Citizens' Opinions About Nuclear Power Plants

Mustafa OZCAN

Electricity and Electronics Department, Şişli Technical School, Şişli, 34381 İstanbul, Turkey
ozcanm2000@yahoo.com

Abstract

In Turkey which is highly dependent on imported fossil energy sources, electricity is mostly generated by fossil resources. Policy makers of Turkey have various goals to achieve through electricity generation in nuclear power plants (NPP). In this way, they are targeting to reduce dependence on imported sources. Another aim is to decrease the current deficit caused by such dependence. They are also targeting to provide energy supply security. Nuclear power is considered as an alternative for continuous and safe generation of electricity at a minimum cost, which is a requirement for economic growth. In this study, the opinions of Turkish Republic citizens about NPPs have been evaluated through a survey. 70% of the survey participants are against NPPs. The participants have noted that the effects of the energy generation on climate should be primarily considered. 40% of the participants have said that only renewable energy sources (RES) should be used for the generation of electricity. 84% of participants who hold this opinion have said that they can individually provide financial support for the promotion of RES.

1. Introduction

In our world one-third of which is without electric power, most of the developed and developing countries use fossil energy as the most important source of electricity. Unless more economical and environmentally friendly power sources are found, the utilization of fossil energy sources will be maintained [1].

Nuclear energy is a source of energy particularly preferred by developing countries for long-term energy plans in order to maintain growth in economy and industry and reduce greenhouse gas emissions. Investments in nuclear energy take a long time to be developed and require large quantities of finance, comprehensive planning and organization [1, 2].

Nuclear power plants (NPP) around the world have a power rate of 372,686 MW. There are 69 nuclear power reactors still under construction. These power reactors 28 of which are in China, 11 of which are in Russia and 7 of which are in India have a power rate of 66,831 MW. The number of nuclear reactors whose commissioning is still being planned is 157 and these will have a power rate of 172,440 MW [3].

Electricity was first generated through nuclear energy in 1951 after the Second World War. During the oil crisis in the early 1970s, the interest in NPPs which were considered to be a cheaper and more environmentally friendly source of energy increased. However, in the following years, this interest decreased due to the economic stagnation and the fall in the prices of fossil sources. After the accidents such as Three Mile Island in 1979, Chernobyl in 1986 and Fukushima in 2011, concerns about nuclear safety increased, and countries checked out their programmes of NPPs and safety measures. Some countries even decided to shut down their NPPs [3,4,5,6,7,8,9,10,11]. As a result of the nuclear accidents, new regulations were made in the design of nuclear reactors, security systems and procedures [3].

Following the Fukushima nuclear disaster, Germany is planning to deactivate all her NPPs until 2022 while Japan is planning to decrease her dependence on nuclear energy and increase the generation of energy from renewable energy sources (RES) [7,8].

There are various positive and negative opinions about NPPs. NPPs are plants that prevent climate change for developed and developing countries, decrease greenhouse gas emissions [1,5,7,8,11,12], provide energy supply security and create sustainable growth [2,5,11,12]. They also have lower external costs such as damage to the environment compared to fossil resources [8]. Being base load plants, they have a stronger system stability and a long duration of operation [1,5,8]. These plants which have a capacity factor with higher values (approximately 90 per cent) can be commissoned for a larger quantity of power [8,11].

In a study about what was experienced after the Fukushima accident [13], it was underlined that the claim nuclear energy is safe was incorrect and that the operators evaded responsibility by arguing that the accident was "unpredictable".

Apart from these positive views, there are numerous negative opinions regarding NPPs. The disposal of the waste from NPPs needs expertise [1,5,6,7,8,9] and has high cost [2,5,6,11]. The decommissioning of the plant is also very expensive [6]. People associate nuclear technology nuclear proliferation and terrorism [8,9] and have a negative opinion about investments in NPPs [5,6,7, 8,9,11].

The fuel cost of NPPs includes the extraction, transformation and enrichment of the ore, the generation of the fuel, its reprocessing and transportation. The fuel cost is about 20 per cent of the overall cost of NPP [6].

Special funds are cashed up for the disposal of the nuclear waste. In the USA, since 1983, the NPP operators have been making a payment of 0.1 cent /kWh to fund the disposal. So far, 24 billions of dollars have been saved as part of this fund [8].

The public has been interested in energy sources and this interest has affected energy policies since the 1973 oil crisis. Since then, the preferences of citizens about energy have been specified through referendums and surveys [7]. The public reactions has to be taken into consideration when investments into NPPs are made [14]. The storage area on the Nevada desert in the USA cannot be used due to the public reaction [14].

Many studies about public opinion regarding energy sources have been carried out in the USA and EU, and the public

opinion has been taken into consideration when investments are made into energy.

There are many studies that evaluate the public opinion about nuclear energy.

Nuclear accidents exacerbate the unease about nuclear energy and have a major impact on public opinion. In the immediate aftermath of nuclear accidents, negative opinions on nuclear energy are strongly exacerbated [7].

While the rate of opposition against NPPs was around 20% in the USA in 1970s, this rate rose up to 60% after the Three Mile Island accident. After the Chernobyl accident 69% of the people went against NPPs according to the referendum in 1986. In the study implemented in 27 countries in the EU in 2008, while 44% of people supported NPPs, 45% opposed them [7,11].

In a survey conducted in 24 countries in 2011, 62% of the participants went against NPPs and 26% of these participants noted that their opinions changed with the accident in Japan. In Europe and some developing countries, the rate of opposition is even higher (Germany 79%, French 67%, Belgium 60%). On the other hand, there is a stronger support in India, Poland and the USA [11].

In their survey conducted with 2422 people in Turkey, Ertör –Akyazi et al. [7] note that there is a high rate of opposition against NPPs and that the Chernobyl accident strongly influenced this tendency. According to this survey, this opposition increased after Fukushima nuclear accident.

In a public poll carried out by Globescan on behalf of BBC in Turkey between 5-18 July 2011, the rate of opposition against NPPs was 41% [15].

In a face-to-face survey conducted by Greenpeace between 16-17 April 2011, the rate of opposition against NPPs was 64% [16].

2. Nuclear Energy in Turkey

In order to provide energy supply security, Turkey is planning to use nuclear energy to generate electricity. The proportion of nuclear energy in electricity generation is targeted to increase to at least 5% by 2020 and to go up even more in the long term. Within this scope, 8 nuclear reactors with a power of 9,280 MW will be operated in Akkuyu, Mersin and Sinop through intergovernmental agreements between Turkey and Russia and Turkey and Japan. In December 2010, the Akkuyu NPP Corp. was established. The goal is to have the Akkuyu NPP Corp. operated for a test generation of electricity by 2018, to start the commissioning of the NPP in Sinop in 2019 and to begin preparations for the commissioning of the third NPP [17, 18, 19, 20,21].

Turkish Electricity Trading and Contracting Corporation (TETAŞ) will buy 70 per cent of the electricity generated in the 1st and 2nd units of the Akkuyu NPP and 30% of the electricity generated in the 3rd and 4th units paying 12.35 Dollar-Cent /kWh throughtout 15 years after the operation of the plant. The other part of the generation will be sold in the free electricity market by the project company or a retailer [17].

The project company will pay into the fuel and radioactive fuel management account of TETAŞ and another 0.15 Dollar-Cent/kWh into the decomissioning account of the TETAŞ. Apart from the sales for TETAŞ, the project company will make the required payments into the related funds in accordance with the T.R. laws and regulations [17].

There are different views regarding the NPPs to be commissioned in Turkey.

Ministry of Energy and Natural Resources (MENR) [17,22] notes that the electricity demands of the targeted economic growth by 2023 will not be met even if the whole RES (wind, solar, geothermal and biomass) potential of Turkey including hydroelectricity is utilized and that the foreign dependence for natural gas and the current deficit resulting from energy importation will decrease thanks to NPPs to be commissioned. The NPP supporters in Turkey state that Turkey will be a symbol of economic and industrial growth, strengthen its power in Eastern Europe and Middle East and that nuclear energy will provide a deterrent force against external threats in the unstable geography of Middle East [9].

Sirin [5] underlines that there are certain deficiencies in the nuclear energy policies of Turkey and there is not a comprehensive regulation of laws pertaining to the long-term and stable nuclear energy policies. Sirin also states that nuclear energy will not be the correct option for energy generation unless the uncertainties related to nuclear energy legislation, technology selection, waste disposal and project financing in Turkey are disambiguated [5].

Chamber of Turkish Electrical Engineers (EMO) [3] remarks that there are certain ambiguities about international surveillance on the Akkuyu NPP and that questions about nuclear fuel generation, plant construction and technology transfer should be clarified beforehand instead of being set with another agreement. The Chamber also notes that Russia is being protected from nuclear risk and the insurance of NPP building and operating processes is under Russia's responsibility. To the Chamber, unless these processes are insured, it is uncertain what is going to be done, how the waste will be disposed or stored, how and through what ways of security the waste will be transported to other countries and how the plant will be decommissioned [3]. An NPP to be established in Akkuyu will increase Turkey's dependence on foreign energy. Because the government of Turkish Republic has guaranteed sales in dollar, the Russian company will take all the income from the sale of the energy generated in foreign currency and the current deficit will inevitably increase [3].

Göktepe [4] indicates that Turkey planning to use nuclear power technology should reconsider her decision as countries inspected their nuclear security after Fukushima.

Yarman [14] notes that the oil and natural gas reserves in countries neighbouring Turkey and the work on RES and energy efficiency have eliminated NPPs from being a good technical option for Turkey and this has rendered NPPs a totally political option. To Yarman, Akkuyu is not appropriate for the construction of NPPs. Seismicity in Turkey increases the cost of NPPs. In the past, Akkuyu was found appropriate for seismicity; however, the region is not appropriate for seismicity today. The license given before the 1979 Three Miles Island and Chernobyl accidents has lost validity under present conditions [3,14]. The plant to be commissioned here may have certain effects on tourism. An investigation should be conducted on its possible effects on tourism. Also, some analyses should be done on the agricultural effects on the area which is convenient for the cultivation of vegetables and fruit. Certain difficulties about the insurance of NPPs will also be experienced. In Turkey, there is not a workforce trained or qualified for nuclear energy generation [14].

3. Survey Study

3.1. The Aim of the Study

The goal of this study is to indicate the opinions of citizens in Turkish Republic about the generation of electricity within the context of climate change and environment. In particular, citizens' opinions about NPPs and the reasons behind these views have been studied. Within the scope of the survey conducted, it has been analysed in detail whether citizens' opinions change depending on their gender, age, income level, education and the geographical location they live through appropriate statistical analysis methods. The survey is a quantitative one and has used the descriptive survey model which aims to depict a case existing in the past and now as it is.

3.2. Population and Sample

The survey was conducted on 1290 people above 15 years of age and from different levels of education and income in Turkey. 485 of the participants were female while 805 of them were male. Participants from Mersin, Sinop, Artvin, İzmir, Balıkesir, Manisa, Kırklareli and İstanbul comprise the survey sample. The city of Artvin was selected because of the high number of Hydroelectric Power Plants (HPP), some of which are still under construction and due to the frequent reactions against these HPPs. Cities of Izmir, Balıkesir and Manisa were selected because of the high proportion of RES power. Cities of Mersin, Sinop and Kırklareli were chosen because some NPPs have started to be built while some others are planned to be built here. In Sinop, people are going against thermal power plants, as well. The reason why Istanbul was selected is that it is a metropolitan city which allows immigrants from other cities and where a lot of people from different socio-economic backgrounds live.

3.3. Development of Data Collection Tool

The survey was conducted through a questionnaire developed by researcher.

Within this scope, an item tool was formed in accordance with the literature. The item tool was presented as a form to university academicians, representatives of occupational organizations and experts working in related non-governmental organizations. In accordance with the feedback from experts, the questionnaire form was revised. Later, a pilot scheme was practiced on a group composed of 30 people of different ages and educational backgrounds. Through this pilot scheme, the survey was conducted face-to-face on each participant to understand how each question is understood by the participant according to their reactions. After the pilot scheme, the survey was put into its final form.

3.4. Data Collection and Analysis

The participants were interviewed face-to-face. The pilot scheme on 30 participators was conducted in May, 2014. The survey was conducted on 1340 participants in total between June 2014 and June 2015. For different reasons, 50 of the surveys were cancelled and as a result 1290 surveys were analysed through statistical methods. The SPSS packaged software was used to analyse the data collected through surveys.

3.5. Findings

The demographic information about the participants of the survey is given in Table 1.

Table 1. Demographic information about the participants

		Freq.	%
Gender	Female	485	37.6
	Male	805	62.4
Age	15-18	319	24.7
	19-24	216	16.7
	25-40	373	28.9
	41-54	275	21.3
	55+	107	8.3
Education	Literate	11	0.9
	Primary	63	4.9
	Middle school	159	12.3
	High school	462	35.8
	College	470	36.4
	Master	83	6.4
	Ph.D.	42	3.3
Monthly household income	1000 TRY and below	201	15.6
	1000 - 2000 TRY	398	30.9
	2001 - 3000 TRY	370	28.7
	3001 - 4500 TRY	151	11.7
	4501 TRY and above	170	13.2
City of residency	Artvin	149	11.6
	Balıkesir	71	5.5
	İstanbul	316	24.5
	İzmir	198	15.3
	Kırklareli	109	8.4
	Manisa	67	5.2
	Mersin	227	17.6
	Sinop	153	11.9

70.20% of the participants noted that they are against NPPs. 18.90% of the participants support the construction of NPPs. 10.90% of the participants noted that they had no opinion about NPPs. The replies to the question "Do you support the construction of a nuclear power plant in Turkey?" are given in Fig.1.

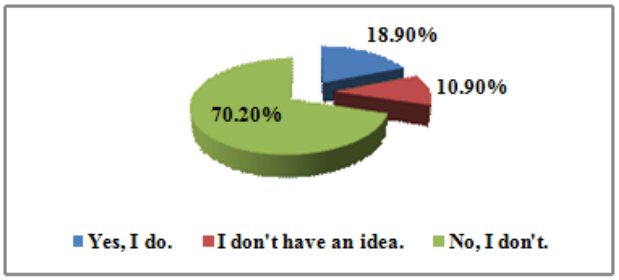

Fig.1. Participants' opinions about NPPs

A total of 227 participants contributed to the survey in Mersin, Turkey where the construction of a NPP has already started. Their replies to the question "Do you support the

construction of a nuclear power plant in Turkey?" are given in Fig.2.

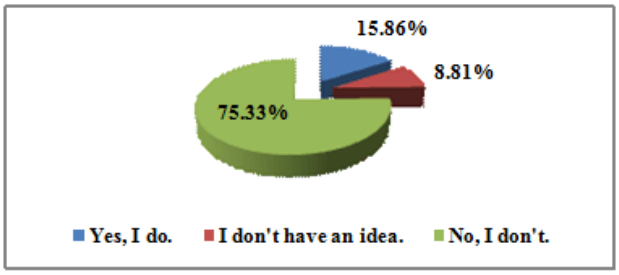

Fig.2. Opinions of participants from Mersin about NPPs

75.33% of participants living in Mersin noted that they are against NPPs. 15.86% of the participants support the construction of NPPs. 8.81% of the participants noted that they had no opinion about NPPs.

A total of 262 participants contributed to the survey in Sinop and Kırklareli, Turkey where the construction of a NPP is being planned. Their replies to the question "Do you support the construction of a nuclear power plant in Turkey?" are given in Fig.3.

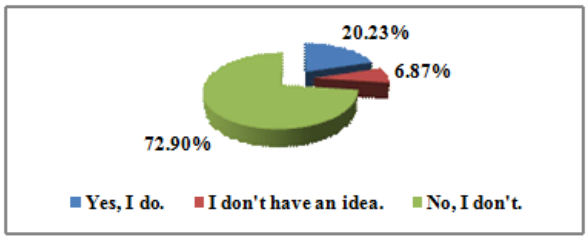

Fig.3. Opinions of participants from Sinop and Kırklareli about NPPs

72.90% of participants living in Sinop and Kırklareli noted that they are against NPPs. 20.23% of the participants support the construction of NPPs. 6.87% of the participants noted that they had no opinion about NPPs.

The participants who gave the reply "Yes, I do." to the question "Do you support the construction of a nuclear power plant in Turkey?" were presented the item "I am not against the construction of a nuclear power plant around where I live". The frequency of this group of participants is 243 and they make up 18.8% of the total number of participants. In Fig.4, the replies of the participants of this group can be seen. When Fig.4 is analysed, it can be seen that NPP supporters are against the construction of a NPP around where they live.

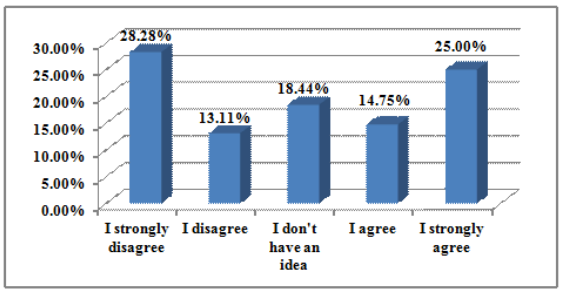

Fig.4. NPP supporters' opinions about the construction of an NPP around where they live

The participatants were asked "Which one of the following do you think should be of prime consideration in energy generation?" and they were asked to choose only one option. The proportion of the replies to this question is given in Table 2.

Table 2. Points to be of prime consideration in energy generation according to participants

	Freq.	%
The effect/impact of energy generation on climate change should be the prime consideration.	895	69.4
Generating energy at a low cost should be the prime consideration.	116	9.0
Reducing foreign dependency shoud be the prime consideration.	279	21.6
Total	1290	100.0

When Table 2 is analysed, it can be seen that 70% of the participants supported the point "The effect of energy generation on climate change should be of prime consideration."

The total frequency of the participants who chose the point "The effect of energy generation on climate change should be of prime consideration." and also chose the "I agree" or "I strongly agree" options for the point "Using only renewable energy resources is adequate in meeting energy demand." is 508. This frequency was later handled as the group who support that "Using only renewable energy resources is adequate in meeting energy demand." This group makes up 40% of the total number of the participants.

The frequency of the replies to the point "I would support the promotion of renewable energy even if I was charged a small extra amount in my electricity bill." by the group who supported the point "Using only renewable energy resources is adequate in electric energy generation" is given in Fig.5.

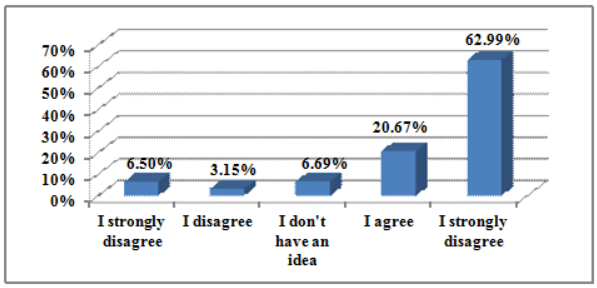

Fig.5. Proportion of participants who supported the point "I would support the promotion of renewable energy even if I was charged a small extra amount in my electricity bill"

4. Conclusion

The rate of opposition against NPPs in Turkey was 64% in the study carried out by Greenpeace between 16 and 17 April, 2011 while this rate was 41% in the study carried out by BBC between 5 and 18 June, 2011. The cities where NPPs are planned to be built were not included in the study conducted by

BBC. 70% of the participants in this study went against NPPs. The rate of opposition against NPPs was about 75% in Mersin where the construction of an NPP has already started while this rate was about 73% in Sinop and Kırklareli where the construction of an NPP is being planned. Both of these rates are above the average.

The majority of the participants who were not against NPPs were actually against the construction of an NPP around where they live.

70% per cent of the participants noted that the effects of energy generation on climate change should be taken into prime consideration. Around 22% of participants indicated that reduction in foreign dependence should be of prime importance.

Around 40% of the participants support the view "Using only renewable energy resources is adequate in electric energy generation." Around 84% of the participants supporting this view shared the opinion "I would support the promotion of renewable energy even if I was charged a small extra amount in my electricity bill."

There is a strong opposition against NPPs in Turkey. The plan of commissioning NPPs in Turkey should be reconsidered, therefore. Moreover, the utilization of RES should be increased and promoted. Works on energy efficiency should be speeded up.

The survey results shared in this study are the first results drawn from the analysis of an extensive study conducted around Turkey.

5. References

[1] J.Vujic, D.P. Antic, Z. Vukmirovic, "Environmental impact and cost analysis of coal versus nuclear power: The U.S. case", *Energy*, vol. *45(1)*, pp. *31-42*, Sept., 2012.

[2] S.Choi, E. Jun, I. Hwang, A. Starz, T. Mazour, S.H. Chang, A.R.Burkart, "Fourteen lessons learned from the successful nuclear power program of the Republic of Korea", *Energ Policy*, vol. *37(12)*, pp. *5494–5508* , Dec., 2009.

[3] TMMOB elektrik mühendisleri odası nükleer enerji raporu 2013, TMMOB Elektrik mühendisleri odası 43. Dönem Enerji Çalışma Grubu Nükleer Enerji Alt Çalışma Grubu, 1.Baskı, Ankara-Kasım 2013, ISBN:978-605-01-0553-7, EMO Yayın No: GY/2013/555

[4] B.G.Göktepe, "Fukushima sonrası dünya enerji politikaları ve nükleer güç", Türkiye 12. Enerji Kongresi, 14-16 Kasım 2012 ODTÜ-Ankara,DEK-TMK.

[5] S.M. Sirin, "An assessment of Turkey's nuclear energy policy in light of South Korea's nuclear experience", *Energ Policy*, vol.*38(10)*, pp. *6145–6152* , Oct., 2010.

[6] E. Erdogdu, "Nuclear power in open energy markets: A case study of Turkey", *Energ Policy*, vol. *35(5)*, pp. *3061–3073*, May, 2007.

[7] P.Ertör-Akyazı, F. Adaman, B.Özkaynak, Ü. Zenginobuz, "Citizens' preferences on nuclear and renewable energy sources:Evidence from Turkey", *Energ Policy*, vol. *47*, pp. *309–320*, August, 2012.

[8] A. Rabl, V.A. Rabl, "External costs of nuclear: Greater orless than the alternatives?", *Energ Policy* vol. *57*, pp. *575–584*, June, 2013.

[9] M. Melikoglu, "Vision 2023: Feasibility analysis of Turkey's renewable energy projection", *Renew Energ*, vol. *50*, pp. *570-575*, Feb., 2013.

[10] Q.Zhang, B.C. Mclellan, T. Tezuka, K.N. Ishihara, "Economic and environmental analysis of power generation expansion in Japan considering Fukushima nuclear accident using a multi-objective optimization model", *Energy*, vol. *44(1)*, pp. *986-995*, August, 2012.

[11] I.N. Kessides, "The future of the nuclear industry reconsidered:Risks,uncertainties, and continued promise", *Energ Policy*, vol. *48*, pp. *185–208*, Sept., 2012.

[12] A.Corner, D. Venables , A. Spence, W. Poortinga, C. Demski, N. Pidgeon, "Nuclear power,climate change and energy security:Exploring British public attitudes", *Energ Policy*, vol. *39(9)*, pp. *4823–4833*, Sept., 2011.

[13] Fukuşima'dan çıkarılacak 10 ders, TMMMOB Elektrik Mühendisleri Odası, 1.Baskı, Ankara-Nisan 2015, ISBN:978-605-01-0672-5, EMO Yayın No: GY/2015/593

[14] T. Yarman, "Enerji sektöründe dışa bağımlılık", Marmara Enerji Forumu 2007, 07-08 Eylül 2007, EMO Bursa-İstanbul-Kocaeli Şubeleri , İstanbul - Yıldız Teknik Üniversitesi Oditoryumu

[15] BBC,http://www.globescan.com/images/images/pressreleases/bbc2011_nuclear_energy/bbc2011_energy.pdf, Erişim tarihi:22.04.2015

[16] Greenpeace,http://www.greenpeace.org/turkey/tr/news/turkiyenin-yuzde-64u-nukleere-hayir-diyor-290411/, Erişim tarihi:22.04.2015

[17] Nükleer güç santralleri ve Türkiye, T.C. Enerji ve Tabii Kaynaklar Bakanlığı Nükleer enerji proje uygulama daire başkanlığı, Yayın no:2,2013.

[18] 62. hükümet programı, T.C. Başbakanlık, 1 Eylül 2014

[19] Onuncu kalkınma planı 2014-2018, T.C. Kalkınma bakanlığı, Ankara – 2013

[20] T.C. ETKB 2015-2019 stratejik planı

[21] Elektrik enerjisi piyasası ve arz güvenliği strateji belgesi, 21 Mayıs 2009, Yüksek Planlama kurulu, Sayı 1701

[22] T.C. Enerji ve tabii Kaynaklar bakanlığı, Nükleer santraller ve ülkemizde kurulacak nükleer santrale ilişkin bilgiler, Nükleer Enerji Proje Uygulama Daire Başkanlığı, Yayın No:1