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GREEN TRANSITION: THE CASE OF TURKEY AND CENTRAL ASIA COUNTRIES

Green transition is the most pressing issue in the modern world and demands collaborative action at the global level. In this context, Turkey, Azerbaijan, Kazakhstan, and Uzbekistan adopted a green agenda to achieve clean electricity production by 2030. Azerbaijan even hosted the world's largest conference on climate change in November 2024. The relevance of the work is a hotly debated issue both globally and within these countries. The study tests the hypothesis that most people are climate responsible and aware. The result showed that people share responsibility for the climate. In addition, the survey questions (100 participants for each country) concerned the root cause of climate change, green energy engineers/experts, and the substitution of the oil and gas sector for renewable energy sources. Concerning green experts, respondents believe that in the future, there will be enough of them. In Turkey, Azerbaijan and Kazakhstan, respondents consider industry/ business the main cause of climate change, while in Uzbekistan, they chose the "people" option. Can renewable energy sources replace the oil and gas sector? Respondents from Turkey (70%) and Kazakhstan (80%) answered "yes". In Azerbaijan, 39% of respondents said "no", 38% – "yes", while in Uzbekistan 80% of participants answered "don't know". Additionally, the Pearson correlation and linear regression methods were also used to identify the relationship between electricity production

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ЗЕЛЕНИЙ ПЕРЕХІД: КЕЙС ТУРЕЧЧИНИ ТА КРАЇН ЦЕНТРАЛЬНОЇ АЗІЇ

Зелений перехід є найактуальнішим питанням у сучасному світі та потребує спільних дій на глобальному рівні. У цьому контексті Туреччина, Азербайджан, Казахстан і Узбекистан прийняли зелений порядок денний, щоб досягти виробництва чистої електроенергії до 2030 р. Азербайджан навіть став господарем найбільшої у світі конференції з питань зміни клімату в листопаді 2024 р. Актуальність роботи є гостро дискутованим питанням як у світовому масштабі, так і в рамках цих країн. У ході дослідження перевіряється гіпотеза, що більшість людей є кліматично відповідальними та обізнаними. Результат показав, що люди поділяють відповідальність за клімат. Крім того, запитання опитування (по 100 учасників для кожної країни) стосувалися першопричини зміни клімату, інженерів/експертів із зеленої енергетики та заміни нафтогазового сектору на відновлювані джерела енергії. Щодо зелених експертів, то респонденти вважають, що в майбутньому їх буде достатньо. У Туреччині, Азербайджані та Казахстані респонденти вбачають промисловість/бізнес основною причиною зміни клімату, тоді як в Узбекистані вони вибрали варіант "люди". Чи можуть відновлювані джерела енергії замінити нафтогазовий сектор? Респонденти з Туреччини (70%) та Казахстану (80%) відповіли "так". В Азербайджані 39% опитуваних сказали "ні", 38% – "так", тоді як в Узбекистані 80% учасників відповіли "не знаю". Також для визначення зв'язку між виробництвом електроенергії та зростанням чисельності населення використано кореляцію Пірсона та методи



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and population growth. Population growth contributes to an increase in electricity production by 9.98 units in Turkey, 6.98 in Azerbaijan, 13.62 in Kazakhstan, and 3.03 units in Uzbekistan.

Keywords: renewable energy, research, transition, investment, climate.

лінійної регресії. Приріст населення сприяє збільшенню виробництва електроенергії на 9.98 од. у Туреччині, 6.98 в Азербайджані, 13.62 в Казахстані та 3.03 од. в Узбекистані.

Ключові слова: відновлювана енергія, дослідження, перехід, інвестиції, клімат.

JEL Classification: Q21, Q22, Q27, Q28.

Introduction

Transition to clean, environmentally friendly energy usage is one the most complex tasks of today's humanity. Preventing global climate change and temperature rise depends on hand-in-hand or collaborative action and future vision. The modern world is already likely to be ready to wean fossil fuels off and accelerate the shifting process to renewables. The countries, Turkey, Azerbaijan, Kazakhstan, and Uzbekistan that comprise the topic of this research, generate most of their electricity from fossil fuels, approximately 80–90%. Therefore, their green agenda and future-forward policies must be examined.

As green energy can play a pivotal role in preventing our sole planet from destruction, researchers around the globe focused on improving energy transition issues from a scientific point of view. Bilgin and Kara (2024) collected people's comments, made only energy-related news on the YouTube social platform, and revealed Turkey's public attitudes towards all energy sources. The result showed that people have a great interest in nuclear, hydro, solar, wind, geothermal, and biomass – respectively.

Umarov (2024) examined the weak and strong sides of renewables in Uzbekistan in the framework of solar energy and noted that the lack of financing and public awareness is on the list of weakest sides. To prove this notion, we carried out a survey among the Uzbek population.

The production of green hydrogen in Kazakhstan was explored by Tleubergenova et al. (2023), and they came to the result that two million tonnes of green hydrogen would demand 30 gigawatts of power. Additionally, the minerals (gold, copper, molybdenum, etc.) demanded for the manufacturing of solar and wind devices were determined.

Humbatova et al. (2019) explored the relationship between electricity consumption and people's income in Azerbaijan. According to the research, a 1% increase in electricity consumption of the population diminishes their income by 20.5%. Hampel-Milagrosa et al. (2020) research predicted that population growth is expected in Azerbaijan in the near future.

DW Planet A's (2023, September 15) exploration of the carbon emissions of renewables proved that solar and wind energy production also emits 40 g and 16 g carbon emissions per kilowatt hour, respectively.

The aim of the research is to assess people's approach towards green energy transition and to identify people-electricity connections. The study tests the hypothesis that most people are climate responsible and aware. The survey method was utilized to conduct research, and the results indicated a positive approach. The purpose of the study:

- examining the green policy of the countries, green investors, green projects, and targets;
- surveying people to reveal their opinions on the ongoing green transition;
- to identify the relationship between population growth and electricity production.

The main methods of research are statistical, comparative, survey, correlation, and regression analyses.

All studies have centered on renewable energy production and public attitude (through the Internet). Studying people's approach to renewables in Turkey, Azerbaijan, Kazakhstan, and Uzbekistan can be called the research gap. That is why we conducted a survey to determine people's thoughts on wind and solar energies. The survey consists of 4 questions and has 100 respondents from each country. The questions are the following:

- Which of the following caused climate change the most?
- Is each of us responsible for combating climate change?
- Are there enough experts in the field of green energy in your country?
- Can renewable energy replace the oil-gas sector?

The structure of the research consists of three sections. The first and second sections are dedicated to green energy policy and projects and green energy surveys, respectively, and the last section discusses population growth and electricity production relationships.

1. Renewable energy transition in Turkey, Azerbaijan, Kazakhstan and Uzbekistan

Turkey, Azerbaijan, Kazakhstan, and Uzbekistan utilize fossil fuels (oil, natural gas, coal) to generate electricity. Except for Turkey, the rest of the countries have massive hydrocarbon reserves. That is why large-scale extraction and usage of fossil fuels are understandable in those countries. Now, the modern world has difficulty preventing global warming and keeping 1.5 °C within reach. All countries in the world, including Turkey, Azerbaijan, Kazakhstan, and Uzbekistan, take significant steps and provide unwavering support in the renewable energy field in order to reach clean and green energy targets and reduce greenhouse gas (GHG) levels. As for targets, we need to look at *Table 1* to comprehensively understand the countries' transition process.

Table 1

The countries' targets and incentives for green transition

Targets and incentives	Turkey	Kazakhstan	Uzbekistan	Azerbaijan
GHG target 2030	41% reduction (base year 2012)	15–25% reduction (base year 1990)	35% reduction (base year 2010)	35% reduction (base year 1990)
RE production target in energy mix	50% share by 2030 80% by 2053	15% by 2030	40% by 2030	35.5% by 2030
Tax and incentives	Machinery and equipment purchases and importation (related to renewables) are exempted from VAT and import duties. Corporate tax reduction depends on the region and investment scale. The guaranteed purchase price for a specific period in the feed-in tariff	The guaranteed purchase price for a 15 year period in the feed-in tariff. Areas for the installation of renewables are exempted from property and land tax. Machinery and equipment importation (related to renewables) is exempted from import duties. Corporate income tax reduction depends on the region and investment scale. Green auction	Introduces tax incentives for renewable energy producers. Reducing corporate income tax property tax by 50%. Machinery and equipment importation (related to renewables) is exempted from import duties. Areas for the installation of renewables are exempted from land tax (or at reduced rate). The guaranteed purchase price for a specific period in the feed-in tariff	Machinery and equipment importation (related to renewables) is exempted from import duties. Areas for the installation of renewables are exempted from land tax. Import of electric vehicles is exempted from VAT. Corporate tax exemption

Source: made by the author from AzStat (n. d.); TÜİK (n. d.); QazStat (n. d.); Statistic Agency of Uzbekistan (n. d.); Yalçın (2024, February 22); Uzbekistan – Introduces tax incentives for renewable energy producers (n. d.).

Table 1 shows what steps have been undertaken by the countries to accelerate smooth transition. By 2030, Turkey aims to achieve a 41% GHG reduction compared to 2012, 50% renewables share in entire electricity production (by 2053, 80%).

Machinery and equipment purchases and importation (related to renewables) are exempted from value-added tax (VAT) and import duties not only in Turkey but also in Azerbaijan, Kazakhstan, and Uzbekistan. Corporate tax reduction or exemption has been implemented in these countries, and land areas allocated to install renewable energy devices have an exception from property or land tax. The guaranteed purchase price for electricity in the feed-in tariff system has been adopted and measured.

With respect to the GHG target, Azerbaijan plans a 35% reduction (base year 1990), Kazakhstan 15–25%, and Uzbekistan 35% (base year 2010) until 2030 (KAZ Policy Brief (2022)). Regarding green energy production in the energy landscape, Azerbaijan aims to achieve a 35.5% share, Kazakhstan 15%, and Uzbekistan 40% by 2030.

At this point, we should scrutinize renewable energy companies that have made investments in the countries and implemented clean energy projects (*Figure 1*).

Turkey	Azerbaijan	Kazakhstan	Uzbekistan
<ul style="list-style-type: none"> • TotalEnergies • JinkoSolar Holding Co. LTD • Statkraft AS • Gangfeng Lithium Group • IC İÇTAŞ Energy Investment Holding • Sanko Energy Group • Akxa Energy • Akfen Renewables • Kalyon Holding 	<ul style="list-style-type: none"> • Masdar • Nobel Energy Management • ACWA Power • TotalEnergies • China Gezhouba Group Overseas Investment • Notus • Fortescue Future Industries • bp • Czech Engineering • SOCAR Green 	<ul style="list-style-type: none"> • Masdar • Total Eren • China Power International Holding • Universal Energy • Samruk-Energy • Kazakh National Invest Holding • SVEVIND Energy Group 	<ul style="list-style-type: none"> • Masdar • ACWA Power • Voltalia • Gezhouba Overseas Investment Group • China Datang Overseas Investment

Figure 1. Renewable energy companies

Source: compiled by the author.

Figure 1 clearly shows both local and international companies that invested in the renewable energy sector of Turkey, Azerbaijan, Kazakhstan, and Uzbekistan. Masdar is the most active player and has partnered with Azerbaijan, Kazakhstan, and Uzbekistan, while ACWA Power invested in Azerbaijan and Uzbekistan. Fossil fuel company TotalEnergies has collaborated with Azerbaijan and Turkey.

Besides that, if we highlight the renewable energy partners of the countries, the list of them is this:

- JinkoSolar Holding Co. LTD, Statkraft AS, Gangfeng Lithium Group, IC İÇTAŞ Energy Investment Holding, Sanko Energy Group, Akxa Energy, Akfen Renewables, Kalyon Holding have invested in Turkey;

- Nobel Energy Management, China Gezhouba Group Overseas Investment, Notus, Fortescue Future Industries, bp, Czech Engineering, (SOCAR Green local company) in Azerbaijan;

- Total Eren, China Power International Holding, Universal Energy, Samruk-Energy, Kazakh National Invest Holding, SVEVIND Energy Group in Kazakhstan;

- Voltalia, Gezhouba Overseas Investment Group, China Datang Overseas Investment in Uzbekistan.

ACWA Power’s second-largest market is Uzbekistan, with a portfolio of 11.4 gigawatts (9.9 out of which is green energy). In Azerbaijan, Masdar owns the biggest renewable energy portfolio, with precisely ten portfolios (Salian, 2024, November 1).

If we know what companies have made investments in the green energy field in the countries, the next step must be to illustrate the projects on the map of the countries in order to perceive the ongoing shifting journey more accurately (*Figures 2–5*).

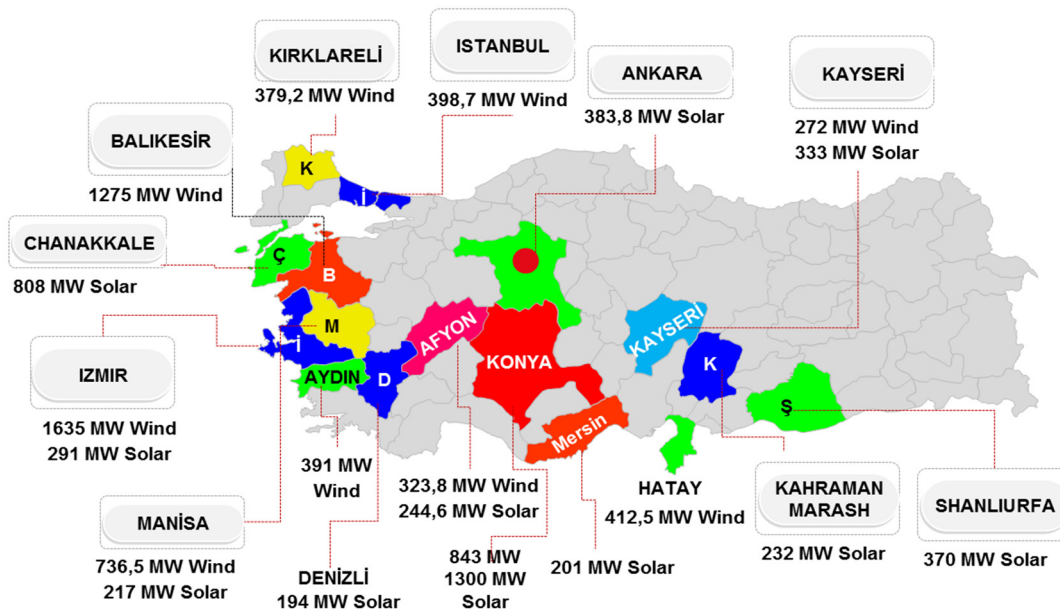


Figure 2. Turkey’s main wind and solar map

Source: made by the author based on TurkStat (n. d.), and Kaya (2021).

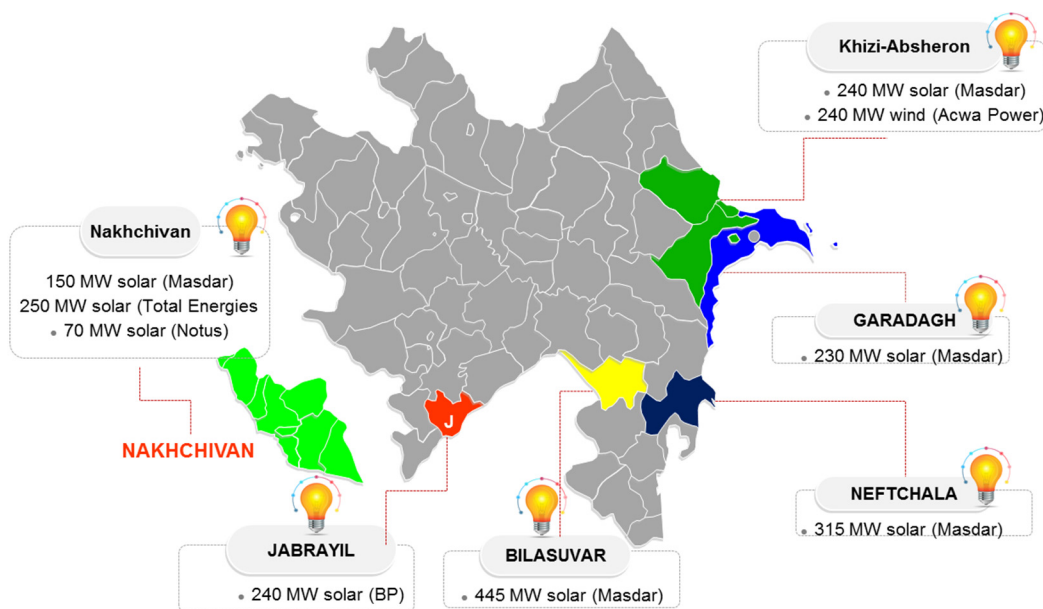


Figure 3. Azerbaijan’s wind and solar map

Source: made by the author based on Azerbaijan Renewable Energy Agency (n. d.).

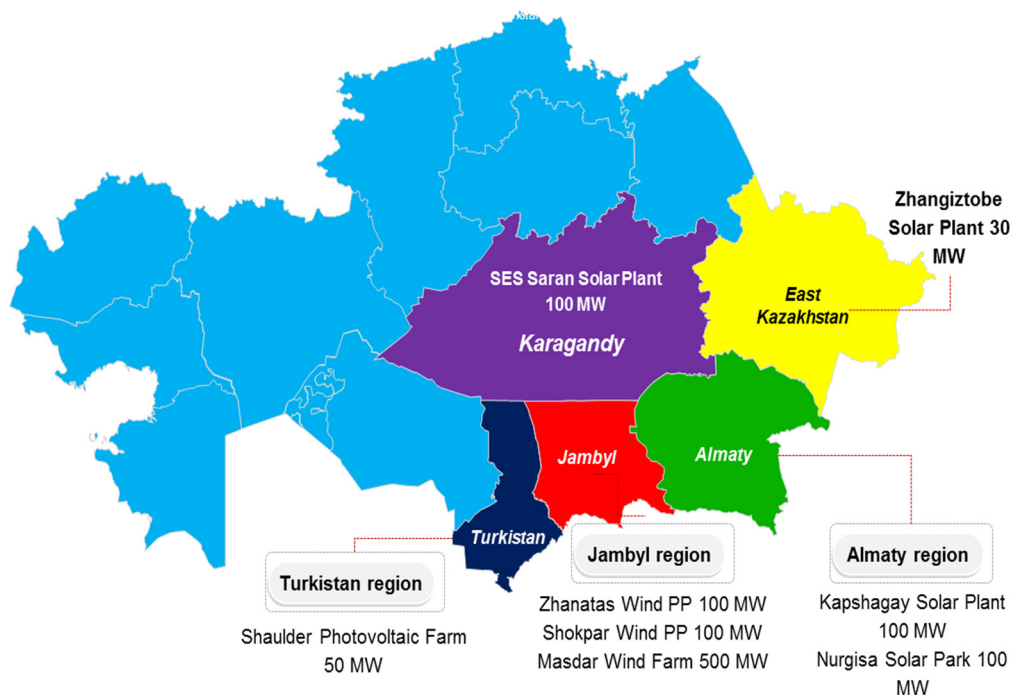


Figure 4. Kazakhstan’s wind and solar map

Source: made by the author based on Onsat (2023, September 28).

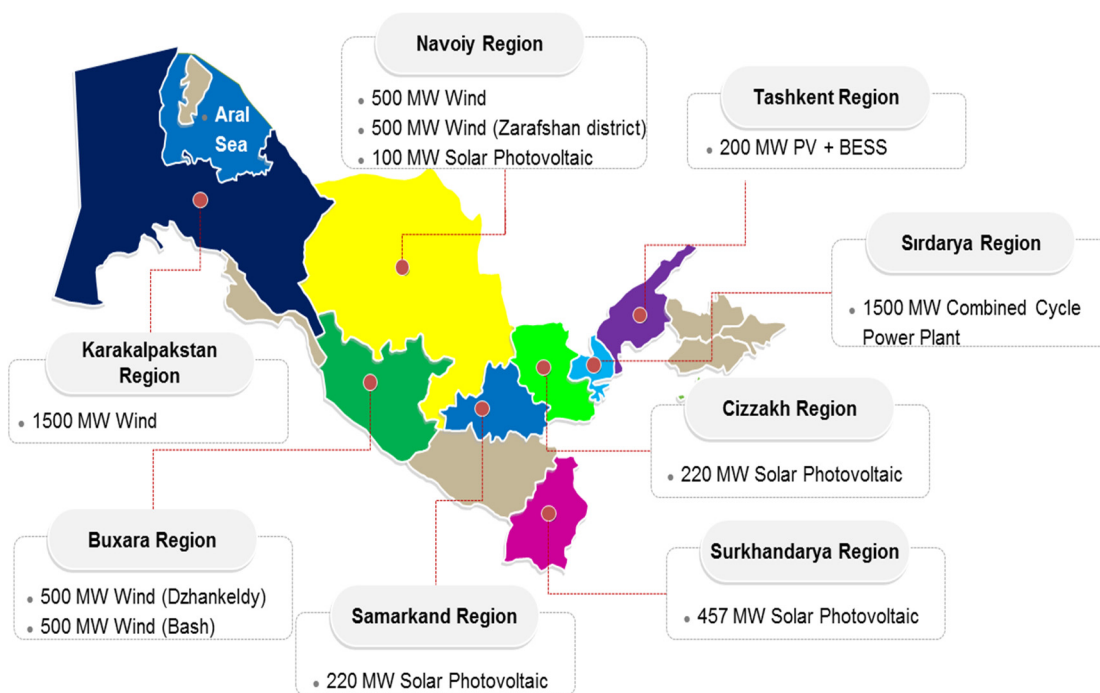


Figure 5. Uzbekistan’s wind and solar map

Source: made by the author based on Guliyev (2024).

As we look at the maps, initially, we see that Konya, Izmir, Balikesir, Manisa, and Chanakkale are leading renewable energy zones in Turkey. In Azerbaijan, Khizi-Absheron, Nakhchivan Bilasuvar regions, in Kazakhstan, Jambyl and Almaty, and in Uzbekistan, Karakalpakstan, Navoiy, and Bukhara regions have taken leadership in the field of green energy, especially wind and solar.

We have to note the fact that Azerbaijan, Kazakhstan, and Uzbekistan agreed to export clean electricity to Europe in the near future (Sakenova, 2024, November 13). The Green Energy Corridor starts in Azerbaijan and ends in Hungary, with a capacity of 4 gigawatts. Besides that, Kazakhstan is going to export 2 million tons of green hydrogen to the European Union (EU) by 2030. With this amount, the EU will meet 20% of its hydrogen demand (bne Intellinews, 2024, September 21).

2. Green energy surveys

The second line of our study has focused on a questionnaire in the renewable field. The number of participants in our survey is 100 for each country. The first question is related to climate awareness and the root cause of this irreversible change (*Figure 6*).

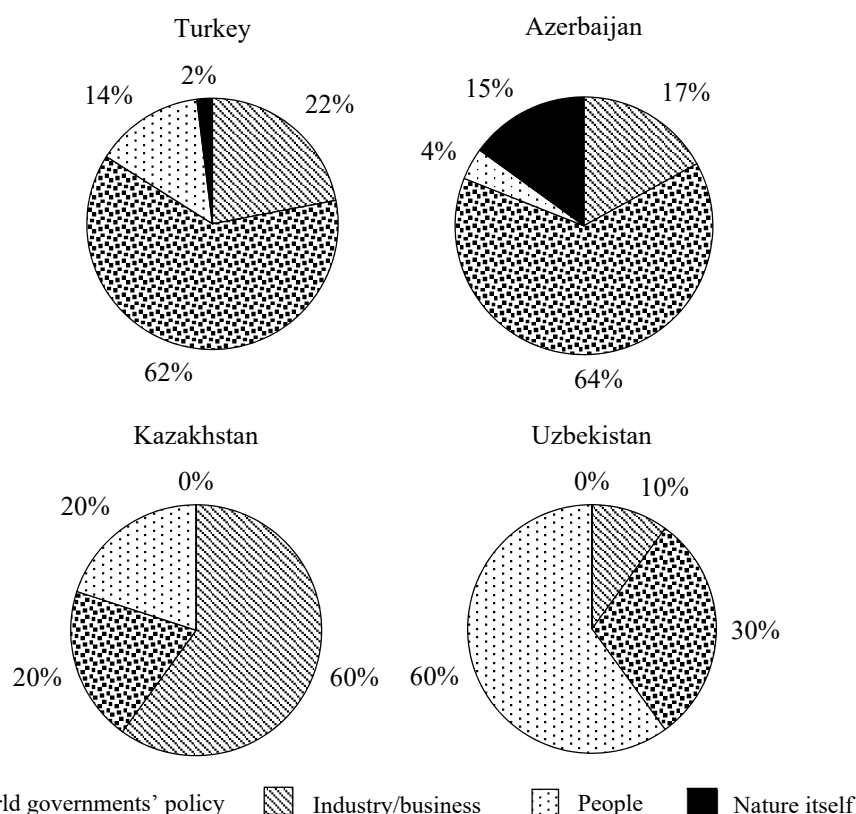


Figure 6. Climate change question

Source: made by the author.

Figure 6 shows that respondents from Turkey, Azerbaijan, and Kazakhstan believe that the industry/business sector is the culprit of climate change 62%, 64%, and 60%, respectively. Our surveyors from Uzbekistan (60%) noted that people are most responsible for climate disasters. The next questions below investigate the climate responsibilities and skilled people in the clean energy field of the countries (Figures 7; 8).

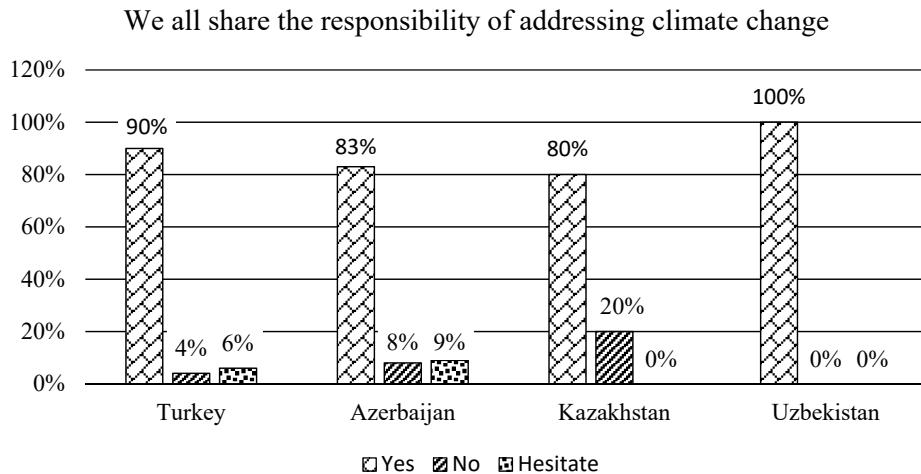


Figure 7. Climate responsibility question

Source: made by the author.

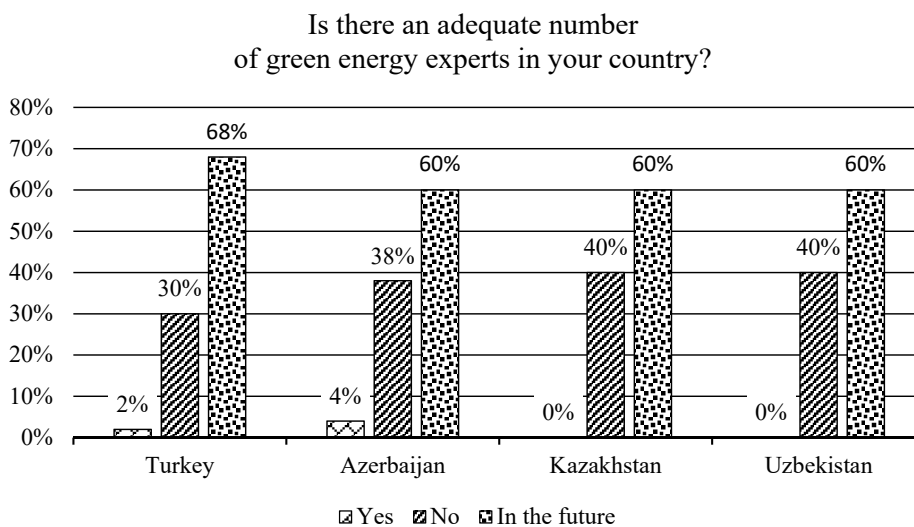


Figure 8. Question regarding green experts

Source: made by the author.

The question is, "Each of us has the responsibility to tackle climate change", and respondents from all countries strongly supported this idea, precisely 90% from Turkey, 83% from Azerbaijan, 80% from Kazakhstan, and 100% from Uzbekistan. Only a small part out of 100 did not consider the responsibility seriously, 4% in Turkey, 8% in Azerbaijan, and 20% in

Kazakhstan. There is a hesitation among respondents only from Turkey and Azerbaijan, 6% and 8%, respectively.

Transitioning to new energy sources demands relevant, skilled, profound knowledge of experts and employees. With respect to this, we asked people how they consider the current situation in the renewables field (*Figure 8*).

According to the results displayed above in *Figure 8*, all surveyors deem that, in the present situation, there is a lack of skilled labor in the green energy field. All of them noted that in the future, green energy experts would be available in their countries (68% Turkey, 58% Azerbaijan, 60% Kazakhstan and Uzbekistan). Only 2% in Turkey and 4% in Azerbaijan believe that there are enough experts.

The last survey question was concerning the replacement of the oil and gas sector by renewables (*Figure 9*).

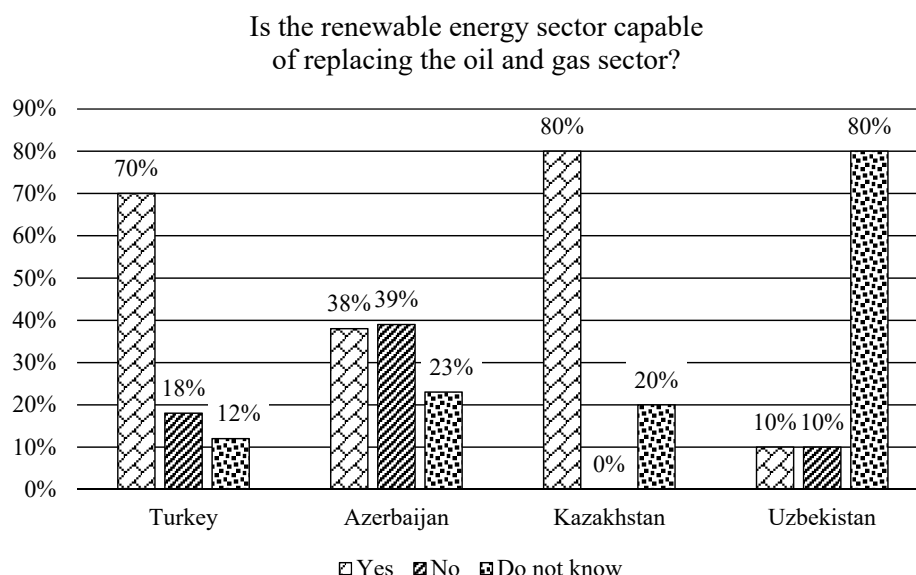


Figure 9. Question regarding green energy and oil and gas

Source: made by the author.

Figure 9 displays the opinions of the people on the substitution, and only the respondents in Turkey and Kazakhstan are in line with the positive approach, 70% and 80%, respectively. In Azerbaijan, surveyors tend to think that renewables cannot substitute the oil and gas sector, precisely 39%. 38% believe that it is possible, and 23% said "don't know." People in Uzbekistan remained neutral, and 80% chose the "don't know" option.

3. The investigation of relationship between population growth and electricity production

The last section of the research aims to identify the available connection between population growth and demand for electricity

production. To this end, we conducted the Pearson correlation and simple linear regression. The correlation formula is following (Coskun et al., 2019):

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \sum(y_i - \bar{y})^2}}, \quad (1)$$

where: r – correlation coefficient;

x_i – values of the x variable;

\bar{x} – mean of the values of x variable;

y_i – values of the y variable;

\bar{y} – mean of the values of y variable.

As secondary data, we collected statistical material for all countries in the period of 2010–2022. The correlations that have been conducted for each country are as follows (Table 2).

Table 2

The Pearson Correlation for the studied countries

Indicators		Total electricity, kWh billion	Population, million
<i>Azerbaijan</i>			
Electricity production	Pearson Correlation	1	0.922*
	Sig. (2-tailed)		0
	N	13	13
Population	Pearson Correlation	0.922*	1
	Sig. (2-tailed)	0	
	N	13	13
<i>Turkey</i>			
Electricity production	Pearson Correlation	1	0.986*
	Sig. (2-tailed)		0
	N	13	13
Population	Pearson Correlation	0.986*	1
	Sig. (2-tailed)	0	
	N	13	13
<i>Kazakhstan</i>			
Population	Pearson Correlation	0.996*	1
	Sig. (2-tailed)	0	
	N	13	13
Electricity production	Pearson Correlation	1	0.996*
	Sig. (2-tailed)		0
	N	13	13
<i>Uzbekistan</i>			
Uzbek population	Pearson Correlation	0.949*	1
	Sig. (2-tailed)	0	
	N	13	13
Uzbek electricity production	Pearson Correlation	1	0.949*
	Sig. (2-tailed)		0
	N	13	13

* Correlation is significant at the 0.01 level (2-tailed).

Source: made by the author.

Our correlations above determined that there are solid and positive relationships between population and electricity production. As a result of this identification, we applied simple linear regression (Coskun et al., 2019):

$$Y_i = \alpha + \beta_i + \varepsilon_i, \quad (2)$$

where: Y – y coordinate;
 i – observations
 α – y intercept;
 β – slope.

Simple linear regression was conducted with the help of SPSS software and is as follows (Table 3):

Table 3

Regression analysis for the studied countries

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
<i>Azerbaijan</i>					
(Constant)	-42822.155	8549.675		-5.009	0
Population, million	6.987	0.887	0.922	7.876	0
<i>Turkey</i>					
(Constant)	-515.789	40.242		-12.817	0
Population, million	9.987	0.507	0.986	19.690	0
<i>Kazakhstan</i>					
(Constant)	-138.756	6.937		-20.002	0
Population, million	13.625	0.389	0.996	35.034	0
<i>Uzbekistan</i>					
(Constant)	-36.665	9.737		-3.766	0.003
Population, million	3.038	0.304	0.949	9.979	0

Note: Dependent Variable – electricity production.

Source: made by the author.

If the p -value is less than 0.05, then the regression is important, or in other words, is of impact on variables. All values in these regressions are less than the significant value and demonstrate strong relationships. As a result of regression analysis, we can illustrate the outcome as follows:

$$Y = -42822.155 + 6.987 \cdot X + 8549.675 \text{ (AZ)} \quad (3)$$

$$Y = -515.789 + 9.987 \cdot X + 40.242 \text{ (TR)} \quad (4)$$

$$Y = -138.756 + 13.625 \cdot X + 6.937 \text{ (KZ)} \quad (5)$$

$$Y = -36.665 + 3.038 \cdot X + 9.737 \text{ (UZ)} \quad (6)$$

A one-unit increase in population increases electricity production by 6.98 units in Azerbaijan, 9.98 units in Turkey, 13.62 units in Kazakhstan, and 3.03 units in Uzbekistan. According to the International Monetary Fund's calculations, the number of people in these countries is inclined to grow in the years to come.

Conclusions

This research centered on analyzing the green energy transition from the perspectives of the citizens of Turkey, Azerbaijan, Kazakhstan, and Uzbekistan. In parallel to this purpose, the green agenda of the countries, clean energy projects, green-minded policies, and incentives have been brought to the center stage.

People in Turkey, Azerbaijan, and Kazakhstan believe that the industry/business sector is responsible for the irreversible climate change, while the Uzbeks consider just "people" in charge of this damage. People in these countries share climate responsibility and consider tackling climate-related issues both as their and all human beings' equal responsibility. Hence, the outcome was positive and our hypothesis was confirmed.

With respect to green energy-related education backgrounds and skilled people, respondents believe that there is a lack of these kinds of experts in their countries. A majority of surveyors voted for the option that shows in the future there will be.

The last survey question was investigating the hypothesis that represented the replacement of the oil and gas industry by renewable energy. A significant proportion of respondents from Turkey (70%) and Kazakhstan (80%) agree that green energy sources will be the substitution for the oil and gas industry, while in Azerbaijan, with a tiny difference (39%), surveyors do not agree, 38% agree with this opinion. Unlike the previous countries, in Uzbekistan, people chose to remain neutral in this question (10% agree, 10% disagree), and 80% chose the "don't know" option.

As to correlation and regression analyses, our research investigated the possible relationship between population growth and electricity production and results revealed that a unit jump in the number of people increases electricity production by 6.98 units in Azerbaijan, 9.98 units in Turkey, 13.62 units in Kazakhstan, and 3.03 units in Uzbekistan.

For prospective research, researchers may continue to analyze policy implementation, the actual situation on the ground, and people's future climate awareness in these countries, or this study might encourage others to conduct new surveys.

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