, 2009).

Because of the social constraints imposed, it is necessary to consider changes in production, relationships between sectors, and the resulting shock. Total changes in production and relationships between sectors are modeled through the Partial Hypothetical Extraction Method (Ciaschini, 1988; Mahajan et al., 2018; Tan et al., 2018; Ten Raa, 2006, 2017).

3.1. Partial Hypothetical Extraction Method

To study the effect of shocks, one can partially extract a sector rather than completely extract, because there are three possible advantages to the partial hypothetical extraction: first, it is assumed that just α part of intermediate supply have removed to be more consistent with what is happening in the reality of economics. Second, there is no absolute emphasis on the intermediate matrix (quadrant I) but instead the value-added vector and its variations are considered. Third, there is no need to necessarily reduce the α percent of one sector's data, but it can be also assumed to increase the α percent in other sectors for a variety of reasons, such as natural factors, mining and reservoir exploration, economic policymaking (an example of a positive shock: following the outbreak of COVID-19, the supply of medical services has increased in many countries). Finally, since there is no complete extraction, the intermediate exchange matrix will not be smaller. Considering the mentioned points, Dietzenbacher and Lahr (2013) used the partial hypothetical extraction method to analyze the effects of capacity constraints, for example products previously made by one sector are no longer in demand or it is provided by suppliers from outside the local economy, such as imports. As the output of x_k decreases, the intermediate inputs used in activity k, z_{ik} (for all i), decrease by the same percentage. As a result, the k-column of direct needs matrix A remain unchanged. In this case we will have:

$$\bar{a}_{ik} = \frac{\bar{z}_{ik}}{\bar{x}_k} = \frac{(1-a)z_{ik}}{(1-a)x_k} = a_{ik} \qquad i = 1.2.\ldots.n \tag{10}$$

$$\bar{a}_{kj} = \frac{\bar{z}_{kj}}{\bar{x}_j} = \frac{(1-a)z_{kj}}{(1-a)x_j} = a_{kj} \tag{11}$$

According to (Henderson and Searle, 1981), it implies that:

$$\bar{L} = L + \frac{aLe_k\, b_k'\, L}{1+ab_k'\, L\, e_k} \tag{12}$$

$$\bar{x} - x = (\bar{L} - L)f \tag{13}$$

$$\bar{f}_k = (1-a)f_k \tag{14}$$

$$\bar{x} - x = (\bar{L} - L)\bar{f} \tag{15}$$

From the policy point of view, criteria such as employment and value-added can be taken into consideration. The value-added criterion is of interest to economists because it can be a good measure of the degree of economic prosperity in society. The well-being of individuals in society can be determined by how much they consume. Individual consumption is a function of their disposable income, and disposable income is also within GDP. According to what Dietzenbacher and Lahr (2013) have calculated, we will have to calculate total value-added changes:

$$\overline{VA} - VA = \sum_i v_i(\bar{x}_i - x_i) = -\tilde{\lambda}_k \sum v_i l_{ik} = -\tilde{\lambda}_k \mu_k \tag{16}$$

v_i represents the value-added coefficient, which is calculated as the ratio of the value-added of segment i to the output of that segment. Incremental coefficients of value-added are defined as $\mu' = v'L$ where μ_i represents the effects and consequences of increasing a final demand unit of sector i directly and indirectly on total value-added. Therefore,

to calculate total surplus value in all segments, the relationship $VA=\mu\times=\mu LF$ can be used (Dietzenbacher and Lahr, 2013).

3.2. Data and Scenarios

We need to quantify the shock scenarios. The research conducted by Duan et al. (2020) was used to initialize the scenarios of this study, which is reported based on registered factual supply and demand data in China. We use OXCGRT data set to transform China Shock to the one for each of 20 countries based on difference between OXCGRT indices of China and that country in 5 months of January-May. With this strategy, we estimate shock scenarios for each country based on real data. The present study uses the technical coefficients matrices generated in 2015 according to Eora26 guideline. This guideline was proposed in Lenzen et al. (2012). Also, for linking the input-output with different types of primary energies, multiplier coefficients of 9 primary energy consumption and energy footprint of KGM and Associates Institute were used (Table 1).

Input-Output tables of this study have been divided into 26 sectors, described in Table 2.

Since the current situation of the countries due to COVID-19 prevalence and related limitations is in uncertainty, we will examine 10 different scenarios in this article and model the state of energy consumption in each case. These ten scenarios are:

- Scenario 1: Complete improvement in July and cessation of all restrictions until the end of the year
- Scenario 2: Gradual improvement of the disease and removal of bans and restrictions gradually to zero by the end of the year
- Scenario 3: Gradual reduction of the epidemic by the end of the year, but the persistence of the disease and some limitations at a low level
- Scenario 4: Reduction of the epidemic from June and its peak twice in the beginning of autumn (if the second wave is weaker than March to May)
- Scenario 5: Reduction of the epidemic from June and its peak twice in the beginning of autumn (if the second wave is like from March to May)
- Scenario 6: Reduction of the epidemic from June and its peak twice in the beginning of autumn (if the second wave is more severe than March to May)
- Scenario 7: Continuation of restrictions until the end of the year as March to May
- Scenario 8: Gradual progress of the epidemic and the application of gradual restrictions
- Scenario 9: Epidemic progress so that it grows until October and then full quarantine is applied
- Scenario 10: Epidemic bounds (complete quarantine from June to the end of the year).

It should be noted that there are two important assumptions. We assume that from 2015 to the present, the production technologies have not changed (in other words, the technical coefficients of the sectors are the same from 2015 to the present). In addition, it is assumed that with respect to COVID-19 and government decisions, the intensification of the epidemic and social constraints/prohibition are positively correlated. The effect of temperature has not been also considered.

Table 1: 20 European countries studied that had the largest economies (GDP) in 2019

Country	Abbreviation	Country	Abbreviation
Austria	AUT	Norway	NOR
Belgium	BEL	Poland	POL
Czech Republic	CZE	Portugal	PRT
Denmark	DNK	Romania	ROU
Finland	FIN	Russia	RUS
France	FRA	Spain	ESP
Germany	DEU	Sweden	SWE
Ireland	IRL	Switzerland	CHE
Italy	ITA	Turkey	TUR
Netherlands	NLD	United Kingdom	GBR

4. RESULTS AND DISCUSSIONS

The average estimates of OPEC, the International Energy Agency and the US Energy Information Administration for global oil demand growth in 2018 were 1.3 million barrels per day and in 2019, equivalent to 700,000 barrels per day. At the beginning of 2020, it was estimated that the growth rate of demand in 2020 would reach 1.2 million barrels per day, but the prevalence and spread of COVID-19 led to some changes in the estimates. The OPEC and International Energy Agency indicated in April 2020 that energy demand declines sharply and unprecedentedly by the end of 2020, dropping an average of 7.1 million barrels per day. Since 60% of the world's oil production is spent on transportation,

Table 2: Sectors of aggregated input-output tables

Sector	Code	Sector	Code
Agriculture	Sector 1	Construction	Sector 14
Fishing	Sector 2	Maintenance and Repair	Sector 15
Mining and Quarrying	Sector 3	Wholesale Trade	Sector 16
Food and Beverages	Sector 4	Retail Trade	Sector 17
Textiles and Wearing Apparel	Sector 5	Hotels and Restaurants	Sector 18
Wood and Paper	Sector 6	Transport	Sector 19
Petroleum, Chemical and Non-Metallic Mineral Products	Sector 7	Post and Telecommunications	Sector 20
Metal Products	Sector 8	Financial Intermediation and Business Activities	Sector 21
Electrical and Machinery	Sector 9	Public Administration	Sector 22
Transport Equipment	Sector 10	Education, Health and Other Services	Sector 23
Other Manufacturing	Sector 11	Private Households	Sector 24
Recycling	Sector 12	Others	Sector 25
Electricity, Gas and Water	Sector 13	Re-export and Re-import	Sector 26

and because most countries have adopted quarantine and travel restrictions, fuel demand in the transportation sector has declined sharply. This part of decline will be mitigated after lockdown, but the return on demand in the industrial sector will take more time and will depend on their economic situation after the Corona crisis. In this article, an attempt has been made to consider the restrictions and prohibitions in the 1st months of 2020 to evaluate the situation of the coming months, based on 10 scenarios and for 26 sectors.

Tables 3-22 show the change in the consumption of different types of primary energy in 20 European countries. Table 23 and Figure 2 show the aggregate change for all countries. In Figures 3-11, you can see the state of energy consumption change in the 20 countries under 10 scenarios. As shown in these charts, in the biomass and waste electricity consumption, the largest decrease in consumption according to the optimistic scenario (scenario one) is for Russia with −4.26% and in the pessimistic scenario (scenario ten) is for Spain with −15.49%. According to the optimistic scenario, Russia has the highest decrease in coal consumption with −3.36% and Spain with −14.62% in the pessimistic scenario. In the geothermal electricity consumption, the largest decrease in consumption according to the optimistic and pessimistic scenario is for Italy with −2.84% and −13.94% respectively. In the hydroelectric electricity consumption, the largest reduction in consumption according to the optimistic and pessimistic scenario is for France with −4.72% and −17.79% respectively. In the Natural Gas consumption, the largest decrease in consumption according to the optimistic scenario is for Russia with −3.31% and in the pessimistic scenario for Italy

Table 3: Changing the consumption of different types of primary energy in Austria (10 scenarios)

Primary energies	Scenario 1 (%)	Scenario 2 (%)	Scenario 3 (%)	Scenario 4 (%)	Scenario 5 (%)	Scenario 6 (%)	Scenario 7 (%)	Scenario 8 (%)	Scenario 9 (%)	Scenario 10 (%)
Natural Gas	−0.54	−0.83	−1.08	−1.30	−1.69	−2.62	−1.90	−4.09	−5.79	−10.57
Coal	−0.15	−0.29	−0.39	−0.47	−0.61	−0.94	−0.68	−1.44	−2.03	−3.64
Petroleum	−0.69	−1.03	−1.32	−1.60	−2.06	−3.19	−2.32	−4.97	−7.02	−12.78
Nuclear Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydroelectric Electricity	−0.55	−0.85	−1.10	−1.34	−1.74	−2.72	−1.95	−4.28	−6.09	−11.13
Geothermal Electricity	−0.63	−0.94	−1.21	−1.46	−1.90	−2.96	−2.13	−4.64	−6.58	−12.03
Wind Electricity	−0.55	−0.85	−1.10	−1.34	−1.74	−2.72	−1.95	−4.28	−6.09	−11.13
Solar, Tide and Wave Electricity	−0.80	−1.16	−1.47	−1.78	−2.30	−3.57	−2.59	−5.58	−7.89	−14.39
Biomass and Waste Electricity	−0.56	−0.90	−1.17	−1.42	−1.84	−2.86	−2.07	−4.48	−6.35	−11.60
Total Primary Energy	−0.57	−0.88	−1.13	−1.37	−1.77	−2.75	−1.99	−4.29	−6.07	−11.07

Table 4: Changing the consumption of different types of primary energy in Belgium (10 scenarios)

Primary Energies	Scenario 1 (%)	Scenario 2 (%)	Scenario 3 (%)	Scenario 4 (%)	Scenario 5 (%)	Scenario 6 (%)	Scenario 7 (%)	Scenario 8 (%)	Scenario 9 (%)	Scenario 10 (%)
Natural Gas	−0.29	−0.50	−0.67	−0.76	−0.94	−2.16	−1.07	−2.64	−3.13	−4.78
Coal	−0.50	−0.83	−1.10	−1.24	−1.54	−3.62	−1.76	−4.43	−5.27	−8.11
Petroleum	−1.03	−1.61	−2.10	−2.37	−2.93	−6.74	−3.33	−8.21	−9.73	−14.79
Nuclear Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydroelectric Electricity	−0.55	−0.90	−1.20	−1.35	−1.67	−3.94	−1.91	−4.83	−5.75	−8.85
Geothermal Electricity	−0.55	−0.90	−1.20	−1.35	−1.67	−3.94	−1.91	−4.83	−5.75	−8.85
Wind Electricity	−0.55	−0.90	−1.20	−1.35	−1.67	−3.94	−1.91	−4.83	−5.75	−8.85
Solar, Tide and Wave Electricity	−0.55	−0.87	−1.15	−1.29	−1.60	−3.74	−1.83	−4.57	−5.43	−8.34
Biomass and Waste Electricity	−0.51	−0.86	−1.15	−1.30	−1.60	−3.64	−1.81	−4.45	−5.27	−8.03
Total Primary Energy	−0.63	−1.02	−1.35	−1.52	−1.88	−4.35	−2.14	−5.31	−6.30	−9.63

Table 5: Changing the consumption of different types of primary energy in Czech Republic (10 scenarios)

Primary Energies	Scenario 1 (%)	Scenario 2 (%)	Scenario 3 (%)	Scenario 4 (%)	Scenario 5 (%)	Scenario 6 (%)	Scenario 7 (%)	Scenario 8 (%)	Scenario 9 (%)	Scenario 10 (%)
Natural Gas	−0.30	−0.47	−0.62	−0.71	−0.96	−1.42	−1.08	−2.32	−3.28	−5.97
Coal	−0.44	−0.71	−0.93	−1.08	−1.45	−2.14	−1.63	−3.50	−4.94	−8.99
Petroleum	−0.39	−0.63	−0.82	−0.95	−1.28	−1.89	−1.44	−3.09	−4.37	−7.95
Nuclear Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydroelectric Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Geothermal Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wind Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Solar, Tide and Wave Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Biomass and Waste Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Primary Energy	−0.39	−0.63	−0.82	−0.95	−1.28	−1.90	−1.44	−3.09	−4.37	−7.95

Table 6: Changing the consumption of different types of primary energy in Denmark (10 scenarios)

Primary Energies	Scenario 1 (%)	Scenario 2 (%)	Scenario 3 (%)	Scenario 4 (%)	Scenario 5 (%)	Scenario 6 (%)	Scenario 7 (%)	Scenario 8 (%)	Scenario 9 (%)	Scenario 10 (%)
Natural Gas	−0.83	−1.17	−1.45	−1.72	−2.42	−3.53	−2.31	−4.75	−5.57	−8.36
Coal	−0.87	−1.23	−1.53	−1.81	−2.57	−3.76	−2.45	−5.07	−5.96	−8.95
Petroleum	−0.72	−1.03	−1.28	−1.51	−2.11	−3.04	−2.02	−4.06	−4.75	−6.99
Nuclear Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydroelectric Electricity	−0.87	−1.23	−1.53	−1.82	−2.57	−3.75	−2.45	−5.06	−5.94	−8.91
Geothermal Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wind Electricity	−0.91	−1.28	−1.60	−1.90	−2.69	−3.94	−2.56	−5.31	−6.25	−9.40
Solar, Tide and Wave Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Biomass and Waste Electricity	−0.84	−1.20	−1.50	−1.77	−2.51	−3.67	−2.39	−4.95	−5.82	−8.74
Total Primary Energy	−0.79	−1.12	−1.39	−1.65	−2.32	−3.37	−2.22	−4.53	−5.31	−7.91

Table 7: Changing the consumption of different types of primary energy in Finland (10 scenarios)

Primary Energies	Scenario 1 (%)	Scenario 2 (%)	Scenario 3 (%)	Scenario 4 (%)	Scenario 5 (%)	Scenario 6 (%)	Scenario 7 (%)	Scenario 8 (%)	Scenario 9 (%)	Scenario 10 (%)
Natural Gas	−0.20	−0.56	−0.73	−0.93	−1.20	−1.72	−1.45	−3.19	−4.60	−8.66
Coal	−0.27	−0.63	−0.80	−1.02	−1.31	−1.87	−1.58	−3.45	−4.96	−9.31
Petroleum	−0.56	−0.88	−1.03	−1.29	−1.64	−2.30	−1.97	−4.15	−5.92	−10.99
Nuclear Electricity	−0.33	−0.76	−0.97	−1.23	−1.58	−2.27	−1.91	−4.21	−6.08	−11.42
Hydroelectric Electricity	−0.33	−0.76	−0.97	−1.23	−1.58	−2.27	−1.91	−4.21	−6.08	−11.42
Geothermal Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wind Electricity	−0.33	−0.76	−0.97	−1.23	−1.58	−2.27	−1.91	−4.21	−6.08	−11.42
Solar, Tide and Wave Electricity	−0.32	−0.55	−0.67	−0.84	−1.07	−1.51	−1.29	−2.77	−3.98	−7.46
Biomass and Waste Electricity	−0.15	−0.54	−0.73	−0.93	−1.20	−1.72	−1.45	−3.22	−4.65	−8.79
Total Primary Energy	−0.31	−0.69	−0.87	−1.10	−1.41	−2.01	−1.70	−3.70	−5.32	−9.98

Table 8: Changing the consumption of different types of primary energy in France (10 scenarios)

Primary Energies	Scenario 1 (%)	Scenario 2 (%)	Scenario 3 (%)	Scenario 4 (%)	Scenario 5 (%)	Scenario 6 (%)	Scenario 7 (%)	Scenario 8 (%)	Scenario 9 (%)	Scenario 10 (%)
Natural Gas	−2.14	−2.87	−3.01	−3.71	−5.48	−6.15	−5.46	−7.44	−7.95	−8.97
Coal	−2.14	−2.86	−3.00	−3.70	−5.46	−6.13	−5.44	−7.41	−7.92	−8.93
Petroleum	−2.14	−2.87	−3.01	−3.72	−5.48	−6.15	−5.46	−7.45	−7.96	−8.97
Nuclear Electricity	−1.98	−2.69	−2.82	−3.48	−5.15	−5.78	−5.13	−6.99	−7.48	−8.43
Hydroelectric Electricity	−4.72	−5.91	−6.12	−7.56	−10.99	−12.30	−10.96	−14.83	−15.82	−17.79
Geothermal Electricity	−2.14	−2.87	−3.01	−3.71	−5.48	−6.14	−5.46	−7.44	−7.95	−8.96
Wind Electricity	−1.91	−2.64	−2.78	−3.43	−5.10	−5.73	−5.08	−6.95	−7.44	−8.40
Solar, Tide and Wave Electricity	−1.95	−2.63	−2.75	−3.40	−5.01	−5.63	−5.00	−6.81	−7.28	−8.20
Biomass and Waste Electricity	−2.14	−2.87	−3.01	−3.71	−5.48	−6.15	−5.46	−7.44	−7.95	−8.97
Total Primary Energy	−2.15	−2.88	−3.02	−3.73	−5.50	−6.17	−5.48	−7.47	−7.99	−9.00

Table 9: Changing the consumption of different types of primary energy in Germany (10 scenarios)

Primary Energies	Scenario 1 (%)	Scenario 2 (%)	Scenario 3 (%)	Scenario 4 (%)	Scenario 5 (%)	Scenario 6 (%)	Scenario 7 (%)	Scenario 8 (%)	Scenario 9 (%)	Scenario 10 (%)
Natural Gas	−0.34	−0.59	−0.76	−0.88	−1.18	−1.68	−1.39	−2.94	−4.03	−7.30
Coal	−0.36	−0.65	−0.84	−0.98	−1.32	−1.89	−1.56	−3.33	−4.58	−8.32
Petroleum	−0.80	−1.22	−1.50	−1.74	−2.33	−3.28	−2.73	−5.67	−7.72	−13.69
Nuclear Electricity	−0.44	−0.76	−0.98	−1.13	−1.54	−2.20	−1.82	−3.89	−5.37	−9.80
Hydroelectric Electricity	−0.44	−0.76	−0.98	−1.13	−1.54	−2.20	−1.82	−3.89	−5.37	−9.80
Geothermal Electricity	−0.37	−0.61	−0.77	−0.89	−1.20	−1.72	−1.42	−3.02	−4.17	−7.61
Wind Electricity	−0.44	−0.76	−0.98	−1.13	−1.54	−2.20	−1.82	−3.89	−5.37	−9.80
Solar, Tide and Wave Electricity	−0.43	−0.73	−0.94	−1.09	−1.47	−2.10	−1.74	−3.71	−5.12	−9.34
Biomass and Waste Electricity	−0.44	−0.78	−1.00	−1.16	−1.57	−2.23	−1.85	−3.93	−5.41	−9.80
Total Primary Energy	−0.51	−0.84	−1.06	−1.23	−1.65	−2.35	−1.95	−4.09	−5.61	−10.08

Table 10: Changing the consumption of different types of primary energy in Ireland (10 scenarios)

Primary Energies	Scenario 1 (%)	Scenario 2 (%)	Scenario 3 (%)	Scenario 4 (%)	Scenario 5 (%)	Scenario 6 (%)	Scenario 7 (%)	Scenario 8 (%)	Scenario 9 (%)	Scenario 10 (%)
Natural Gas	−1.35	−1.97	−2.48	−2.59	−3.41	−5.30	−4.11	−6.38	−9.81	−10.48
Coal	−1.48	−2.14	−2.69	−2.81	−3.69	−5.75	−4.45	−6.91	−10.62	−11.35
Petroleum	−1.52	−2.25	−2.83	−2.96	−3.88	−6.06	−4.69	−7.29	−11.25	−12.02
Nuclear Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydroelectric Electricity	−1.61	−2.33	−2.93	−3.06	−4.02	−6.27	−4.85	−7.54	−11.59	−12.38
Geothermal Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wind Electricity	−1.61	−2.33	−2.93	−3.06	−4.02	−6.27	−4.85	−7.54	−11.59	−12.38
Solar, Tide and Wave Electricity	−1.05	−1.54	−1.93	−2.02	−2.65	−4.13	−3.20	−4.97	−7.65	−8.17
Biomass and Waste Electricity	−1.28	−1.91	−2.41	−2.52	−3.31	−5.15	−3.99	−6.19	−9.50	−10.15
Total Primary Energy	−1.44	−2.12	−2.67	−2.79	−3.67	−5.72	−4.42	−6.87	−10.59	−11.32

Table 11: Changing the consumption of different types of primary energy in Italy (10 scenarios)

Primary Energies	Scenario 1 (%)	Scenario 2 (%)	Scenario 3 (%)	Scenario 4 (%)	Scenario 5 (%)	Scenario 6 (%)	Scenario 7 (%)	Scenario 8 (%)	Scenario 9 (%)	Scenario 10 (%)
Natural Gas	−2.57	−2.96	−3.16	−4.36	−6.08	−7.44	−5.77	−6.67	−8.13	−12.54
Coal	−2.35	−2.73	−2.92	−4.03	−5.63	−6.88	−5.34	−6.17	−7.52	−11.60
Petroleum	−3.32	−3.83	−4.08	−5.62	−7.82	−9.54	−7.43	−8.56	−10.41	−15.96
Nuclear Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydroelectric Electricity	−2.82	−3.26	−3.49	−4.81	−6.72	−8.22	−6.38	−7.37	−8.98	−13.85
Geothermal Electricity	−2.84	−3.29	−3.51	−4.84	−6.77	−8.28	−6.42	−7.42	−9.04	−13.94
Wind Electricity	−2.82	−3.26	−3.49	−4.81	−6.72	−8.22	−6.38	−7.37	−8.98	−13.85
Solar, Tide and Wave Electricity	−2.79	−3.22	−3.44	−4.74	−6.63	−8.11	−6.29	−7.27	−8.86	−13.67
Biomass and Waste Electricity	−3.14	−3.62	−3.86	−5.32	−7.43	−9.09	−7.05	−8.15	−9.93	−15.32
Total primary energy	−2.88	−3.32	−3.55	−4.89	−6.82	−8.33	−6.47	−7.47	−9.10	−14.00

Table 12: Changing the consumption of different types of primary energy in Netherlands (10 scenarios)

Primary Energies	Scenario 1 (%)	Scenario 2 (%)	Scenario 3 (%)	Scenario 4 (%)	Scenario 5 (%)	Scenario 6 (%)	Scenario 7 (%)	Scenario 8 (%)	Scenario 9 (%)	Scenario 10 (%)
Natural Gas	−0.75	−1.16	−1.20	−1.48	−2.04	−3.20	−2.48	−3.86	−5.55	−6.39
Coal	−0.64	−1.03	−1.07	−1.31	−1.81	−2.84	−2.21	−3.43	−4.93	−5.67
Petroleum	−0.91	−1.39	−1.43	−1.76	−2.41	−3.76	−2.93	−4.53	−6.50	−7.47
Nuclear Electricity	−1.01	−1.58	−1.63	−2.01	−2.78	−4.39	−3.39	−5.29	−7.66	−8.82
Hydroelectric Electricity	−1.01	−1.58	−1.63	−2.01	−2.78	−4.39	−3.39	−5.29	−7.66	−8.82
Geothermal Electricity	−0.44	−0.63	−0.66	−0.81	−1.12	−1.77	−1.37	−2.14	−3.09	−3.57
Wind Electricity	−1.01	−1.58	−1.63	−2.01	−2.78	−4.39	−3.39	−5.29	−7.66	−8.82
Solar, Tide and Wave Electricity	−0.92	−1.41	−1.45	−1.79	−2.47	−3.88	−3.00	−4.68	−6.76	−7.79
Biomass and Waste Electricity	−1.16	−1.78	−1.84	−2.26	−3.13	−4.94	−3.82	−5.96	−8.62	−9.94
Total Primary Energy	−0.82	−1.28	−1.32	−1.62	−2.23	−3.49	−2.71	−4.20	−6.05	−6.96

Table 13: Changing the consumption of different types of primary energy in Norway (10 scenarios)

Primary Energies	Scenario 1 (%)	Scenario 2 (%)	Scenario 3 (%)	Scenario 4 (%)	Scenario 5 (%)	Scenario 6 (%)	Scenario 7 (%)	Scenario 8 (%)	Scenario 9 (%)	Scenario 10 (%)
Natural Gas	−1.00	−1.26	−1.51	−1.78	−2.39	−3.63	−2.27	−5.17	−6.12	−9.45
Coal	−0.19	−0.33	−0.43	−0.51	−0.67	−0.99	−0.64	−1.40	−1.63	−2.42
Petroleum	−1.43	−1.96	−2.43	−2.86	−3.82	−5.70	−3.63	−8.04	−9.43	−14.07
Nuclear Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydroelectric Electricity	−0.62	−0.93	−1.18	−1.39	−1.89	−2.89	−1.79	−4.13	−4.89	−7.46
Geothermal Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wind Electricity	−0.62	−0.93	−1.18	−1.39	−1.89	−2.89	−1.79	−4.13	−4.89	−7.46
Solar, Tide and Wave Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Biomass and Waste Electricity	−0.69	−1.06	−1.36	−1.61	−2.17	−3.30	−2.06	−4.71	−5.55	−8.42
Total Primary Energy	−0.93	−1.31	−1.64	−1.94	−2.60	−3.92	−2.47	−5.57	−6.56	−9.88

Table 14: Changing the consumption of different types of primary energy in Poland (10 scenarios)

Primary Energies	Scenario 1 (%)	Scenario 2 (%)	Scenario 3 (%)	Scenario 4 (%)	Scenario 5 (%)	Scenario 6 (%)	Scenario 7 (%)	Scenario 8 (%)	Scenario 9 (%)	Scenario 10 (%)
Natural Gas	−1.13	−1.70	−2.14	−2.28	−3.03	−4.61	−3.56	−5.44	−8.33	−8.90
Coal	−1.19	−1.86	−2.37	−2.52	−3.37	−5.18	−3.98	−6.12	−9.44	−10.09
Petroleum	−2.19	−3.23	−4.05	−4.31	−5.71	−8.66	−6.70	−10.19	−15.49	−16.52
Nuclear Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydroelectric Electricity	−1.30	−2.05	−2.62	−2.78	−3.73	−5.76	−4.41	−6.80	−10.51	−11.24
Geothermal Electricity	−1.37	−2.02	−2.54	−2.70	−3.59	−5.48	−4.22	−6.47	−9.94	−10.62
Wind Electricity	−1.30	−2.05	−2.62	−2.78	−3.73	−5.76	−4.41	−6.80	−10.51	−11.24
Solar, Tide and Wave Electricity	−1.41	−2.07	−2.59	−−2.76	−3.67	−5.60	−4.31	−6.61	−10.16	−10.85
Biomass and Waste Electricity	−1.31	−2.03	−2.57	−2.73	−3.64	−5.57	−4.29	−6.57	−10.10	−10.78
Total Primary Energy	−1.45	−2.20	−2.79	−2.96	−3.95	−6.03	−4.65	−7.11	−10.91	−11.64

Table 15: Changing the consumption of different types of primary energy in Portugal (10 scenarios)

Primary Energies	Scenario 1 (%)	Scenario 2 (%)	Scenario 3 (%)	Scenario 4 (%)	Scenario 5 (%)	Scenario 6 (%)	Scenario 7 (%)	Scenario 8 (%)	Scenario 9 (%)	Scenario 10 (%)
Natural Gas	−1.32	−1.99	−2.05	−2.44	−3.57	−5.45	−4.17	−6.43	−8.52	−10.54
Coal	−1.63	−2.45	−2.52	−3.00	−4.40	−6.75	−5.15	−7.96	−10.54	−13.05
Petroleum	−1.85	−2.71	−2.77	−3.30	−4.80	−7.29	−5.60	−8.59	−11.34	−14.01
Nuclear Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydroelectric Electricity	−1.64	−2.47	−2.54	−3.02	−4.42	−6.79	−5.18	−8.00	−10.60	−13.13
Geothermal Electricity	−1.66	−2.49	−2.55	−3.04	−4.46	−6.83	−5.22	−8.06	−10.67	−13.21
Wind Electricity	−1.64	−2.47	−2.54	−3.02	−4.42	−6.79	−5.18	−8.00	−10.60	−13.13
Solar, Tide and Wave Electricity	−1.64	−2.37	−2.42	−2.88	−4.19	−6.40	−4.91	−7.55	−9.99	−12.36
Biomass and Waste Electricity	−1.04	−1.70	−1.76	−2.09	−3.06	−4.69	−3.59	−5.54	−7.34	−9.09
Total Primary Energy	−1.59	−2.38	−2.44	−2.91	−4.24	−6.47	−4.95	−7.62	−10.08	−12.46

Table 16: Changing the consumption of different types of primary energy in Romania (10 scenarios)

Primary Energies	Scenario 1 (%)	Scenario 2 (%)	Scenario 3 (%)	Scenario 4 (%)	Scenario 5 (%)	Scenario 6 (%)	Scenario 7 (%)	Scenario 8 (%)	Scenario 9 (%)	Scenario 10 (%)
Natural Gas	−1.03	−1.58	−1.73	−2.21	−2.89	−4.48	−3.38	−5.00	−7.13	−8.17
Coal	−1.55	−2.39	−2.63	−3.35	−4.41	−6.87	−5.17	−7.66	−10.94	−12.53
Petroleum	−1.64	−2.42	−2.64	−3.36	−4.39	−6.81	−5.13	−7.59	−10.83	−12.42
Nuclear Electricity	−1.67	−2.58	−2.84	−3.61	−4.75	−7.40	−5.57	−8.25	−11.79	−13.50
Hydroelectric Electricity	−1.67	−2.58	−2.84	−3.61	−4.75	−7.40	−5.57	−8.25	−11.79	−13.50
Geothermal Electricity	−1.19	−1.73	−1.89	−2.40	−3.15	−4.89	−3.69	−5.46	−7.81	−8.96
Wind Electricity	−1.67	−2.58	−2.84	−3.61	−4.75	−7.40	−5.57	−8.25	−11.79	−13.50
Solar, Tide and Wave Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Biomass and Waste Electricity	−1.18	−1.76	−1.92	−2.44	−3.20	−4.96	−3.74	−5.54	−7.91	−9.08
Total Primary Energy	−1.39	−2.11	−2.31	−2.94	−3.86	−6.00	−4.52	−6.69	−9.56	−10.95

Table 17: Changing the consumption of different types of primary energy in Russia (10 scenarios)

Primary Energies	Scenario 1 (%)	Scenario 2 (%)	Scenario 3 (%)	Scenario 4 (%)	Scenario 5 (%)	Scenario 6 (%)	Scenario 7 (%)	Scenario 8 (%)	Scenario 9 (%)	Scenario 10 (%)
Natural Gas	−3.31	−4.25	−4.43	−5.17	−7.10	−6.84	−7.35	−10.85	−11.51	−12.16
Coal	−2.47	−3.27	−3.42	−4.02	−5.59	−5.37	−5.78	−8.63	−9.16	−9.69
Petroleum	−4.95	−6.14	−6.36	−7.33	−9.87	−9.53	−10.19	−14.77	−15.62	−16.46
Nuclear Electricity	−2.49	−3.40	−3.58	−4.26	−6.06	−5.81	−6.28	−9.52	−10.13	−10.73
Hydroelectric Electricity	−2.49	−3.40	−3.58	−4.26	−6.06	−5.81	−6.28	−9.52	−10.13	−10.73
Geothermal Electricity	−2.49	−3.40	−3.58	−4.26	−6.06	−5.81	−6.28	−9.52	−10.13	−10.73
Wind Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Solar, Tide and Wave Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Biomass and Waste Electricity	−4.26	−5.09	−5.25	−5.91	−7.69	−7.45	−7.92	−11.21	−11.83	−12.44
Total Primary Energy	−3.46	−4.43	−4.61	−5.37	−7.36	−7.09	−7.61	−11.21	−11.89	−12.55

Table 18: Changing the consumption of different types of primary energy in Spain (10 scenarios)

Primary Energies	Scenario 1 (%)	Scenario 2 (%)	Scenario 3 (%)	Scenario 4 (%)	Scenario 5 (%)	Scenario 6 (%)	Scenario 7 (%)	Scenario 8 (%)	Scenario 9 (%)	Scenario 10 (%)
Natural Gas	−1.55	−2.27	−2.47	−3.14	−4.09	−6.32	−4.78	−7.04	−10.02	−11.48
Coal	−1.67	−2.48	−2.70	−3.43	−4.48	−6.92	−5.23	−7.71	−10.98	−12.57
Petroleum	−2.31	−3.33	−3.61	−4.57	−5.94	−9.09	−6.91	−10.11	−14.26	−16.27
Nuclear Electricity	−1.85	−2.72	−2.97	−3.77	−4.93	−7.63	−5.77	−8.50	−12.11	−13.86
Hydroelectric Electricity	−1.85	−2.72	−2.97	−3.77	−4.93	−7.63	−5.77	−8.50	−12.11	−13.86
Geothermal Electricity	−1.72	−2.38	−2.56	−3.25	−4.23	−6.50	−4.93	−7.26	−10.32	−11.83
Wind Electricity	−1.85	−2.72	−2.97	−3.77	−4.93	−7.63	−5.77	−8.50	−12.11	−13.86
Solar, Tide and Wave Electricity	−1.83	−2.68	−2.92	−3.70	−4.84	−7.49	−5.66	−8.35	−11.88	−13.61
Biomass and Waste Electricity	−2.14	−3.10	−3.37	−4.27	−5.56	−8.57	−6.49	−9.54	−13.55	−15.49
Total Primary Energy	−1.98	−2.88	−3.13	−3.96	−5.16	−7.94	−6.02	−8.84	−12.53	−14.31

Table 19: Changing the consumption of different types of primary energy in Sweden (10 scenarios)

Primary Energies	Scenario 1 (%)	Scenario 2 (%)	Scenario 3 (%)	Scenario 4 (%)	Scenario 5 (%)	Scenario 6 (%)	Scenario 7 (%)	Scenario 8 (%)	Scenario 9 (%)	Scenario 10 (%)
Natural Gas	0.01	−0.20	−0.30	−0.27	−0.34	−0.49	−0.34	−2.03	−2.75	−5.84
Coal	0.04	−0.09	−0.15	−0.14	−0.17	−0.25	−0.17	−0.99	−1.33	−2.79
Petroleum	−0.12	−0.45	−0.62	−0.58	−0.70	−1.00	−0.73	−4.07	−5.47	−11.44
Nuclear Electricity	0.05	−0.20	−0.33	−0.29	−0.37	−0.55	−0.38	−2.42	−3.31	−7.13
Hydroelectric Electricity	0.05	−0.20	−0.33	−0.29	−0.37	−0.55	−0.38	−2.42	−3.31	−7.13
Geothermal Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wind Electricity	0.05	−0.20	−0.33	−0.29	−0.37	−0.55	−0.38	−2.42	−3.31	−7.13
Solar, Tide and Wave Electricity	0.03	−0.17	−0.27	−0.24	−0.30	−0.45	−0.31	−1.96	−2.66	−5.72
Biomass and Waste Electricity	0.14	−0.18	−0.33	−0.29	−0.37	−0.55	−0.36	−2.42	−3.31	−7.13
Total Primary Energy	0.02	−0.26	−0.40	−0.36	−0.45	−0.65	−0.46	−2.79	−3.78	−8.05

Table 20: Changing the consumption of different types of primary energy in Switzerland (10 scenarios)

Primary Energies	Scenario 1 (%)	Scenario 2 (%)	Scenario 3 (%)	Scenario 4 (%)	Scenario 5 (%)	Scenario 6 (%)	Scenario 7 (%)	Scenario 8 (%)	Scenario 9 (%)	Scenario 10 (%)
Natural Gas	−0.36	−0.53	−0.61	−0.77	−0.99	−1.43	−1.17	−2.46	−3.51	−6.54
Coal	0.15	0.15	0.15	0.19	0.25	0.39	0.30	0.74	1.10	2.21
Petroleum	−0.64	−0.92	−1.05	−1.32	−1.71	−2.46	−2.02	−4.25	−6.06	−11.27
Nuclear Electricity	−0.49	−0.80	−0.95	−1.20	−1.55	−2.27	−1.84	−3.97	−5.70	−10.66
Hydroelectric Electricity	−0.49	−0.80	−0.95	−1.20	−1.55	−2.27	−1.84	−3.97	−5.70	−10.66
Geothermal Electricity	−0.39	−0.56	−0.64	−0.80	−1.03	−1.49	−1.22	−2.59	−3.70	−6.94
Wind Electricity	−0.49	−0.80	−0.95	−1.20	−1.55	−2.27	−1.84	−3.97	−5.70	−10.66
Solar, Tide and Wave Electricity	−0.44	−0.64	−0.74	−0.93	−1.20	−1.74	−1.42	−3.03	−4.34	−8.13
Biomass and Waste Electricity	−0.39	−0.62	−0.73	−0.92	−1.19	−1.74	−1.41	−3.03	−4.34	−8.11
Total Primary Energy	−0.53	−0.80	−0.93	−1.16	−1.51	−2.19	−1.78	−3.80	−5.43	−10.12

Table 21: Changing the consumption of different types of primary energy in Turkey (10 scenarios)

Primary Energies	Scenario 1 (%)	Scenario 2 (%)	Scenario 3 (%)	Scenario 4 (%)	Scenario 5 (%)	Scenario 6 (%)	Scenario 7 (%)	Scenario 8 (%)	Scenario 9 (%)	Scenario 10 (%)
Natural Gas	−0.87	−1.32	−1.67	−1.77	−2.37	−3.65	−2.78	−4.32	−6.72	−7.20
Coal	−0.89	−1.36	−1.72	−1.82	−2.44	−3.77	−2.87	−4.46	−6.94	−7.43
Petroleum	−1.18	−1.74	−2.19	−2.33	−3.10	−4.77	−3.63	−5.64	−8.78	−9.40
Nuclear Electricity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydroelectric Electricity	−1.12	−1.69	−2.14	−2.27	−3.05	−4.72	−3.59	−5.59	−8.70	−9.31
Geothermal Electricity	−0.97	−1.43	−1.80	−1.91	−2.55	−3.93	−2.99	−4.66	−7.25	−7.76
Wind Electricity	−1.12	−1.69	−2.14	−2.27	−3.05	−4.72	−3.59	−5.59	−8.70	−9.31
Solar, Tide and Wave Electricity	−0.92	−1.33	−1.66	−1.77	−2.36	−3.62	−2.76	−4.29	−6.69	−7.17
Biomass and Waste Electricity	−0.94	−1.36	−1.70	−1.81	−2.42	−3.71	−2.83	−4.40	−6.85	−7.33
Total Primary Energy	−0.98	−1.46	−1.84	−1.96	−2.62	−4.04	−3.07	−4.78	−7.44	−7.96

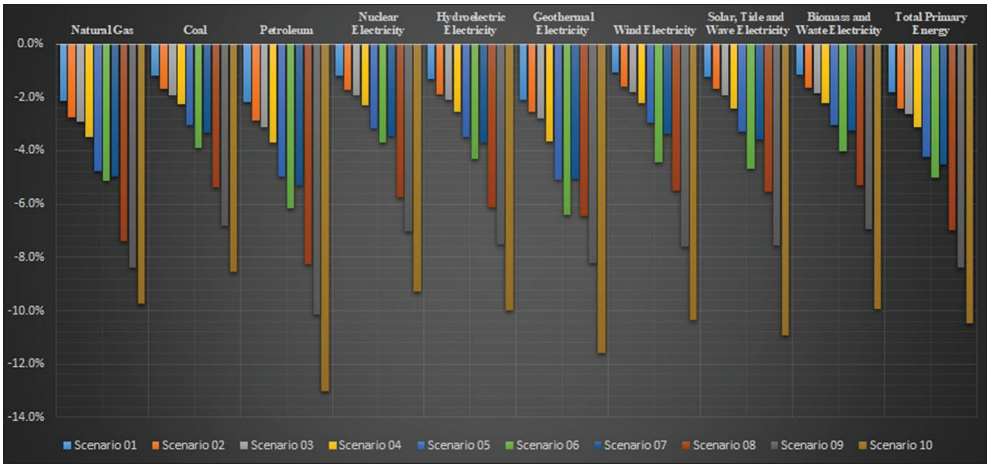
Table 22: Changing the consumption of different types of primary energy in United Kingdom (10 scenarios)

Primary Energies	Scenario 1 (%)	Scenario 2 (%)	Scenario 3 (%)	Scenario 4 (%)	Scenario 5 (%)	Scenario 6 (%)	Scenario 7 (%)	Scenario 8 (%)	Scenario 9 (%)	Scenario 10 (%)
Natural Gas	−0.11	−0.16	−0.17	−0.17	−0.26	−0.41	−0.25	−0.55	−0.74	−0.93
Coal	−0.10	−0.15	−0.16	−0.17	−0.25	−0.39	−0.24	−0.53	−0.71	−0.90
Petroleum	−0.24	−0.35	−0.36	−0.38	−0.57	−0.86	−0.54	−1.17	−1.57	−1.97
Nuclear Electricity	−0.11	−0.17	−0.18	−0.19	−0.29	−0.44	−0.27	−0.60	−0.81	−1.02
Hydroelectric Electricity	−0.11	−0.17	−0.18	−0.19	−0.29	−0.44	−0.27	−0.60	−0.81	−1.02
Geothermal Electricity	−0.07	−0.12	−0.12	−0.13	−0.19	−0.30	−0.19	−0.41	−0.56	−0.71
Wind Electricity	−0.11	−0.17	−0.18	−0.19	−0.29	−0.44	−0.27	−0.60	−0.81	−1.02
Solar, Tide and Wave Electricity	−0.08	−0.13	−0.13	−0.14	−0.21	−0.33	−0.20	−0.44	−0.60	−0.76
Biomass and Waste Electricity	−0.15	−0.24	−0.24	−0.25	−0.39	−0.59	−0.37	−0.80	−1.08	−1.36
Total Primary Energy	−0.15	−0.23	−0.23	−0.24	−0.37	−0.56	−0.35	−0.76	−1.02	−1.28

Table 23: Changing the consumption of different types of primary energy in 20 countries (10 scenarios)

Primary Energies	Scenario 1 (%)	Scenario 2 (%)	Scenario 3 (%)	Scenario 4 (%)	Scenario 5 (%)	Scenario 6 (%)	Scenario 7 (%)	Scenario 8 (%)	Scenario 9 (%)	Scenario 10 (%)
Natural Gas	−2.11	−2.75	−2.93	−3.47	−4.76	−5.13	−4.97	−7.37	−8.39	−9.74
Coal	−1.19	−1.69	−1.92	−2.24	−3.05	−3.91	−3.32	−5.40	−6.80	−8.55
Petroleum	−2.19	−2.86	−3.13	−3.71	−4.98	−6.17	−5.31	−8.27	−10.15	−13.01
Nuclear Electricity	−1.19	−1.74	−1.91	−2.29	−3.16	−3.69	−3.44	−5.76	−7.03	−9.29
Hydroelectric Electricity	−1.33	−1.88	−2.10	−2.53	−3.50	−4.32	−3.68	−6.12	−7.51	−9.98
Geothermal Electricity	−2.09	−2.55	−2.80	−3.66	−5.09	−6.39	−5.05	−6.43	−8.21	−11.60
Wind Electricity	−1.07	−1.58	−1.80	−2.20	−2.97	−4.45	−3.36	−5.51	−7.59	−10.36
Solar, Tide and Wave Electricity	−1.24	−1.70	−1.93	−2.43	−3.27	−4.67	−3.57	−5.56	−7.54	−10.92
Biomass and Waste Electricity	−1.15	−1.63	−1.85	−2.23	−3.02	−4.04	−3.26	−5.29	−6.96	−9.96
Total Primary Energy	−1.81	−2.42	−2.63	−3.12	−4.24	−5.02	−4.50	−6.97	−8.39	−10.46

Figure 2: Changing primary energy consumption due to COVID-19 pandemic in 20 European counties



with −12.54%. In the Nuclear Electricity consumption, the biggest decrease in consumption according to the optimistic scenario is for o Russia with −2.49% and in the pessimistic scenario is for Spain with −13.86%. In the oil consumption, the biggest decrease in consumption according to the optimistic scenario is for Russia with −4.95% and in the pessimistic scenario is for Poland with −16.52%. In the solar, tide and wave electricity consumption, the highest consumption reduction according to the optimistic scenario is for Italy with −2.79% and in the pessimistic scenario for Austria with −14.39%. In the wind electricity consumption, the highest consumption reduction according to the optimistic scenario is for Italy with −2.82% and in the pessimistic scenario for Spain with −13.86%. Figures 12-20 also show the status of countries' Heat Maps (slight reduction is green, medium reduction is yellow, and sharp reduction is red).

According to the tables and figures above, the situation of changes in primary energy consumption in these 20 countries under 10 different scenarios can be summarized as follows:

1. If the restrictions and quarantines remain until the end of July and all restrictions are lifted after that, Turkey, Norway, Netherlands, Denmark, Belgium, Austria, Switzerland, Germany, Czech

Figure 3: Changing Biomass and Waste Electricity consumption

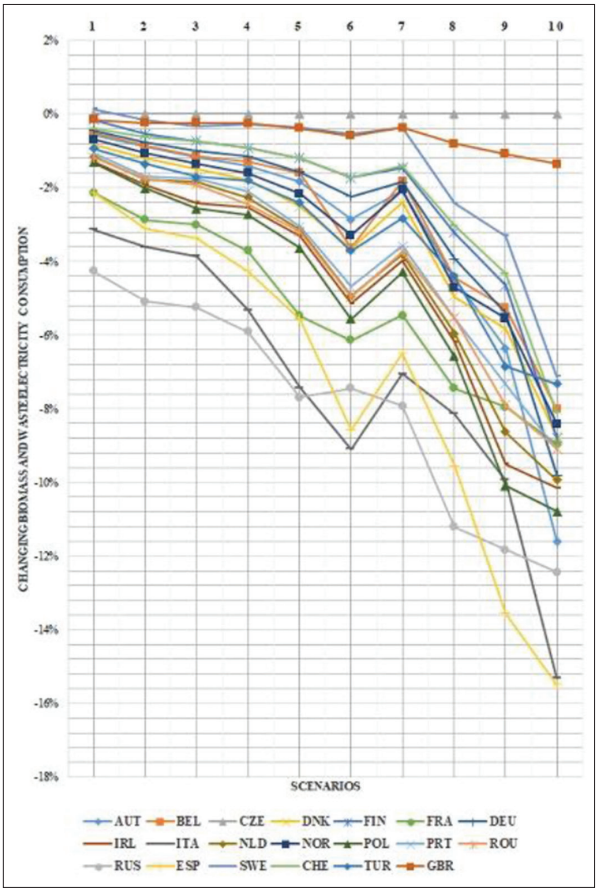


Figure 4: Changing coal consumption

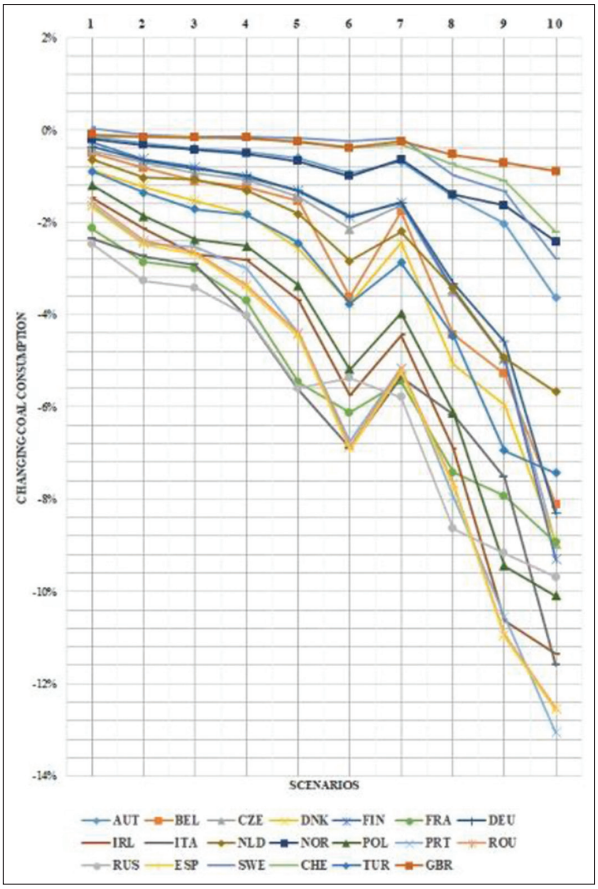


Figure 5: Changing Geothermal Electricity consumption

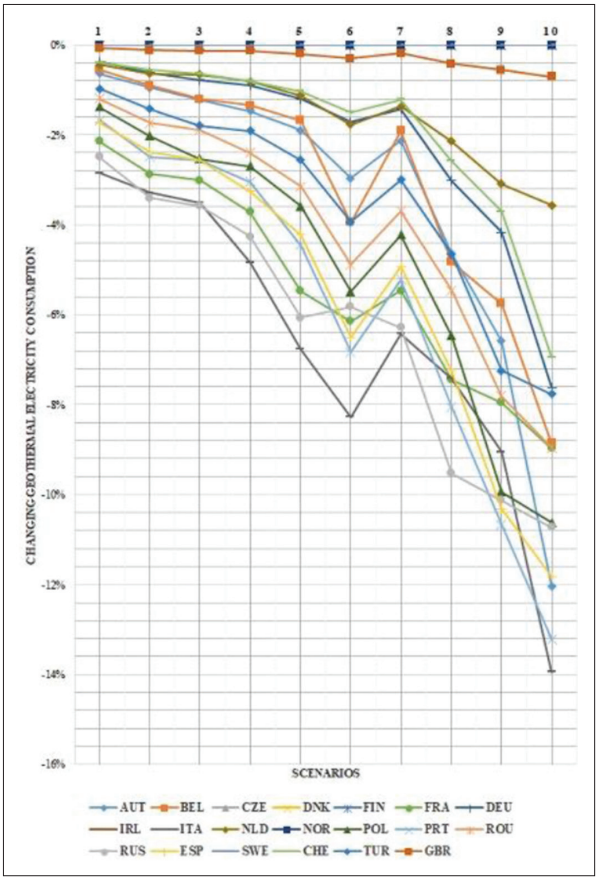


Figure 6: Changing Hydroelectric Electricity consumption

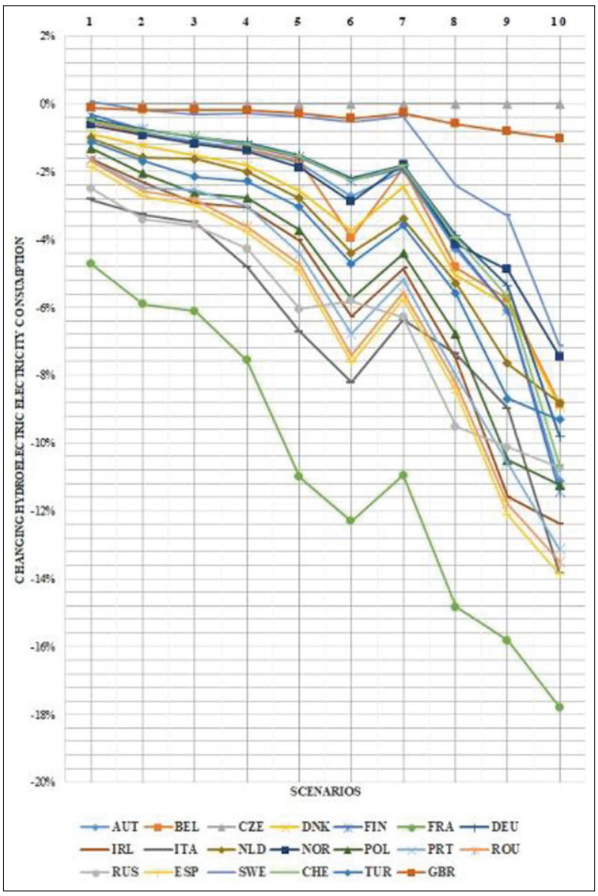


Figure 7: Changing Natural Gas consumption

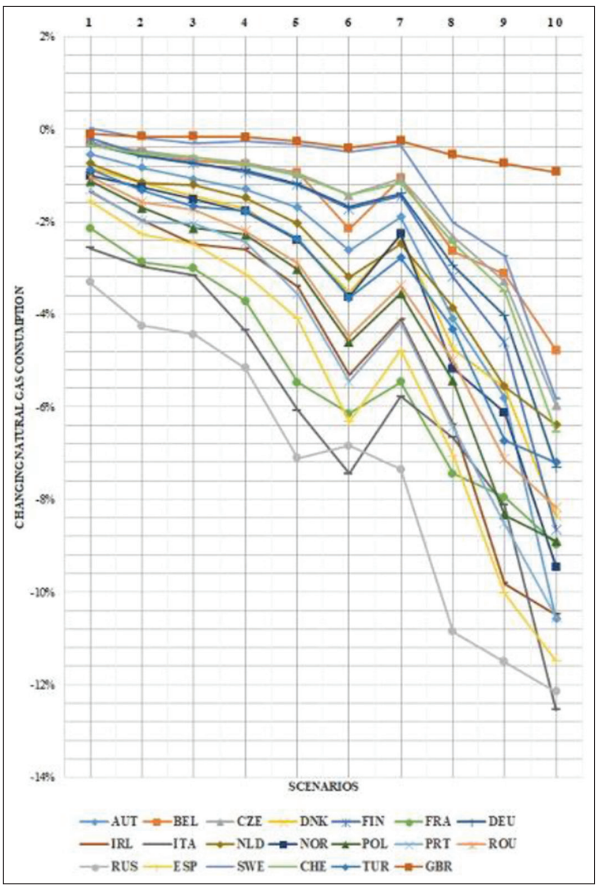


Figure 8: Changing Nuclear Electricity consumption

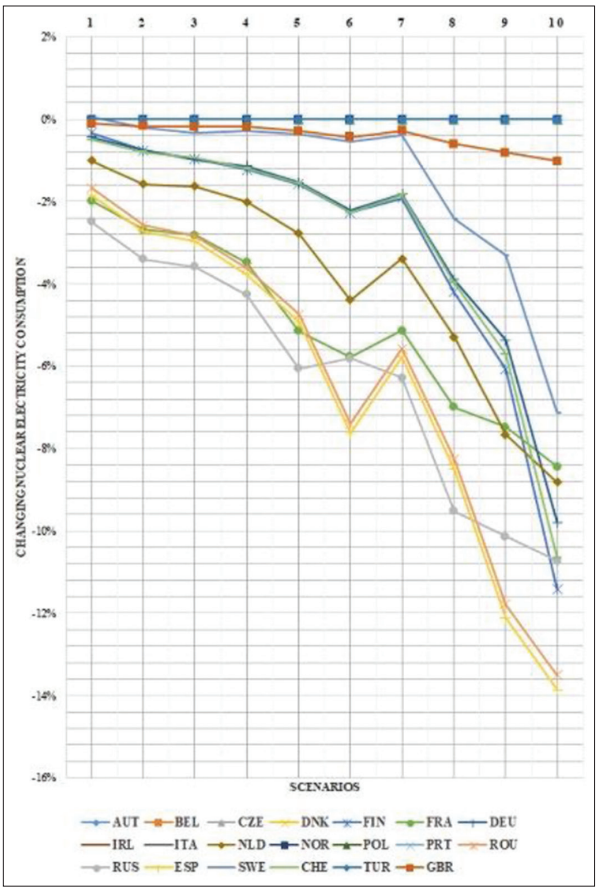


Figure 9: Changing Petroleum consumption

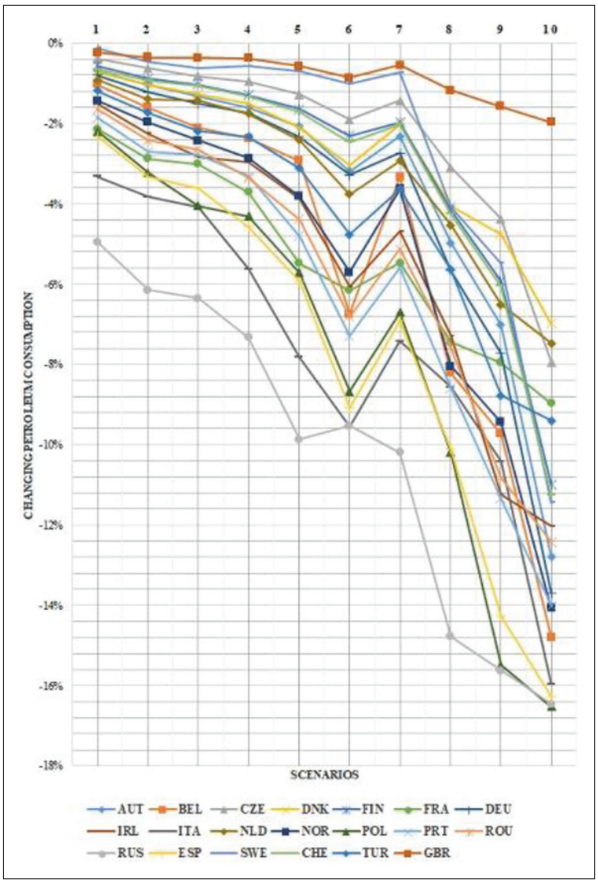


Figure 10: Changing Solar, Tide and Wave Electricity consumption

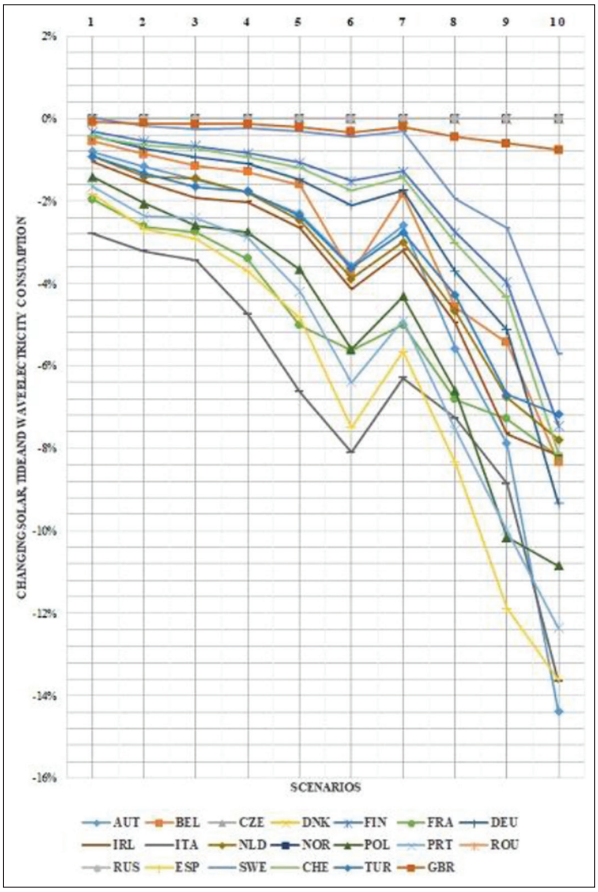


Figure 11: Changing Wind Electricity consumption

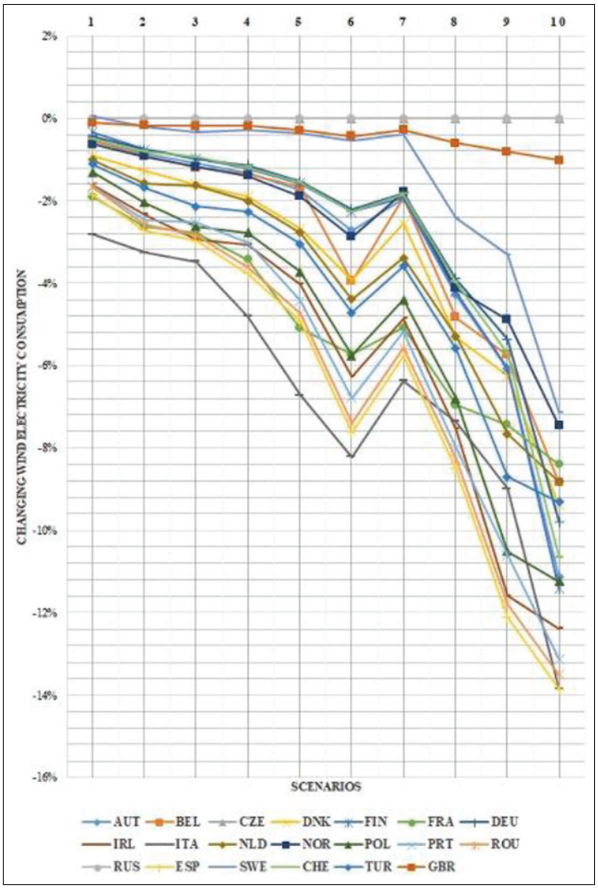
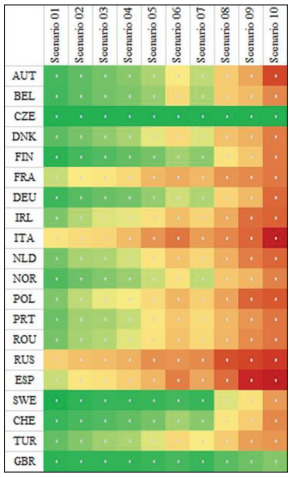


Figure 12: Changing Biomass and Waste Electricity consumption under 10 scenarios



Republic, Finland, United Kingdom, and Sweden will have very little change in energy consumption (<1% reduction). Five countries of Spain, Portugal, Poland, Ireland and Romania reduce energy consumption by 1-2%, and three countries of Russia, Italy and France experience a 2-3.5% reduction.

2. If the gradual recovery of the disease and the lifting of bans and restrictions continue, all restrictions will be lifted in December, 7 countries of Austria, Switzerland, Germany, Czech Republic, Finland, United Kingdom, sand Sweden will have below 1% Reduction of energy consumption. 5 countries of Turkey, Norway, Netherlands, Denmark, and Belgium decrease consumption by 1-2%, and 6 countries of France, Spain, Portugal, Poland, Ireland, and Romania will reduce energy consumption between 2% and 3%. Italy's and Russia's decline will be 3% and 3.5% respectively.

Figure 13: Changing Coal consumption under 10 scenarios

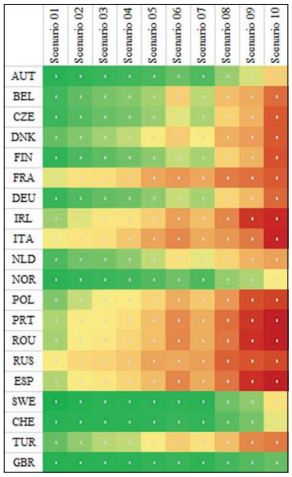


Figure 14: Changing Geothermal Electricity consumption under 10 scenarios

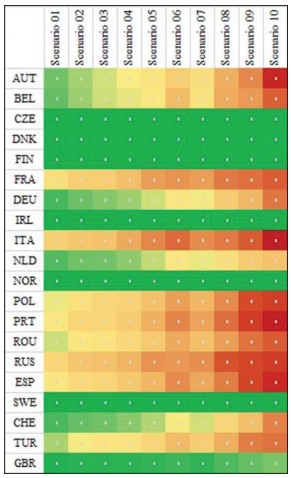


Figure 15: Changing Hydroelectric Electricity consumption under 10 scenarios

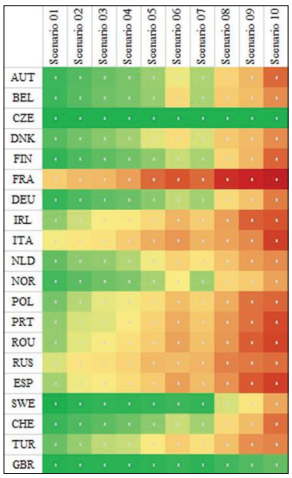


Figure 16: Changing Natural Gas consumption under 10 scenarios

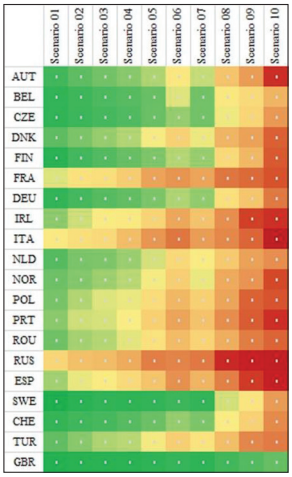


Figure 17: Changing Nuclear Electricity consumption under 10 scenarios

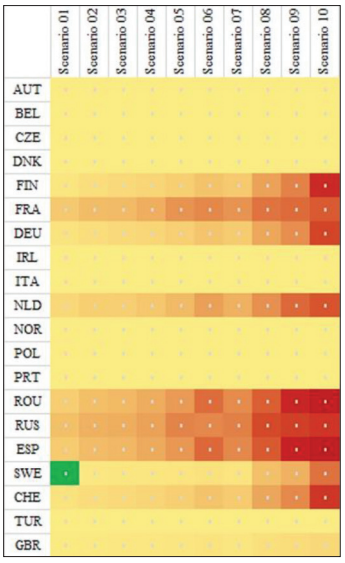
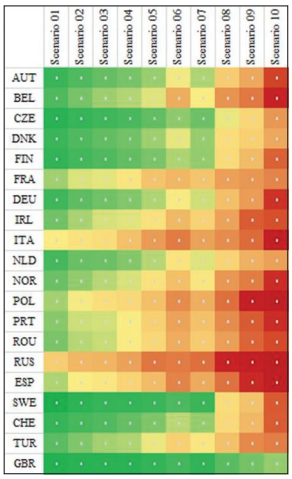


Figure 18: Changing Petroleum consumption under 10 scenarios



3. If the gradual reduction of the epidemic occurs by the end of the year, but a small amount of restrictions remain (if the OXCGRT index is between 15 and 25), 12 countries of

Figure 19: Changing Solar, Tide and Wave Electricity consumption under 10 scenarios

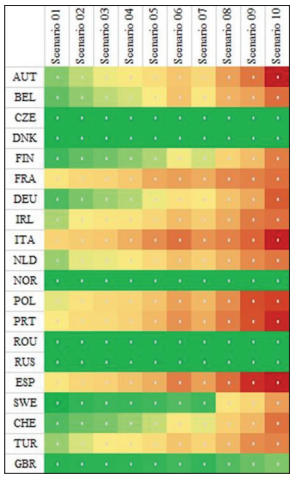
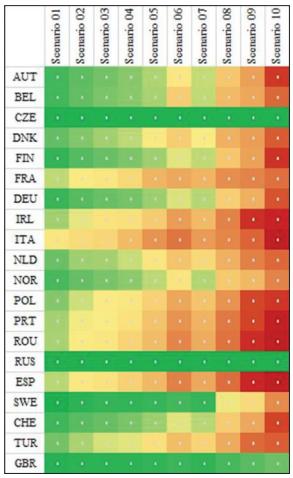


Figure 20: Changing Wind Electricity consumption under 10 scenarios



Turkey, Norway, Netherlands, Denmark, Belgium, Austria , Switzerland, Germany, Czech Republic, Finland, United Kingdom, and Sweden will have <2% reduction in energy consumption. 7 countries of Italy, France, Spain, Portugal, Poland, Ireland, and Romania will reduce energy consumption by 2-3.5%. Russia will reduce energy consumption by more than 4.5%.

4. If the epidemic declines from June and peaks twice as early as autumn (so that the second wave is weaker than in March to May), the three Czech Republic, United Kingdom, and Sweden will fall below 1%. Energy consumption for 9 countries of Turkey, Norway, Netherlands, Denmark, Belgium, Austria, Switzerland, Germany, and Finland decrease by 1-2%, four countries of Portugal, Poland, Ireland, and Romania decrease by 2-3%, and France and Spain decrease by 3-4%. Italy will fall by 5% and Russia will fall by 5.37%.
5. If pandemic slows down from June and peaks again in the fall (the second wave is like March to May), the United Kingdom and Sweden will experience a 1% drop in energy consumption. Ten countries of Turkey, Norway, Netherlands, Denmark, Belgium, Austria, Switzerland, Germany, Czech Republic, and Finland reduce by 1% to 3%. Four countries of Portugal, Poland, Ireland, and Romania experience decline of 3% to

Table 24: The amount of initial shocks for 26 economic sectors (per month) in ten range

	Range of OxCGRT index (%)									
	90-100	80-89.9	70-79.9	60-69.9	50-59.9	40-49.9	30-39.9	20-29.9	10-19.9	0-9.99
Sector										
Agriculture	−0.223	−0.096	−0.040	−0.022	−0.009	−0.006	−0.002	−0.001	0.009	0.001
Fishing	−1.559	−0.733	−0.354	−0.228	−0.112	−0.082	−0.053	−0.026	−0.025	0.000
Mining and Quarrying	−0.946	−0.428	−0.199	−0.123	−0.057	−0.040	−0.024	−0.011	−0.010	0.003
Food and Beverages	−0.322	−0.168	−0.091	−0.065	−0.035	−0.028	−0.019	−0.010	−0.011	0.003
Textiles and Wearing Apparel	−0.237	−0.100	−0.042	−0.022	−0.009	−0.005	−0.002	0.000	0.001	0.002
Wood and Paper	−0.285	−0.124	−0.054	−0.031	−0.013	−0.009	−0.004	−0.002	0.006	0.047
Petroleum, Chemical and Non−Metallic Mineral Products	0.536	0.235	0.107	0.064	0.028	0.019	0.011	0.004	0.007	0.005
Metal Products	−0.549	−0.250	−0.117	−0.073	−0.034	−0.024	−0.015	−0.007	−0.006	0.006
Electrical and Machinery	−0.338	−0.152	−0.070	−0.043	−0.020	−0.014	−0.008	−0.004	0.002	0.012
Transport Equipment	−0.463	−0.212	−0.100	−0.063	−0.030	−0.021	−0.013	−0.006	−0.006	0.007
Other Manufacturing	−0.351	−0.156	−0.069	−0.041	−0.018	−0.012	−0.007	−0.003	0.005	0.023
Recycling	−0.646	−0.292	−0.136	−0.084	−0.039	−0.027	−0.016	−0.007	−0.007	0.005
Electricity, Gas and Water	−0.508	−0.229	−0.105	−0.063	−0.029	−0.020	−0.012	−0.005	0.000	0.010
Construction	−0.637	−0.292	−0.139	−0.088	−0.041	−0.029	−0.018	−0.009	−0.008	0.004
Maintenance and Repair	−0.389	−0.172	−0.077	−0.045	−0.020	−0.014	−0.008	−0.003	0.004	0.015
Wholesale Trade	−1.987	−0.919	−0.432	−0.269	−0.129	−0.093	−0.058	−0.027	−0.025	0.001
Retail Trade	−3.173	−1.492	−0.726	−0.470	−0.230	−0.169	−0.109	−0.053	−0.103	−0.100
Hotels and Restaurants	−5.312	−2.503	−1.211	−0.781	−0.383	−0.282	−0.182	−0.088	−0.171	−0.166
Transport	−1.496	−0.686	−0.324	−0.204	−0.097	−0.069	−0.043	−0.020	−0.018	0.003
Post and Telecommunications	−0.298	−0.130	−0.056	−0.031	−0.014	−0.009	−0.004	−0.002	0.008	0.048
Financial Intermediation and Business Activities	−0.365	−0.161	−0.072	−0.043	−0.019	−0.013	−0.007	−0.003	0.004	0.017
Public Administration	0.669	0.298	0.137	0.084	0.039	0.025	0.014	0.006	0.012	0.009
Education, Health and Other Services	−0.230	−0.083	−0.024	−0.005	0.002	0.005	0.006	0.004	0.011	0.014
Private Households	3.159	1.477	0.718	0.466	0.225	0.165	0.108	0.052	0.099	0.097
Others	−0.583	−0.258	−0.116	−0.069	−0.031	−0.020	−0.012	−0.005	0.002	0.011
Re−export and Re−import	−0.384	−0.169	−0.076	−0.045	−0.020	−0.013	−0.007	−0.003	0.049	−0.034

5%, and four countries of Russia, Italy, France, and Spain will see a 5% to 7.5% decrease in energy consumption.

6. If pandemic declines from June and peaks twice in the fall (the second wave is more severe than in March to May), the United Kingdom and Sweden will see a reduction of <1% in energy consumption. The Czech Republic will also reduce its energy consumption by 1.9%. 7 countries of Norway, Netherlands, Denmark, Austria, Switzerland, Germany, and Finland decrease by 2-4%. Two countries of Turkey and Belgium decrease by 4-5% and five countries of France, Portugal, Poland, Ireland, and Romania decrease by 5-7%. Russia, Spain, and Italy decrease in energy consumption are 7%, 7.9% and 8.3% respectively.
7. If the restrictions continue until the end of the year as much as the countries have applied from March to May, then seven countries of Austria, Switzerland, Germany, Czech Republic, Finland, United Kingdom, and Sweden reduce their energy consumption by <2%. 9 countries of Portugal, Poland, Ireland, Romania, Turkey, Norway, Netherlands, Denmark, and Belgium reduce their consumption by 2-5%. The other four countries of Russia, Italy, France and Spain also cut their consumption by about 5.5-7.5%.
8. If more restrictions are imposed, United Kingdom will have <1% reduction in energy consumption and Sweden also experiences a 2.8% drop. Ten countries of Turkey, Norway, the Netherlands, Denmark, Belgium, Austria, Switzerland, Germany, the Czech Republic, and Finland will have a 3-6% reduction in energy consumption. Seven countries of Italy, France, Spain, Portugal, Poland, Ireland and Romania will see 6.5-8.5% decrease, and Russia will see a two-digit drop of 11%.
9. If the pandemic progresses and spreads in such a way that countries are forced to apply full quarantine from October, the three countries, the United Kingdom, Sweden and the Czech Republic, will see a decrease of 1.02%, 3.78%, and 4.37% in energy consumption, respectively. Denmark, Switzerland, and Germany will fall 5-6%. France, Turkey, Norway, Netherlands, Belgium, and Austria will fall 6-8%, and Italy and Romania will fall 9.1% and 9.5%, respectively. Five countries of Russia, Spain, Portugal, Poland and Ireland, decrease energy consumption by 10.5-12%.
10. If a sharp progress of the epidemic takes place and full quarantine is applied from June to the end of the year, the United Kingdom alone will not see a sharp decline in energy consumption, which will only decrease by 1.28%. The Netherlands decline is about 7%. Eight countries of France, Turkey, Norway, Belgium, the Czech Republic, Finland, Sweden and Denmark will reduce their energy consumption by 8% to 10%. Eight countries of Poland, Ireland, Romania, Austria, Switzerland, Germany, Russia and Portugal will also reduce their energy consumption by 10-12.5%. Italy's and Spain's decline are also 14% and 14.3% respectively (Table 24).

5. CONCLUSION

From a sectoral perspective, the greatest decline in energy demand has been related to the hotel, restaurant and retail sectors. Sectors such as mineral, chemical and petroleum products, as well as

education and health services, have seen less decline. However, the post and communications sector faces increasing demand. According to IEA (2020) based on a pre-COVID forecast, European energy demand in 2019 decreased by 1.01% compared to 2018. The major change was due to switching from coal to natural gas, as well as a decline in oil demand of 15,000 barrels per day, mainly because of increased vehicle efficiency and reduced industrial production. According to these scenarios, the forecast of European energy demand according to the model of this research, will face an average decrease of about 5 times the reduction forecast for 2020, an issue that will affect investment and consumption patterns in the long run.

The important concern here is about the continuity and stability of the conditions overriding energy demand in the future. During the lockdown time, people stayed at home due to restrictions while only few factories have returned to operation after a short pause in compliance with health protocols. Hence the question is how much changes in demand will be temporary and how long will they last. It is important to note that there are some companies that have the possibility of telecommuting or have provided its infrastructure. For them, change in quarantine conditions will not affect energy consumption.

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7. APPENDIX: INITIAL SHOCKS

Table 24 shows the amount of initial shocks for 26 economic sectors (per month) in ten range.

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