The effect of the Syrian crisis on electricity supply and the household life in North-West Syria: a university-based study

Fuad Alhaj Omar, Selçuk University, Turkey
fuad2081@hotmail.com
Ibrahim Mahmoud, University of Aleppo, Syria
Abdulrahman Hussian, University of Aleppo, Syria
Lennart Mohr, German Environment Agency (UBA), Germany
Hanadi Omaish Abdullah, Gaziantep University, Turkey
Abdulnasser Farzat, University of Aleppo, Syria

Abstract

This study analysed the current situation of access to electricity in Northwestern Syria. Using a household survey [N=136], a questionnaire with generator owners [N=8] and interviews with academics [N=2] in Idlib and Azaz regions of Syria, the research revealed that electricity generation has become nearly entirely dependent on the private sector and the expenditure on electricity increased by 82 percent, limiting the availability of electricity mostly between 2 and 10 hours per day.

Key Words

Conflict
Energy crisis
Electricity
Syria

To cite this article: Omar, F. A., Mahmoud, I., Hussian, A., Mohr, L., Abdullah, H. O. and Farzat, A. (2020) The effect of the Syrian crisis on electricity supply and the household life in North-West Syria: a university-based study, *Education and Conflict Review*, 3, 77–86.

What is the problem?

Entering the ninth year of violent conflict, the scale, severity, and complexity of needs of basic services across Syria remain overwhelming (United Nations, 2019). This is the result of continued hostilities in local areas, new and protracted displacement, increased self-organised returns of formerly displaced people and the sustained erosion of communities' resilience during the protracted crisis. Across Syria, an estimated 11.7 million people are in need of various forms of humanitarian assistance, with certain population groups facing particularly high levels of vulnerability. Whilst there has been a reduction in violence in many parts of the country over the past year, conflict continues to be the principal driver of humanitarian needs, with the civilian population in many parts of the country exposed to significant protection risks which threaten life, dignity and wellbeing on a daily basis. Over 50 percent of the infrastructure in Syria is not operational, often because it has been destroyed as a result of hostilities (United Nations, 2018). Also, electricity production, transmission and distribution have been heavily affected by ongoing hostilities, leaving most of Syria's electricity infrastructure non-operational. Therefore, almost 70 percent of the population in Syria lacks sustained access to electricity which has had negative impacts on people's lives and the economy. UN agencies and non-governmental organisations (NGOs) generally focus on providing basic needs, namely health, water, sanitation and hygiene (WASH), non-food items (NFIs), shelter and protection, but energy has not been included in

their humanitarian activities. Without stable access to power, institutions such as hospitals depend on diesel generators only, which makes them vulnerable to outages and price gouging. Patients frequently suffer and die when electricity supply fails.

When it is available, electricity supply is limited to only a few hours during the day and is expensive in relation to the average income of the family. Given that most people in Syria have severe electricity needs, providing solutions, such as large solar power plants, which take advantage of the abundance in irradiation, would offer good alternatives to restore power to Syrian cities, such as Aleppo. Also, dispersed solar generation systems could add resilience to an energy system that has been severely damaged by war and will remain at risk of violent attack (Muth, 2016). Although various technical solutions exist, there is a lack of comprehensive research to identify the current gap between production and needs of electricity in Syria. So far, Syrian academics have not conducted any studies related to the issue of the need for electric energy, nor of the status of the electrical network in order to identify alternative solutions for Syrian families in light of the crisis.

This article presents an analysis of the current state of electricity supply in two regions in Northwest Syria. It includes an empirical survey of electricity consumption and production under the current crisis situation. Overall, the study identifies gaps between the two. The study was designed and implemented by a team of researchers who took part in an academic support program organised the Cara (Council for At-Risk Academics) between November 2018 and July 2019. The empirical survey was undertaken in the regions of Idlib and Azaz throughout February and March 2019 by student researchers from collaborating universities (Idlib University and Sham University). It makes the case for the importance of addressing and quantifying energy as an important human need in the current and reconstruction periods. It also illustrates the contribution that university academics and their students might make, as local and informed researchers, to assessing these needs and recommending or designing solutions through research and innovations to address the problem of electricity shortages using renewable sources. Besides, they can also make the subject of renewable energies and its applications an an essential part of the curriculum.

Previous studies

There are a number of published studies related to the crisis in Syria, which focus on the various needs of Syrian citizens. However, none of these focus on electricity needs. Research shows destructive effects of the crisis on the electricity sector, significantly reducing power generation, which pre-crisis met over 75 percent of the country's essential everyday social and economic needs (Sputnik News, 2017).

The latest available figures indicate, however, that the Syrian government continued to export electricity to Lebanon (Sputnik News, 2017). The power level of electricity exported varied between 100 and 120MW in 2016, depending on the functioning of the network running from the Syrian Samarian station to the Lebanese Direnboh station (Sputnik News, 2017). Furthermore, the Ministry website noted that it continued to issue electricity bills to people who lived in areas abandoned since the start of the crisis ranging in value between 500,000 and 800,000 Syrian pounds (1000 to 1600 US dollars, 1 USD = 500 SYP) (Hal.net, 2018). This indicates the problem of electricity costs for returnees, who were forced to pay bills which have accumulated over years in spite of no electricity consumption and ongoing fighting in the region causing power outages during their absence.

Apart from these figures, the literature review did not provide any more statistics on the quantity of electricity required by Syria nor on the number of power stations out of order as a result of the war. Hence, there is a lack of evidence about the required and available amounts of electricity at present. With regards to potential future developments, it was indicated that Turkey and, following the return of stability, Syria, would be the route to Europe for projects connecting electrical networks with the Gulf States. Additionally, a decline in oil prices in the world market would not affect the set-up of solar power plants in the Gulf countries which contain vast uninvested areas and abundant solar energy throughout the year. Thus, that also indicates the benefits of connected networks between Arab countries and Turkey (GCCIA, 2016).

Hasan (2012) found that the application of energy-saving measures at the individual household level in Iraq could result in a reduction of 63.4 percent in annual electricity consumption from

71,500 kWh to 26,167 kWh. Although the study was conducted in Iraq, it used this example to estimate a comparable reduction of electricity consumption in households in Damascus, Syria. Another study indicated the geographical distribution of solar radiation across Syrian regions and their ranges over different periods (Tarboush, 1969). This study, despite the timeframe (1960)Hamoudi (2009) discussed a number of solar power generation related topics, which included solar panels and their angles of deflection looking at the electrical power that can be generated from solar energy. Other studies addressed the cost of solar-powered electricity production and compared it to the cost of other renewable energies, and showed the superiority of solar energy to produce electricity over the rest of the renewable energy sources in terms of abundance and efficiency (Kost *et al*., 2018). Further studies discussed specific issues such as calculating the cost of setting up a solar-powered farm in remote areas (Mohammed and Jasem, 2012), which detail the solar power supplies and tools needed to feed such a farm.

Methodology

This study was designed to gather information about the situation of electricity supply, needs and levels of consumption in Idlib and Azaz regions in Northwestern Syria by using questionnaires and interviews. Within this context, three relevant groups of actors were identified and analysed as shown in figure 1. The first group consisted of private households which represent the demand side of energy. For this group, a questionnaire survey was conducted comprising 51 questions to explore the energy use in the target communities, the availability of electrical equipment and to determine the amount of energy consumption and related costs. It addressed a sample size of 120 households, which was determined to be sufficient for quantifying the daily needs and consumption of electricity in households within the target region. The second group consisted of generator owners, which represents the supply side of energy. For this group, another questionnaire survey comprising 10 questions was conducted to explore available electricity supply, determine the amount of electricity produced, the duration of service provision and challenges. It addressed a sample size of eight generator owners which was seen to be sufficient for getting a picture of the supply side within the target region. Finally, the third group consisted of academics within the study area who worked in the situation of mostly non-operational electricity infrastructure. To this end, key informant interviews (KIIs) with academics of two universities within the target region were conducted in order to look at links between their research or projects related to this study and how they could address the lack of electricity by carrying out or intensifying research on renewable energy. For the questionnaires, the programme 'KoBo Toolbox', which is a free open source tool to collect data using mobile devices without a network connection, was used to collect the data. Furthermore, Microsoft 'Power BI' was employed for data analysis and to display results in charts and tables.

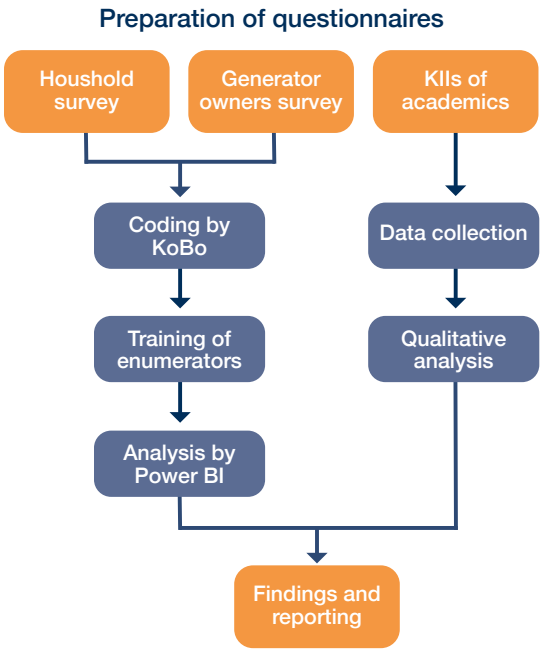

Figure 1.
Flow chart of the research

For the first group (i.e. households) the data collection process was undertaken by 20 enumerators who were undergraduates, graduate university students and academics from Idlib University (Idlib city) and Sham University (Azaz). We trained the participating students on how to use KoBo Toolbox and explained to them how to use the questionnaire and gather energy consumption information. Data collection was carried out from 23 December 2018 to 25 March 2019.

The samples represented both genders and different age groups. The total number of collected responses amounted to 136, which were randomly selected from 35 communities located in the two different regions (see figure 2). This sample size is comprehensive and sufficient for a level of confidence of 95 percent and 10 percent margins of error (SurveyMonkey, 2019), as long as the number of households in the target community did not exceed four million. For the second group (i.e. generator owners) data collection was carried out from 14 March to 4 April 2019, whereby 8 generator owners within six communities in the same two regions participated in the survey. Furthermore, two academics who lived and worked in the target areas were interviewed on 22 March 2019. Within this third group, we faced some limitations as some academics were reluctant to participate due to concerns about potential future repression. Information from them could only be obtained by guaranteeing anonymity and the non-disclosure of personal data. Other academics asked for money to participate in the interviews and provide information. Therefore, it was not possible to include more academics in the study.

Findings

The distribution of household (HH) demographics was determined through the questionnaire, as seen in table 1. The HH survey respondents were asked inter alia about the main source of electricity in their shelter, the average hours of usage and related prices (see figure 3).

The subscription of amperes to obtain electricity appeared to be a new mechanism of accessing electricity during the Syrian crisis. It depends on a private provider who deploys a relatively powerful generator and to build up an electrical mini-grid, connecting the households in the neighbourhood. Subscribers determine the amounts of amperes and hours they need per day. On average, the respondents' households subscribed to 2.5 amperes. The number of hours provided using the ampere network was different according to each provider. However, the respondents stated the availability of on average 6 hours of electricity per day.

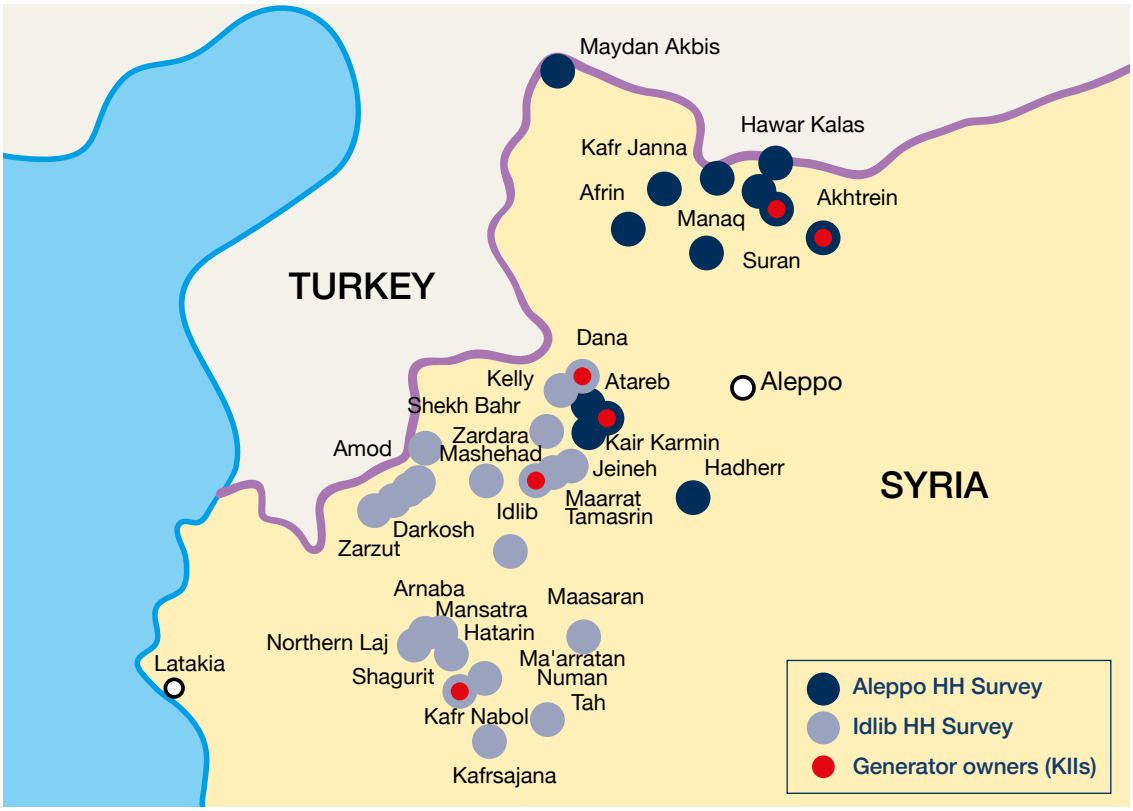

Figure 2.
Mapping of targeted communities studied in surveys and KIIs

Demographic variable	Percent
Respondent gender	
Male	79%
Female	21%
Marital status	
Married	88%
Widowed	4%
Single	7%
Divorced	1%
Type of household	
Host community	63%
IDPs	35%
Returnees	1%
Type of shelter	
House	94%
Camps	4%
Collective center	2%
Monthly income	
SYP	64,375 SYP*
USD	129 USD*
Other household demographic variables	
Mean age of respondent	37 years
Mean household size	6.1 persons

* 1 USD = 500 SYP

Table 1.
Distribution of household demographics

The second main source used for electric power was private generators. These were mainly diesel generators, with only two families reporting the use of petrol-operated ones. This source provides free choice with regard to working hours during the day. The respondents' generators worked on an average of 6.2 hours per day. The respective average daily consumption of fuel was 10 litres per day. The price of fuel is often security-dependent according to the region's dominant authorities and accessibility on the ground. However, the respondents stated 341 SYP = 0.68 USD per litre (1 USD = 500 SYP) as the average price of fuel.

The Syrian crisis strongly affected the possibility of using electric equipment at home which is due to the limited availability of electricity. Figure 4 shows the electric equipment used.

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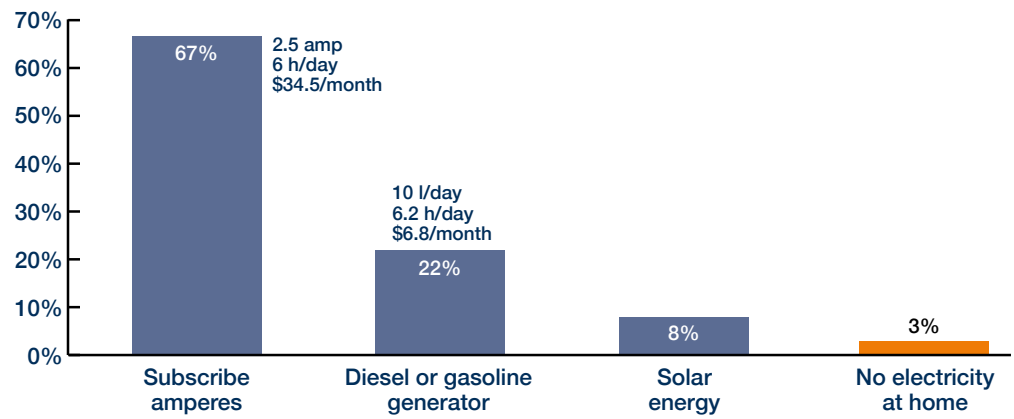

Figure 3.
Main sources of electricity, usage and prices

The second main source used for electric power was private generators. These were mainly diesel generators, with only two families reporting the use of petrol-operated ones. This source provides free choice with regard to working hours during the day. The respondents' generators worked on an average of 6.2 hours per day. The respective average daily consumption of fuel was 10 litres per day. The price of fuel is often security-dependent according to the region's dominant authorities and accessibility on the ground. However, the respondents stated 341 SYP ≈ 0.68 USD per litre (1 USD ≈ 500 SYP) as the average price of fuel.

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Due to the limited availability of electricity in many areas of Syria, especially in areas beyond the control of the Syrian government, people have started using solar energy as an alternative. In general, the intensity of light radiation is high and sunshine is available for a long period of the year. Within the group of respondents, 8 percent named solar energy as the main source of electrical energy in their homes. However, 33.8 percent of them use solar panels additionally for loading batteries and for lighting as well as to power some electrical equipment (see table 2 and figure 5). In addition, 11.8 percent of respondents use solar energy to heat water for domestic use.

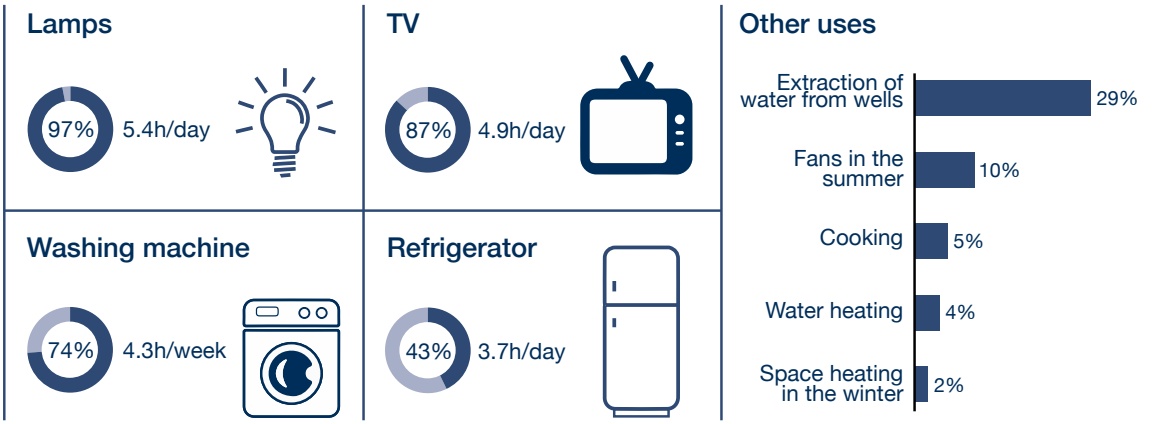

Figure 4.
Electric equipment used

Variable	Value
Number of solar panels (average)	3 panels
Number of batteries (average)	2 batteries
Hours of daily work	8 hours
Cost of one solar panel	101,500 SYP*
	203 USD*

* 1 USD ≈ 500 SYP

Table 2.
Usage of solar energy and batteries

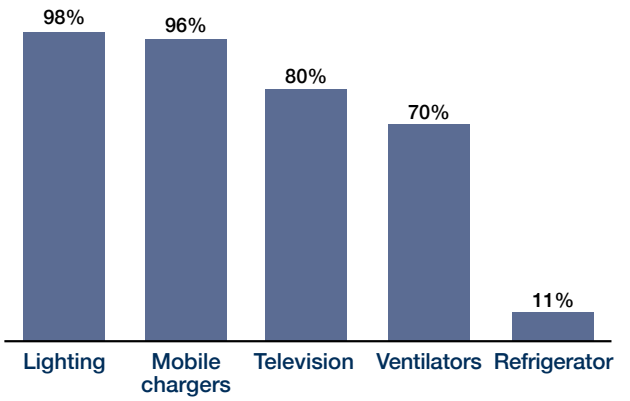

Figure 5.
Electrical equipment operated on solar-powered batteries

In order to look at the impact of the Syrian crisis with regard to electric power, a comparison between the pre- and post-civil war situations is useful. The average availability of electricity was 23 hours per day before the crisis. Figure 6 provides information about the equipment used at that time. Furthermore, figures 7 and 8 show energy sources for cooking, space heating and water heating used before the crisis. Moreover, the questionnaire also addressed the household income before the crisis and at the time of the study as shown in table 1. The average household income before the crisis was 46,000 SYP = 1,023 USD per month (1 USD = 45 SYP before 2011). The respective monthly household expenditure on electricity was 494 SYP (11 USD).

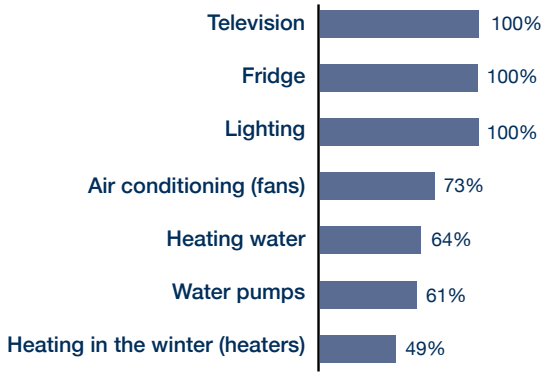

Figure 6.
Electrical equipment used before the Syrian crisis

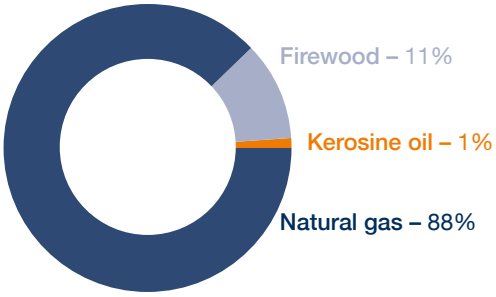

Figure 7.
Energy sources for cooking

Looking at the service providers of amperes, all generator owners reported using diesel generators. The average daily consumption of diesel was 177 liters per day. The average generator ran 7.5 hours per day, while none worked more than 10 hours per day. The price of diesel per litre was reported to be at an average of 227 SYP = 0.45 USD (1 USD = 500 SYP). The average monthly price of one ampere was 8,425 SYP = 16.85 USD (1 USD = 500 SYP). Generator owners who provide electricity to subscribers also face challenges as shown in figure 9.

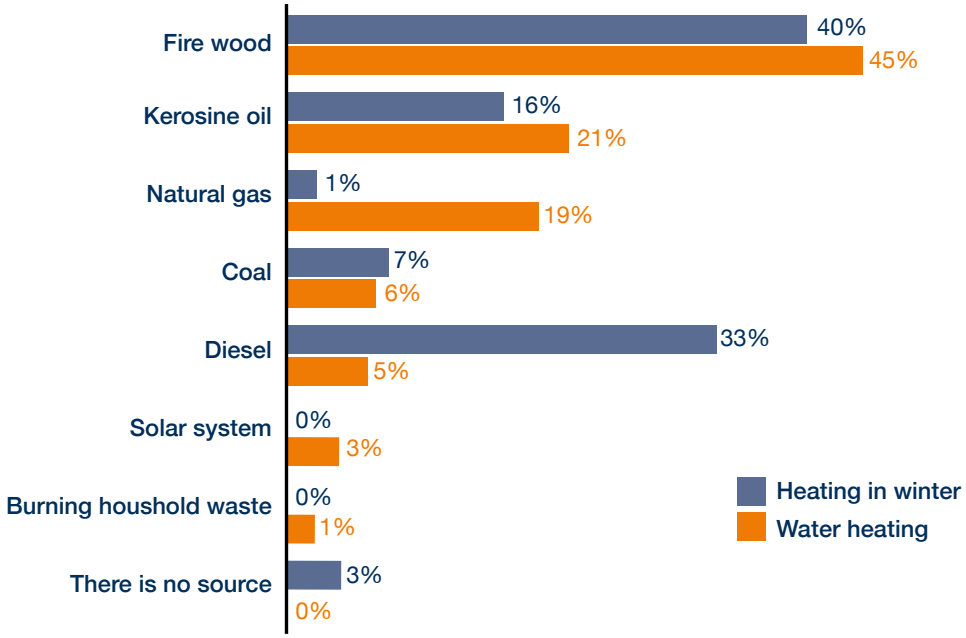

Figure 8.
Energy sources for space heating and hot water

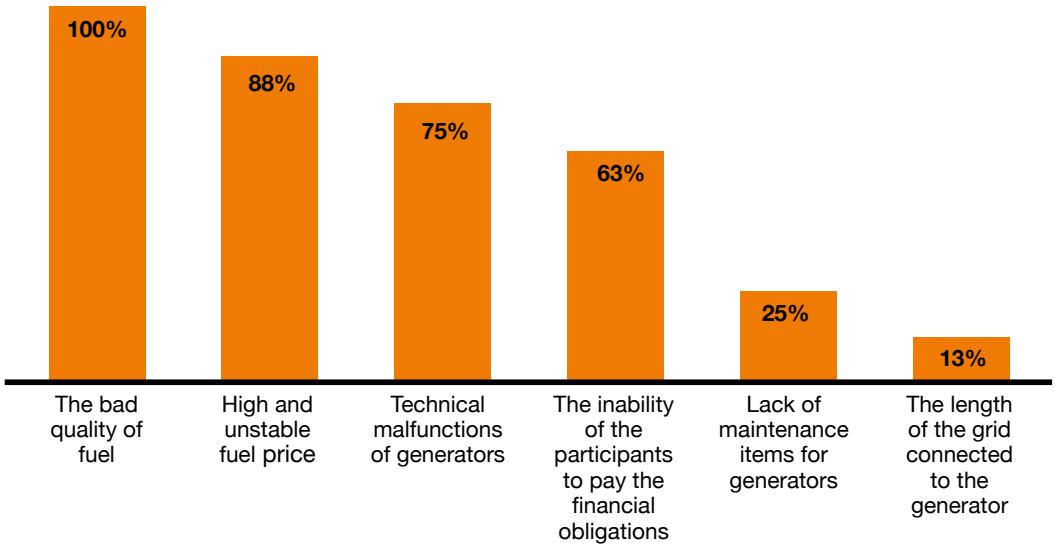

Figure 9.
Challenges faced by generator owners who provide electricity to subscribers

During the interviews, the academics pointed out that there was a university curriculum on electrical energy generation and transmission. However, there was no curriculum related to the distribution of electricity to consumers. Therefore, these curricula were mainly theoretical and did not provide solutions for the current state of energy needs in Northwest Syria. Currently, electricity is not available at the level of mass generation to supply cities or villages. The interviewees stated that there were no student projects related to the transfer and distribution of electricity within the university and that there were no graduate students in this field. Presumably, this will create a gap between the university and the society, especially as the lack of energy is one of the most important problems facing the lives of people in these areas.

Looking at solutions, the academics could improve the present situation of electricity crisis by using alternative and renewable energy, such as solar, wind and bioenergy. The subscription of amperes could also be used as a temporary solution to cover part of the needs. They also reported about experiments in some border villages in the regions of Jarabulus and Azaz in order to benefit from the Turkish electricity network. However, this requires the restoration of the damaged infrastructure which needs network rehabilitation and distribution systems in communities far from the border.

The academics referred to solar energy being the most important source of alternative energy in Syria. Alternative energy solutions have been used recently, not only for household needs but also to irrigate crops in areas close to rivers. The academics also stressed that there were currently no studies that analysed the state of electric energy in the target areas. Furthermore, they would encourage the establishment of research centres which could bridge the gap between energy needs and generation.

What are the implications for Syria?

This research reveals that there has been a significant loss of household income and rise of expenditure for electricity. Comparing pre-crisis income to present income shows a substantial decrease by 87 percent. On the contrary, household expenditure for electricity rose from monthly 494 SYP (equivalent to 11 USD) before the conflict started in 2011 to currently, 9,984 SYP (equivalent to 20 USD at current prices). Thus, the expenditure for electricity increased by 82 percent. Eventually, the ratio of electricity cost to household income increased from 1.1 percent to 15.5 percent, whereby the quality of supply has declined substantially.

What is striking about the statistical results is also the large discrepancy between the number of hours of electricity availability before the crisis (20 to 24

hours per day in 91 percent of the households) and limited availability now (2 to 10 hours per day). The estimated demand for electricity in Syria in 2009 of about 43,406 GW was supplied by electricity stations of the government. On the contrary, electricity generation after the crisis has become nearly entirely dependent on the private sector, namely numerous generator owners, since there is no government power station in the studied areas, which has turned the electricity sector into a purely commercial and profit oriented sector. Hence, this has entailed a high cost and a great burden to households to secure their necessary electricity needs. Beyond it, the current method for measuring the supply of electricity depends on amperes and not on watt-hours as it was before the crisis. This is a primitive method and requires the use of an ordinary circuit breaker without the need to use electronic meters. However, while maintaining the agreed level of amperes a generator owner might be tempted to lower the output voltage by choking her generator to save fuel, which adversely affects the customers' electrical appliances by reducing their lifetimes. The current electricity consumption starts from 1 ampere whereby the average voltage equals to 205 volts within a range of 130 to 250 volts. From the survey findings, it is shown that the average electricity available for household consumption is about 3 kWh per day or 1,095 kWh per year. References from comparable regions with a functioning electricity infrastructure showed a household consumption of electricity between 71,500 kWh and 26,167 kWh per year.

Conclusion

During the war in Syria, the infrastructure of public utility services, electric power stations, transmission stations and distribution networks has been destroyed or stolen. Syrian people stayed without electricity services over long periods of time. This study demonstrated that Syrian people in the Northwestern region have access to a bare minimum level of electricity; comparatively more expensive than pre-crisis times; and supplied by private generator owners. The loss of university infrastructure and lack of research into issues around electricity supply, the academic contribution to knowledge production about electric energy has been lost. As the conflict continues, the following five conclusions can be drawn with regards to improving access to electricity in Northwestern Syria. Firstly, the possibility of linking the Turkish electrical network to the Syrian network in these areas needs to be explored. Secondly, academics in Syrian universities should be involved in studying the extent to which current solutions to energy crisis are effective. Furthermore, the university courses could be amended, including aspects of distribution of electricity to consumers. Thirdly, the distribution of solar energy equipment to households could help mitigate their energy needs. Fourthly, large electricity generators could be provided for certain areas with high demand. Finally, the demographic indicators obtained from this study could be used to inform humanitarian support programmes as well as to design broader studies with the view of developing durable energy solutions

Author Bios

Fuad Alhaj Omar has an MSc and PhD in Electronic Engineering from University of Aleppo. Currently, he is conducting the second PhD at Selçuk University, Turkey. He was a visiting scholar in the School of Engineering and Materials Science, Queen Mary, University of London, UK.

Ibrahim Mahmoud is Monitoring, Evaluation, Accountability and Learning (MEAL) Manager for Shafak organisation, with a PhD in analytical of chemistry from University of Aleppo (2011) where he was a lecturer.

Abdulrahman Hussian specialises in Automation Engineering from Istanbul University. He is currently Academic Coordinator at Al-Maaly University and head of the Automation Control Department at University of Aleppo.

Lennart Mohr is a Research Associate at the German Environment Agency (UBA) and has worked as an international energy consultant.

Hanadi Omaish Abdullah has a PhD in Applied Mathematics from Al-Baath University and currently works as Assistant Professor at Gaziantep University.

Abdulnasser Farzat has a PhD in technical communication (1995) and a PhD in Information Security License (2006) from St. Petersburg. He was Assistant Professor at the University of Aleppo.

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