

## Article

# Public Attitude towards Nuclear and Renewable Energy as a Factor of Their Development in a Circular Economy Frame: Two Case Studies

Anzhelika Karaeva <sup>1,2</sup>, Elena Magaril <sup>2</sup> , Vincenzo Torretta <sup>1</sup> , Paolo Viotti <sup>3</sup> and Elena Cristina Rada <sup>1,\*</sup> 

<sup>1</sup> Department of Theoretical and Applied Sciences, Insubria University of Varese, Via G.B. Vico 46, 21100 Varese, Italy; akaraeva@uninsubria.it (A.K.); vincenzo.torretta@uninsubria.it (V.T.)

<sup>2</sup> Department of Environmental Economics, Ural Federal University, Mira Str., 19, 620002 Ekaterinburg, Russia; magaril67@mail.ru

<sup>3</sup> Department of Civil and Environmental Engineering, University of Rome La Sapienza, Eudossiana Str., 18, 00184 Roma, Italy; paolo.viotti@uniroma.it

\* Correspondence: elena.rada@uninsubria.it; Tel.: +39-0332218782

**Abstract:** Nowadays, most countries of the world are implementing the transition to the low-carbon economy which implies the need to carry out a full-scale eco-modernization of the energy sector. Green energy may be identified as one of the core concerns of energy sector modernization as it allows a considerable decrease in emissions of harmful substances into the atmosphere. Therefore, nuclear and renewable energy may become key areas of global energy development in the near future, which is also in agreement with circular economy concepts. However, public opinion (and other controversial visions/aspects) is one of the barriers to their development. The purpose of this study is to analyze the relationship between attitudes towards nuclear and renewable energy in two countries: a EU country (Italy) and a non-EU country (Russia), considering the level of their development. The authors conducted a survey among residents regarding their attitude towards nuclear and renewable energy, as well as their attitude to the present energy policy. The cluster analysis technique was used to analyze the results. The obtained results confirmed the dependence between the level of development of nuclear and renewable energy and the public attitude towards it. The national energy policy also might influence public opinion on the development of nuclear or renewable energy. The authors identified public attitude as one of the key factors in the development of energy and the achievement of environmental and social sustainability.

**Keywords:** renewable energy; nuclear energy; environmental awareness; circular economy; social sustainability; energy policy; energy sector



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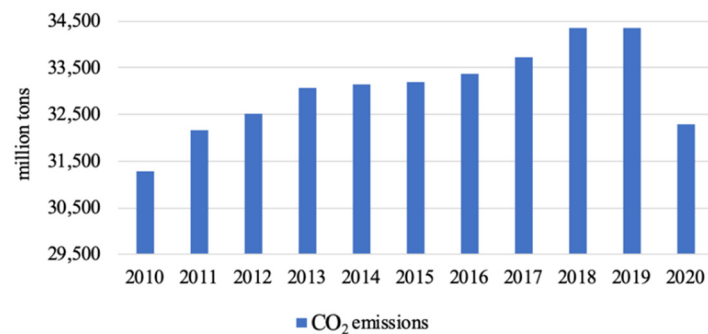
## 1. Introduction

In 2015, the world community prepared and accepted the Paris Agreement that sets a global climate goal for all mankind—to keep the increase in the average temperature on the planet within 2 °C (in the best scenario no higher than 1.5 °C) from the pre-industrial level [1]. In 2021, most attendees of the 26th UN Climate Change Conference (COP26), the third meeting of the parties to the Paris Agreement, agreed on the limitations of methane emissions and set the target to reach net-zero carbon emissions over the next decades [2].

In the conditions of rapid scientific and technological progress, the growth in world production, and the growth of energy consumption all over the world, achieving the stated goals requires a revision of energy policies of most developed and developing countries [3–7]. Considering the circular economy (CE) concepts, many countries are developing or already following the programs to transfer the economy to a new sustainable and low-carbon path of its development, attract investments in the development of green technologies, and force polluting enterprises to reduce emissions of harmful substances into the atmosphere [8–14].

Despite the current climate agenda since 2015, the dynamics of global CO<sub>2</sub> emissions into the atmosphere showed an upward trend until 2019 (Figure 1).

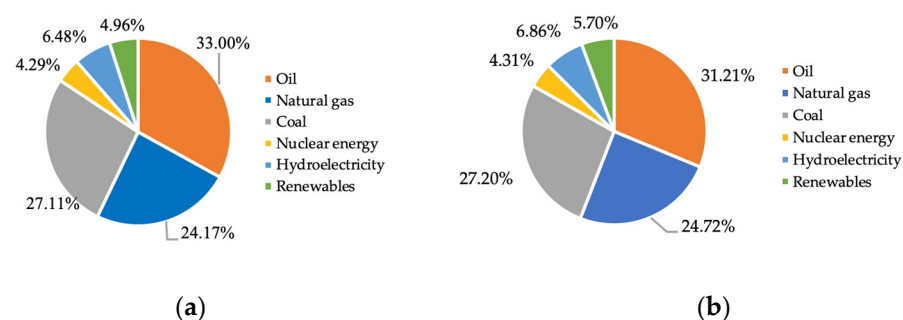
In 2019, world CO<sub>2</sub> emissions amounted to 34,357 million tons, but in 2020, emissions decreased by 6.03% (to 32,284 million tons) due to the suspension of most enterprises in the world because of the restrictions imposed by most countries due to the COVID-19 pandemic. Enterprises of many industries were forced to reduce production volumes or even suspend work for a certain period of time, which led to a significant reduction of the level of anthropogenic pressure on the environment [15].



**Figure 1.** World CO<sub>2</sub> emissions from 2010 to 2020, million tons (created by the authors using data from [16]).

Despite the positive environmental impact, the COVID-19 pandemic and restrictive measures had an extremely unfavorable impact on the global economic situation: deterioration of macroeconomic indicators, falling incomes, rising inflation, etc. All this led to a decrease in investment activity in many sectors of the economy. Moreover, the connection between CE and the COVID-19 situation may be seen in terms of waste-to-energy and clean energy [17–24].

The global energy sector is one of the environmental polluters: according to the statistical data in 2018, more than 48.7% of CO<sub>2</sub> emissions were produced by energy enterprises [16]. Therefore, the decarbonization policy of many countries is aimed primarily at eco-modernization of the energy sector, namely the implementation of environmental measures at existing traditional energy facilities and increasing the share of green energy in the structure of energy produced. Figure 2 shows the structure of global energy consumption by fuel type in 2019 and 2020.

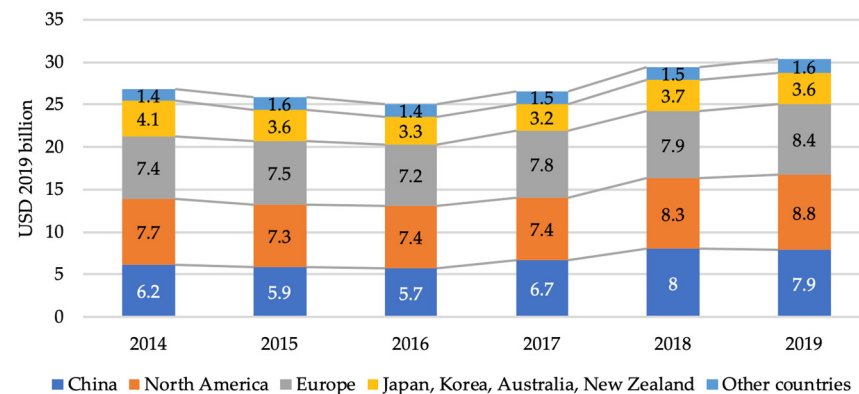


**Figure 2.** (a) World energy consumption by fuel in 2019, %; (b) world energy consumption by fuel in 2020, % (created by the authors using data from [16]).

The structure of world energy consumption by fuel types remained almost unchanged. The positive dynamic is a slight increase in the share of renewable energy from 4.96% to 5.70%, an increase in the share of hydropower to 6.86%. In the structure of energy consumption, traditional sources (oil, gas, coal) occupy more than 80%, which is a negative factor and indicates a rather low rate of transition to a new sustainable and low-carbon direction of further development. The share of nuclear power remains unchanged, despite

its great potential, while they are able to produce large amounts of energy necessary to ensure the normal functioning of large settlements.

For a full-fledged transition to a low-carbon path of development, the implementation of the principles of the circular economy and the achievement of sustainable development goals, a large-scale eco-modernization of the fuel and energy complex of most countries of the world is required. The energy sector's eco-modernization requires significant costs and investments [25]. Figure 3 shows world spending on research and development (R&D) in the energy sector.



**Figure 3.** Spending on energy R&D by country from 2014 to 2019, USD 2019 billion (created by the authors using data from [26]).

The volume of R&D expenditures shows an upward trend in the period from 2014 to 2019. According to the IEA [26], more than 80% of the costs are for the development and implementation of low-carbon technologies. The increase in government spending on the development of low-carbon and green energy technologies may considerably reduce the anthropogenic impact of the sector on the environment in the future.

The largest amount of funds for the development and implementation of technologies in the energy sector is spent by developed countries, namely North American and European countries (USD 8.8 billion and USD 8.4 billion, respectively) and China (USD 7.9 billion), whereas other countries (including developed and developing countries) account for more than USD 1.6 billion in costs [26]. In order to achieve the goals set by the international community, developing countries also need to pursue an active policy of eco-modernization and decarbonization of the energy sector. Moreover, they need to increase the volume of expenditures and investments in this area of the economy, since many developing countries are among the largest environmental pollutants.

According to some opinions, the nuclear sector can play an important role in achieving the stated climate goal. Its development could contribute to solving the problem of switching to a low-carbon direction of energy sector development in the immediate future [25–30]. However, the governments of many countries have a negative attitude towards nuclear power enterprises due to the risks of accidents at facilities. For instance, the Italian government suspended the construction and operation of nuclear power facilities due to the risks of man-made disasters, and the Italian population, according to the results of previous studies, demonstrates a negative attitude towards nuclear energy [31,32].

In addition, the attitude towards renewable energy sources (RES) and their development in the country are also interrelated: the result of a previous study showed that Russian residents do not consider green energy as promising that correlates with the pace of its development: traditional energy facilities prevail in Russia to a greater extent [5,33–35]. Consequently, the attitude of society, in this case, may also be considered as one of the barriers to the development of renewable energy in Russia.

Generally, the main reason for the negative attitude towards nuclear or renewable energy is the low level of public awareness. It includes insufficient knowledge of the population about the principles of operation of nuclear power plants (NPP) and existing

safety systems in Italy and the lack of awareness of the Russian population about the potential of using green energy facilities.

Public opinion and the ecological outlook of the population can stimulate or, conversely, slow down the development of green energy and the transition to a low-carbon economy. Therefore, the governments of the countries need to apply a comprehensive transition in the implementation of national programs to achieve the stated climate goals, such as Sustainable Development goals in agreement with the circular economy concepts of “closing the loop”. In addition to financial support for enterprises and green energy projects, it is necessary to raise public awareness through various public programs, events, the inclusion of thematic courses in university programs, etc. [36–40].

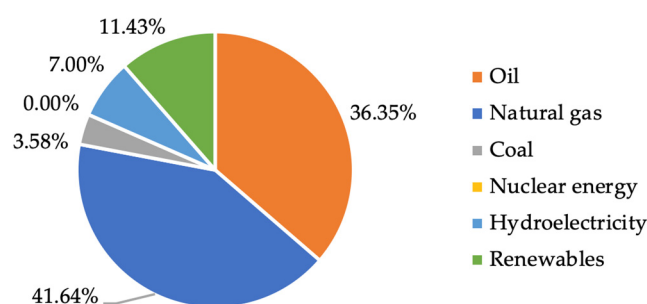
The purpose of this study is to analyze the relationship between attitudes towards nuclear and renewable energy in Italy and Russia and the level of their development. The authors conducted a cluster analysis to identify groups of young people in relation to them in Russia and Italy and identify the main trends in relation to both types of energy.

The structure of the paper includes a brief overview of the Italian and Russian energy sectors, a description of the used research methods, results, as well as a discussion and conclusion of the key results of the conducted study.

## 2. Italian and Russian Energy Sectors: Key Trends and Differences

Different priorities of the energy state policy and the different structures of the economy cause significant differences in the energy sectors in EU and non-EU countries like Italy and Russia. However, both countries are including the circular economy concepts in their policies also involving the energy sector, as a key point to complete as a sustainable strategy.

The total energy consumption in Italy in 2020 was 139.96 Mtoe, 9.3% less than in 2019. The decrease in energy consumption in 2020 is due to COVID-19 restrictions that had a negative impact on the production volumes. The energy policy of the Italian government is more focused on the development of renewable energy: currently, Italy demonstrates high rates of its development: renewable energy sources generate 114 TWh of all electricity in Italy (10th place in the world [41] from different sources [42–45]). The government is actively developing bioenergy, wind energy, and solar energy: according to data for 2020, Italy accounts for 4.1% of all energy produced in the world at solar energy facilities (the total capacity of the facilities is 20.1 GW) [41]. Figure 4 shows the structure of energy consumption in Italy by fuel type.



**Figure 4.** Energy consumption by fuel in Italy in 2020, % (created by the authors using data from [41]).

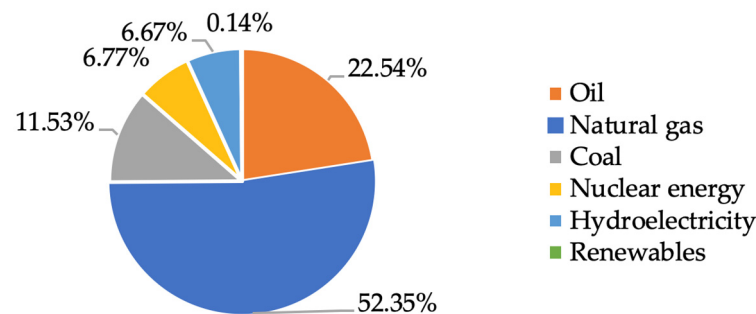
Green energy accounts for 18.43% of the structure, 7% of which is hydropower, 11.43% is renewable energy. The share of natural gas is 41.64%, which could be considered as a positive factor: the use of natural gas as fuel for energy production is a more environmentally friendly option compared to oil. The generation of emissions of harmful substances into the atmosphere when using gas as fuel is significantly lower, especially if advanced environmental technologies are used at the energy facility. The share of oil in the structure, despite the policy of the Italian government, is 36.55%.

In the 1960s and 1980s, the Italian government implemented programs for nuclear energy development, but the disaster at the Chernobyl nuclear power plant (a territory

of the former USSR) forced the Italian government to reconsider its views. Currently, the operation and construction of nuclear power facilities have been completely suspended [42].

In the Russian energy sector, due to a large volume of natural energy carriers (oil, gas, coal), traditional energy facilities predominate. But despite the availability of cheap energy carriers, the Russian government actively supports the implementation of projects in the nuclear power industry: currently, Russia is one of the leaders in this industry, the total capacity of nuclear power facilities operated in Russia is 27 GW [41,46,47].

The total energy consumption in Russia in 2019 and 2020 were 714.14 Mtoe and 676.18 Mtoe respectively. The COVID-19 restrictions also negatively affected the Russian economy: the decline in energy consumption is 5.5% which is lower than in Italy. Figure 5 shows energy consumption by fuel type in Russia in 2020.



**Figure 5.** Energy consumption by fuel in Russia in 2020, % (created by the authors using data from [41]).

More than 50% of the structure of energy consumption is natural gas, followed by oil (22.54%) and coal (11.53%). Nuclear power accounts for 6.77% of all energy consumed, while the share of green energy, which can include renewable energy and hydropower, is 6.81% (6.67%—hydropower, 0.14%—renewable energy).

Thus, in Russia, the level of development of green energy remains at a low level in comparison with Italy. The predominance of traditional energy facilities causes substantial CO<sub>2</sub> emissions: according to 2020 data, the volume of CO<sub>2</sub> emissions in Russia amounted to 1482 million tons, whereas in 2010 it amounted to 1526 million tons. Consequently, the reduction in CO<sub>2</sub> emission in Russia from 2010 to 2020 was only 2.9%.

The volume of CO<sub>2</sub> emissions in Italy shows a stable downward trend: in 2010, the volume of emissions was 397.1 million tons of CO<sub>2</sub>, in 2020—317.1 million tons of CO<sub>2</sub>, i.e., a decrease of 20.1%. It should be noted that in 2020, the global emissions indicator decreased due to the restrictions imposed due to the COVID-19 pandemic [48].

The dynamics of CO<sub>2</sub> emissions in Russia remains ambiguous: despite the eco-modernization of the energy industry that is the main environmental polluter, the volume of CO<sub>2</sub> emissions in 2020 remains almost at the level of 2010, while in the period from 2011 till 2019, the volume of CO<sub>2</sub> emissions was higher than in 2010. It should be noted that an increase in CO<sub>2</sub>-specific emissions in the process of fossil fuel combustion correlates with increased toxic substances emission, and consequently characterizes the dynamics of environmental pollution [49,50].

Table 1 shows the main indices of energy production and consumption in Italy and Russia.

Russia, due to its more traditional energy sector, shows the worst indicators: the ratio of CO<sub>2</sub> emissions to gross domestic product (GDP) is almost 6.6 times higher than in Italy. The same trend could be observed in the ratio of CO<sub>2</sub> emissions to the population as the amount of CO<sub>2</sub> emissions in Russia is considerably higher than in Italy. However, the ratio of CO<sub>2</sub> emissions to the volume of energy produced is lower due to the larger volume of energy produced in Russia. The ratio of the volume of energy produced to the population in Italy is 2.49 toe/capital, in Russia 5.26 toe/capital which indicates a higher energy production in Russia per inhabitant. The TES/GDP indicator, where TES is a total energy supply, showed similar dynamics. Electricity consumption by one resident of Russia

is 32.5% higher than in Italy that is related, first of all, to the climatic features (prolonged winter period, large territories located in the northern regions with permafrost).

**Table 1.** Energy sector indicators for Italy and Russia for 2018 (created by the authors using data from [41]).

Country	CO <sub>2</sub> , Mt of CO <sub>2</sub>	TES, Mtoe	GDP, USD 2015 Billion	TES */ Population (Toe/Capita)	TES/ GDP (Toe/2015 USD)	Electricity Consumption/ Population (kWh/Capita)	CO <sub>2</sub> /TES (tCO <sub>2</sub> /Toe)	CO <sub>2</sub> / Population (tCO <sub>2</sub> /Capita)	CO <sub>2</sub> /GDP (kgCO <sub>2</sub> /2015 USD)
Italy	317.1	150.6	1906.5	2.49	0.08	5 220	2.11	5.25	0.17
Russia	1587	759.3	1421.7	5.26	0.53	6 917	2.09	10.98	1.12

\* TES—total energy supply.

The energy sector of Italy and Russia is characterized by significant differences:

- in Russia, 86.42% of the structure of the energy sector is presented by traditional energy enterprises using oil (22.54%), coal (11.53%), and natural gas (52.35%) as fuel for energy production, the share of green energy enterprises is 6.81% (6.67%—hydropower, 0.14%—renewable energy);
- in Italy, despite the predominance of natural gas in the structure of energy consumption (41.64%), the share of green energy is 18.43%, 7% of which is hydropower, 11.43% is renewable energy, which indicates a relatively high rate of development of this energy sector;
- Italy has abandoned the use and development of nuclear energy; currently, no nuclear power facilities are operated on the territory of the country, while Russia is a leader in this industry: the total capacity of nuclear power facilities operated on the territory of Russia is 27 GW (fifth place in the world according to 2020 data).

### 3. Materials and Methods

The research entails an international project studying young people's attitudes towards nuclear and renewable energy in Italy and Russia. The authors carried out a survey among 62 Russian and 50 Italian students in December for a period of 10–12 days. Students from both universities (University of Trento, Italy, and Ural Federal University, Russia) studied at engineering faculties. The age of respondents was 20–26 years. All respondents attended academic courses regarding ecology or environmental technologies.

The survey was conducted by using printed copies and online tools (Google Forms). The respondents were asked to answer the eight questions of the survey without any time limitations.

The conducted survey includes 2 parts:

- 4 multiple-choice questions about the attitude towards nuclear and renewable energy (Table 2).
- 4 questions with the evaluation scale (from 1 to 10) about the attitude towards the current government energy policy (Table 3).

The cluster analysis of the obtained results was carried out separately for groups of respondents from Italy and from Russia. The cluster analysis is a multidimensional statistical procedure that collects data containing information about a sample of objects, and then arranges objects into relatively homogeneous groups. It is used in many fields: medicine, biology, psychology, chemistry, philology, and sociology. One of the main advantages of cluster analysis is the visibility of clustering visualization.

The analysis was provided by using the SPSS Statistics software (VERSION 18.0.2) (k-means method). K-means method consists in determining the reference clusters, and then each object is attached to the nearest standard. The minimum distance within the cluster relative to the average is used as a criterion.

Analysis of the results obtained from the second part of the survey was carried out separately using the MS Excel software (ms 16.0).

**Table 2.** The structure of the first part of the conducted survey.

The Question	Answer Option
1. What is your attitude towards nuclear power facilities (including the potential nuclear power facilities) near the territory of your current residence? (variable "Attitudes_towards_nuclear energy")	1. Positive 2. Neutral 3. Negative
2. Do you consider nuclear energy as a type of safe and green energy source? (variable "Is_the_nuclear_energy_green_and_safe")	1. Yes 2. No 3. It is hard to answer
3. In your opinion, could renewable energy become the dominant part of energy production in the country of your current residence? (variable "Attitudes_towards_renewable_energy_implementation")	1. Yes, it could 2. No, it couldn't 3. It is hard to answer
4. Would you prefer the development of renewable or nuclear energy in the territory of your current residence? (variable "Attitudes_towards_development_green_and_nuclear_energy")	1. I would prefer only the development of renewable energy 2. I would prefer only the development of nuclear energy 3. I would prefer development of both types of energy facilities 4. I would prefer the development of traditional energy

**Table 3.** The structure of the second part of the conducted survey.

The Question	Evaluation Scale
1. How would you assess the level of energy development in your country (the efficiency of energy sector management, the use of the best available technologies, the state of energy infrastructure)?	1. Evaluation from 1 to 4 points: I estimate it negatively
2. How would you assess the state's energy policy?	2. Evaluation from 5 to 7 points: I estimate it as normal
3. How would you assess the actions of the state in the framework of support and development of green energy?	3. Evaluation from 8 to 10 points: I estimate it positively
4. How would you assess the level of energy security in your country?	

#### 4. Results and Discussion

Cluster analysis is an effective tool that allows dividing objects of the analysis (the answers of the respondents in the present study) not by the only option but by a number of features [51]. As a result of the cluster analysis (1st part of the survey), three clusters of Italians were identified (Tables 4 and 5).

**Table 4.** Results of cluster analysis of Italian students.

Variable	Cluster's Number		
	№1	№2	№3
Attitudes_towards_nuclear energy	1	2	3
Is_the_nuclear_energy_green_and_safe	1	2	2
Attitudes_towards_renewable_energy_implementation	2	2	1
Attitudes_towards_development_green_and_nuclear_energy	3	3	1

**Table 5.** Number of observations in each cluster.

Cluster's Number	Number of Observations
Cluster №1	9
Cluster №2	12
Cluster №3	29
Valid observations	50
Missed observations	0

Based on the results of the cluster analysis, the following three clusters were identified:

- cluster “Positive attitude towards nuclear energy” (cluster №1).
- cluster “Neutral attitude towards nuclear and renewable energy” (cluster №2).
- cluster “Negative attitude to nuclear energy” (cluster №3).

The smallest cluster “Positive attitude towards nuclear energy” (cluster №1) comprised only 18% of respondents. Representatives of the cluster consider nuclear power to be green and note the low potential of renewable energy as part of the full replacement of traditional energy facilities. The cluster members support the development of both nuclear and renewable energy. Identification of this cluster might be atypical for the Italian young generation as Italy does not accept this type of energy on the government level and according to the results of the previous study, Italians have a low level of awareness of the topic of nuclear energy.

Cluster №2 “Neutral attitude towards nuclear and renewable energy” includes 24% of the respondents. Representatives of the cluster are characterized by a neutral attitude to nuclear energy, do not assess it as safe and alternative, but support its development in Italy in conjunction with the development of renewable energy.

Cluster №3 “Negative attitude to nuclear energy” is the biggest identified cluster that includes 58% of the respondents. All of them have a negative attitude to the appearance of nuclear power facilities in their territory of residence (Italy) and do not consider nuclear power to be a safe alternative. The respondents of this cluster assess the high potential of renewable energy and support only its development. The quantitative benefit of the cluster is due to the present energy policy of Italy: the development of RES is a top priority for the country’s development in the near future.

Thus, the majority of young Italian people showed a negative attitude towards nuclear energy and its potential development, which is connected with the current policy of the Italian government in the field of energy and the high level of development of renewable energy in the country.

Tables 6 and 7 provide the final centers of the obtained clusters for Russians.

**Table 6.** Results of cluster analysis of Russian students.

Variable	Cluster's Number		
	№1	№2	№3
Attitudes_towards_nuclear_energy	1	1	3
Is_the_nuclear_energy_green_and_safe	2	1	2
Attitudes_towards_renewable_energy_implementation	2	2	2
Attitudes_towards_development_green_and_nuclear_energy	3	2	1

**Table 7.** Number of observations in each cluster.

Cluster's Number	Number of Observations
Cluster №1	20
Cluster №2	31
Cluster №3	11
Valid observations	62
Missed observations	0



Based on the results of the cluster analysis, the following three clusters were identified:

- cluster “Positive attitude to nuclear energy and to the potential of RES use” (cluster №1).
- cluster “Positive attitude towards nuclear energy” (cluster №2).
- cluster “Negative attitude to nuclear energy” (cluster №3).

Cluster №1 “Positive attitude to nuclear energy and to the potential of RES use” includes 32% of respondents and has a number of conceptual differences from the other identified clusters: the respondents forming this cluster do not include nuclear energy in the sector of green energy, but they support its development on an equal basis with renewable energy. In addition, the cluster participants also do not share the opinion that RES can fully replace traditional energy facilities.

Cluster №2 “Positive attitude towards nuclear energy” (cluster №2) is the biggest cluster and includes 50% of all respondents. The cluster’s participants have a positive attitude towards nuclear power facilities in their region, support its development, and do not assess the potential of RES at a high level: most of the respondents do not share the opinion that renewables can fully replace traditional energy facilities and do not support the development of this energy sector. Thus, the cluster has congeniality with cluster №1—respondents of neither cluster believe that traditional energy can be fully replaced by renewable energy facilities.

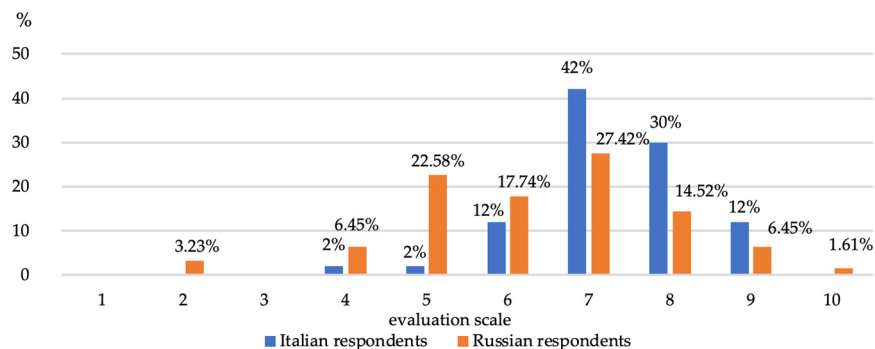
Cluster “Negative attitude to nuclear energy” is the smallest cluster that includes only 18% and is characterized by an extremely negative attitude towards nuclear energy. Despite this, the respondents also do not share the opinion that RES can fully replace traditional energy facilities in Russia, but they are ready to support their construction and development.

Thus, 51 out of 62 respondents showed a positive attitude towards the development of nuclear energy in Russia, forming two clusters. At the same time, the participants of only the first cluster refer to nuclear energy as green energy and support only its development on the territory of the Russian Federation. Participants in the other two classes demonstrate a more positive attitude towards renewable energy sources and are willing to support their development as well.

The results obtained during the cluster analysis generally related to the level of development of nuclear energy in Russia: currently, the Government of the Russian Federation is implementing a number of large-scale projects for the construction of nuclear power plants in the regions and supports scientific and technical research in this industry [46].

The second part of the survey included four questions with an evaluation scale from 1 to 10. The purpose of this part of the survey was to analyze the attitude of the young generation of both countries towards present energy policy and their opinion about the present condition of the energy sector.

The first question was to evaluate the development level of the energy sector (Figure 6).

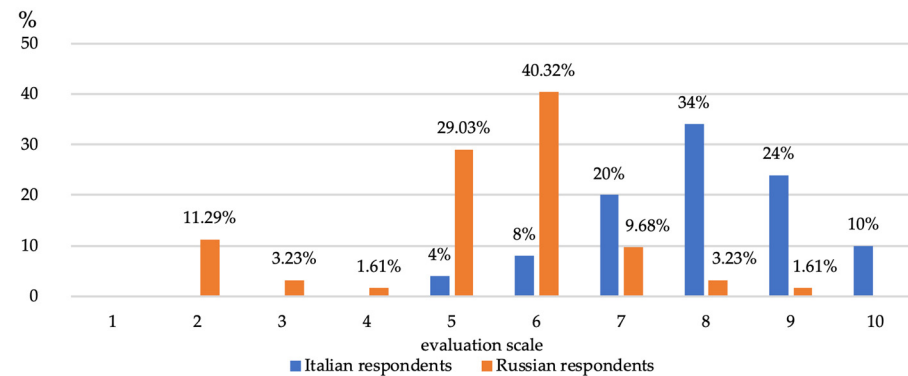


**Figure 6.** Structure of answers to the question “How would you assess the level of energy development in your country?”.

The majority of Italian respondents rated the development level of the energy sector as high: 84% of them rated it from 7 to 9 points. Only 2% of respondents evaluated it below

4 points in comparison to 9% of Russian respondents. Most of them assessed the level of the energy sector's development from 5 to 7, which corresponds to the normal level. Only 22.58% of the Russian respondents evaluate the development level as high.

The second question of the second part of the survey was to evaluate the present energy policy in their country (Figure 7).



**Figure 7.** Structure of answers on the question "How would you assess the state's energy policy?".

According to the given results, Italian respondents support the present energy policy: 68% of the respondents ranked it from 8 to 10 points. The majority of Russian respondents ranked the present energy policy from 5 to 7 points, which corresponds to the normal level of evaluation. However, 16.13% of them assessed it at the lowest level (from 2 to 4 points), which means that some of them completely do not support the government in the field of the energy sector's development.

The last two questions of the second part of the survey were to evaluate the government's action in the field of green energy development (Table 8) and to evaluate the level of energy security in their country (Table 9).

**Table 8.** Structure of answers on the question "How would you assess the state's energy policy?".

Evaluation Scale	% of Italian Respondents	% of Russian Respondents
From 1 to 4 points	2.00	29.03
From 5 to 7 points	34.00	62.90
From 8 to 10 points	64.00	8.06

**Table 9.** Structure of answers on the question "How would you assess the level of energy security in your country?".

Evaluation Scale	% of Italian Respondents	% of Russian Respondents
From 1 to 4 points	10.00	4.84
From 5 to 7 points	70.00	37.10
From 8 to 10 points	20.00	58.06

The Italian respondents' attitude towards government activity in the field of green energy development is positive: 64% of them ranked it at the highest level, 34% of them assessed it from 5 to 7 points. However, 29% of Russian respondents demonstrated a negative attitude towards the Russian government's green energy policy (ranked it from 1 to 4 points). The majority of them (62.9%) assessed it as normal.

Respondents from both countries assessed the level of energy security highly: 70% of Italian respondents ranked it from 5 to 7 points, 20% from 8 to 10 points; 58.06% of Russian respondents assessed it from 8 to 10 points, 37.10% from 5 to 7 points.

The following conclusions could be drawn from the second part of the survey:

- Italian respondents assessed the level of energy development in Italy highly whereas Russians assessed it as “normal”. The identified trends may be due to the level of renewable energy development in both countries: at present, it is the presence of RES that can characterize the level of development of the energy sector as high. In Russia, renewable energy is only at the initial stage of development, while in Italy, more than 11% of the energy consumed is accounted for by RES.
- The Italian young generation supports the present energy policy: 68% of the respondents ranked it from 8 to 10 points. That trend might correlate with the results obtained during the cluster analysis: the Italian government supports RES development and the biggest identified clusters of the respondents support further RES development.
- Italian respondents showed a positive attitude towards the present energy policy in Italy, whereas 29% of Russian respondents demonstrated a negative attitude towards the Russian government’s green energy policy (ranked it from 1 to 4 points). The uncovered trend might correlate with the low level of green energy development in Russia and the predominance of traditional energy facilities in the structure of the energy sector.
- The reason for the higher ranking of the energy security level from Russians might be the low cost of electricity in the residential sector and large deposits of natural resources in Russia.

There is an obvious relationship between the attitude of young people to nuclear energy and the level of its development (or lack of it) in the territory of their country of residence. Public acceptance of nuclear energy mostly depends on the following factors: normative beliefs [52], the level of population’s awareness in the field of nuclear energy [32], the fact of NPP operation in the country [53], and the present energy policy and political environment [53–56]. The last factors, the national energy policy and political environment, might have a considerable impact on nuclear energy development as the government can directly affect the public attitude towards different energy sources through various information tools and social campaigns [52]. If the government does not support nuclear energy, the population also demonstrates a negative attitude.

However, the absence of accidents on nuclear energy facilities over the years and the need of providing stable access of households to electricity positively affect the public attitude. For instance, in the U.S., both of these factors led to the increase of public acceptance of nuclear energy from 49% in 1983 to 65% in 2016 [53]. Thus, the positive attitude of Russians to nuclear energy may be due to its effectiveness and prospects in providing stable energy access in remote areas of the country.

The same trends could be observed in the field of renewable energy. The population of European countries supports the transition to the low-carbon economy and RES implementation. Public perception of renewable energy in most European countries is on the high level that might be related to the level of RES development in the EU and the present European energy policy [57–59]. However, at the end of 2021, the EU has started considering nuclear energy as one of the ways to achieve sustainability and to implement circular economy principles in the energy sector [60]. The population of lead countries in the field of nuclear energy also demonstrates a positive attitude towards renewable energy [32,53] which corresponds to the given results of the present study.

The results of the present study allowed us to identify three main groups with different attitudes towards both considered types of energy among Italian and Russians. The authors uncovered the group of Italians that showed a positive attitude towards nuclear energy. This implies that some part of the population could have a different view regarding the national energy policy. The study also focused on the attitude of the young generation towards the national energy policy and their opinion about the present condition of the national energy sector. Respondents from Italy demonstrated a higher level of government support in the field of energy development in comparison to Russian respondents, which might be related to the different levels of renewable energy development in both countries.

The group of respondents selected for this study was specifically students who were studying at the University of Trento (Italy) and Ural Federal University (Russia) at engineering faculties. The age of respondents was 20–26 years. The results obtained in this study may not be applicable to other age groups in both countries. It is needed to increase the number of respondents in the next studies to produce more accurate results.

In conclusion, young people from Russia demonstrated a low level of awareness of renewable energy issues that are related to the low level of its development in Russia. A similar situation is observed in the attitude of the Italian population to nuclear energy: the refusal of the Italian government to use nuclear energy is connected with a low level of confidence in this energy sector among young people.

Finally, it must be taken into account that the nuclear issue does not have a homogeneous vision as demonstrated in the recent COP26 summit, where the EU countries showed divisions in considering nuclear energy as a green source [61]. In spite of that, some literature underlines the potentialities of nuclear energy to help close the loop of CE [62].

## 5. Conclusions

The obtained results confirm the existence of a correlation between the state policy in the field of energy and the current structure of the energy complex with the attitude of the population to a particular type of energy:

- Russian respondents showed mostly the positive attitude towards nuclear energy development, owing to the level of development of nuclear energy in Russia: currently, the Government of the Russian Federation is implementing a number of large-scale projects for the construction of nuclear power plants in the regions and supports scientific and technical research in this industry;
- the majority of Italian respondents showed a negative attitude towards nuclear energy and its potential development that is due to the current policy of the Italian government in the field of energy and the high level of development of renewable energy in the country.

The results of cluster analysis demonstrated a different attitude of young people in Russia and Italy towards nuclear energy. Two of the three clusters of Italians (cluster №2 and cluster №3) showed a negative or distrustful attitude towards nuclear energy and its development, while representatives of all three clusters have a positive attitude towards the development of renewable energy.

Two of the three identified clusters of Russians evaluate nuclear energy positively and support its further development. At the same time, cluster №1 opposed the development of renewable energy, while the other two clusters support its further development on the territory of the Russian Federation jointly or separately from the development of nuclear energy.

According to the given results, public opinion and the level of people's awareness about nuclear and/or renewable energy have a role to play in their development. Consequently, it is important to implement special programs at the state level that will aim to change public opinion in a positive way regarding different types of energy and to increase people's awareness about the advantages and risks of the operation of the various energy facilities. It might significantly accelerate the transition to the new sustainable and low-carbon world economy and increase the level of social and environmental sustainability.

Nuclear and renewable energy development in EU and non-EU countries are the most promising areas of the energy sector eco-modernization. Both considered types of energy meet the requirements of sustainable development and might be used as an effective tool for the implementation of CE principles in the energetics in the immediate future.

The present work opens to future developments useful to support the decision-makers involved in strategies in the energy sector in the EU and non-EU countries.

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