

The Effect of Temperature on Household Consumption of Electrical Power during the Four Seasons in Al-Marj city-Libya

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Abstract.

The purpose of the article is to study the influence of the temperature variations on electrical power consumption in the Al- Marj household during year seasons. Recently, load shedding has been occurred in Al-Marj city repeatedly, and that because of many reasons, especially, in winter and summer seasons. One of these causes is temperature variations. Using data from General Electricity Company regarding 8 electrical energy consumers in Al- Marj city [1], and the average daily temperature for the year 2022 according to the website of the Al-Marj Meteorological Station [2]. It is clear that the maximum electrical energy consumed during summer and winter seasons is due to the use of electrical appliances for residential cooling and heating [3][4]. Generally, weather conditions are strongly affected power consumption at homes [5]. The average temperature during the Winter is approximately 12.5 C°, Whereas in the Summer about 26 C°, in both seasons. The demand for electrical energy increases with the rise or fall of the temperature [6]. While in the Spring and Autumn, the wheatear is moderate with average temperature of 16.5 C° and 20 C°, respectively, on the other hand, it is noticed a decrease in electrical power consumption because electrical cooling and heating devices are not usually used in these seasons because of moderate climate.

Keywords: temperature variations, electrical power, load shedding, Al- Marj.

تأثير درجة الحرارة على الاستهلاك المنزلي للطاقة الكهربائية خلال الفصول الاربعه في مدينة المرح - ليبيا

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المخلص :-

الهدف من هذه الورقة هو دراسة تأثير درجة الحرارة على الاستهلاك المنزلي للطاقة الكهربائية وتباينها خلال فصول السنة. في الأونة الأخيرة تم طرح الأحمال في مدينة المرح بشكل متكرر وخاصة في فصلي الشتاء والصيف وهذا يرجع لعدة أسباب وأحد هذه الأسباب هو التباين في درجات الحرارة. و باستخدام بيانات المتحصل عليها من الشركة العامة للكهرباء الخاصة ب 8 منازل للمستهلكين للطاقة الكهربائية بمدينة المرح [1] و المتوسط اليومي لدرجات الحرارة لسنة 2022 وفقا للموقع الالكتروني لمحطة الأرصاد الجوية-المرج [2]، يتضح أن أقصى طاقة كهربائية مستهلكة خلال فصلي الصيف و الشتاء بسبب استخدام الأجهزة الكهربائية للتبريد و التدفئة السكنية [3][4]. بشكل عام أحوال الطقس تؤثر بشكل قوي على القدرة المستهلكة في المنازل [5]. حيث متوسط درجة الحرارة خلال فصل الشتاء تقريبا 12.5 C° وفي فصل الصيف حوالي 26 C° . وبالتالي يرتفع الطلب على الطاقة الكهربائية بارتفاع أو انخفاض درجة الحرارة [6]. بينما في فصلي الربيع والخريف يكون الطقس معتدل بمتوسط درجات حرارة 16.5 C° و 20 C° على التوالي و بالمقابل نلاحظ انخفاض القدرة الكهربائية المستهلكة و هذا يرجع إلي قلة استعمال أجهزة الكهرباء الخاصة بالتبريد و التدفئة بسبب اعتدال المناخ.

الكلمات المفتاحية: التغيرات في درجات الحرارة، الطاقة الكهربائية، تسليط الأحمال، المرح

Introduction

In general, climate plays an important role in influencing household consumption of electrical power [6]. By comparing the data, it is noticed that an increase in electrical energy consumption during the winter and summer seasons, which is approximately equivalent to doubling the electrical consumption for the spring and Autumn seasons. This results from the use of cooling and heating devices in summer and winter, respectively. The electrical power consumption is directly affected by the temperature rise. In fact, there are several other factors affect household energy consumption, but in this paper, the focus was on electrical cooling and heating because these devices are the largest consumers of electrical energy at homes [7]. The study relied on the average seasonal temperature and the seasonal average of the consumed power in order to clarify the factors of excess capacity consumption resulting from high and low temperature. The study includes collecting data on the seasonal consumption of electrical energy for 8 homes, the readings of which were taken from the - General Electricity Company of Libya, Technical Affairs Department, Statistics Division for the city of Al-Marj. As for temperature, the website of the Al-Marj meteorological station was used. The seasonal average of the data was taken to suit the objectives of the study. Use the seasonal average of both temperature and power consumption of several homes in the city. There are many electrical appliances used at homes, but in this study the consternation was on electrical cooling and heating devices because they are directly affected by the rise or the fall in temperature , this is can be seen in summer and winter . Then the data was analyzed and the relationship between both temperature variation and the power consumption was studied.

Literature review

This article is related to large literature on the effect of seasonal change on electricity consumption, which mainly concentration on specific countries and areas. For instance, investigation how temperature rises has emotional impact on electricity consumption in Singapore and Hong Kong [8], in addition to another study about the relationships between weather and electricity power

consumption in three West African cities [9]. Study [10] is paying specific attention to seasonal variation in electricity consumption among off- grid households in rural India. In study [11] they claim that based on their research the main climate factor influencing the electrical power consumption are temperature and humidity. The study investigated the relationship between temperature fluctuation and energy consumption in Babolsar, it was found the electricity consumption is sensitive to temperature variation. The study in [12] the study placed in Shanghai and it was found a high peak electrical consumption because of great cooling demand and lower peak in electricity use in winter due to heating demand.

Material and method

The study and data collection took place in Libya. The reaches object was chosen in Al-marj city, which is located in the northeast of Libya. The seasonal electricity demand data of each house was categorized into four distinct seasons depend on the average seasonal temperature. There are many electrical devices in these houses but some of them have a direct effect on power consumption such as cooling and heating appliances. The data of electrical consumption of each house was collected from Libyan General Electrical Company and the temperature was collected from the website of the Al-Marj meteorological station. By using Microsoft Excel, the data were illustrated in tables and graphs to clarify the effect of temperature variation on power consumption.

Results and analysis

Here the results will be presented and analyzed through tables and graphs to illustrate the variation between temperature and electrical power consumption at homes [1][2].

Table (1): The average temperature of city during the seasons [1].

Season	Average temperature during the night C°	Average temperature during the day C°	Average temperature during the whole day C°
Winter	9.33	15.66	12.5
Spring	12.66	20.33	16.5
Summer	22.33	29.66	26
Autumn	16.33	23.66	20

By looking at the table (1) there a clear variation in temperature during the seasons, where the summer recording the highest average temperature at proximately 26 C°. While the Winter recodes the lowest average temperature at approximately 12.5 C°. The average temperatures are moderate during the Spring and Autumn seasons with slight rise in average temperature for last one.

Table (2): The average electrical power consumption per residential unit during the seasons.

Home	The electrical power consumption per season in Kilowatts			
	Winter	Spring	Summer	Autumn
1	1560	981	5808	1338
2	2185	1182	19170	1502
3	2014	1186	4133	1313
4	2849	1437	7245	1636
5	1880	1028	4619	1112
6	1896	1194	1509	1300
7	1863	1067	11143	1600
8	1676	1416	8298	1400
The average of electrical power consumption per season in Kilowatts	1990	1186	5582	1400

From the table (2) we notice the average maximum energy consumed during the Summer season followed by the winter and

this is due to the use of cooling and heating devices. While on the spring, it is lower by about 60% than on the winter and by about 470% than in the summer. If we compare the power consumed during the autumn season with the winter season, we notice slight decreases of about 42 % and compared to the summer season, it decreases by 400%. This is due to the moderate weather and the relative dispensation of devices that consumes electrical energy.

Table (3): Average of electrical power consumption per season in KW and the average temperature during the seasons in C°.

Season	The average of electrical power consumption per season in KW	The average temperature during the season C°
Winter	1990	12.5
Spring	1186	16.5
Summer	5582	26
Autumn	1400	20

When the temperature rise or falls, the demand in electrical energy increases, and this is evident in hot weather during the Summer and cold weather in winter, and the amount of electrical power consumption increase in summer to reach 5582 KW and 1990 KW in the Winter, while energy consumption is within reasonable limits during the moderate climate in the spring and autumn seasons.

The data in table (3) is illustrated in a figure (1) for more clarifying. The previous graph shows the average seasonal of electrical power consumption and the average temperature in Al-Marj, Libya. Through the data shown on the figure (1), we can see the maximum value of the seasonal average temperature and electricity consumption in the summer compared to the other seasons. It is as if there is a direct proportion between temperature and the power consumed in the summer and inverse proportion in the winter. There is a clear difference in temperature and power consumption during summer and winter seasons when compared to the spring and autumn seasons. In winter and summer, the demand for power increases due to consumers using electrical appliances for the

purpose of heating and cooling. While the temperatures are moderate in spring and fall seasons and the demand for energy decreases, this is a result of most citizens dispensing with energy-consuming appliances such as air conditions and heaters with slight increase in consuming electrical power during the autumn due to the insignificant rise in temperature.

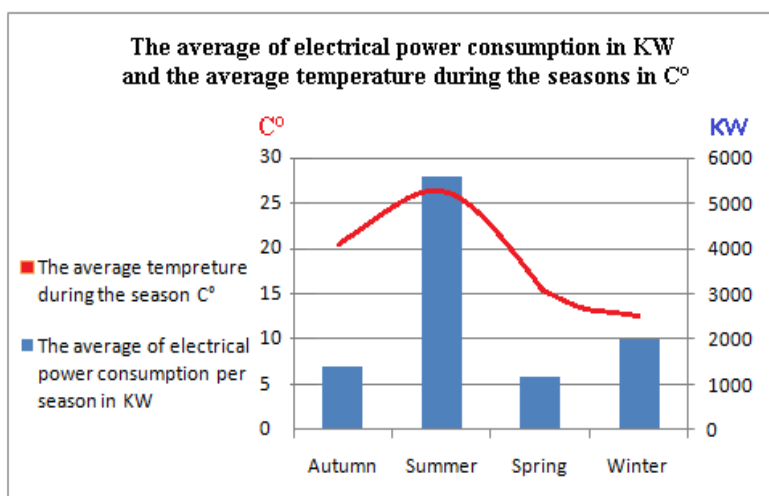


Figure (1). Average of electrical power consumption per season in KW and the average temperature during the seasons in C°.

Conclusion

In general, the temperature variation in the study area plays an important role in the demand for electrical energy during the seasons of the year, especially in the summer, where the average power consumption reaches 5582 KW. This increase is due to the excessive use of electrical cooling devices, and it decreases by about 270% during the winter, reaching 1990 KW. Although heating devices require more electrical current, consumer usually use blankets and heavy clothes to resist the cold, and use coal and gas heaters, In addition to the operating hours of the electrical heating devices

being limited. Whereas, the spring and autumn temperature are moderate and do not require many means of heating or cooling.

References

- [1] General Electricity Company of Libya, Technical Affairs Department, Statistics Division- Almaj, 2022, unpublished data.
- [2] <https://www.accuweather.com/ar/ly/marj/226743/augest-weather/226743?year=2022>.
- [3] Sharma, Arabinda & Kumar, Happy. "Seasonal Variation on Electricity consumption of Academic Building- A case study" .Journal of Thermal Energy System 2017 V. 2 Issue.
- [4] J. Yao. "Electricity consumption and temperature: Evidence from satellite data". IMF Working Paper. Q54, R11, R12. 2021
- [5] Arvids Jakusenoks, Aigars laizans ." Weather Impact on the Household Electric Energy Consumption". Rural Development 2016, Volume1
- [6] Ahmad.M.I. "Seasonal Decomposition of Electricity Consumption Data". Review of Integrative Business and Economics Research, Vol.6, Issue 4.
- [7] Hassan.B ,Adam.N,Seyedeh.Sara." Climate Change and Building Energy Consumption: A Review of The Impact of Weather Parameters Influenced by Climate Change on Household Heating and Cooling Demands" European Journal of Sustainable Development (2021),10,2,1-12.ISSN:2239-5938 .
- [8] Ang, Wang, and Ma. "Climatic influence on electricity consumption: The case of Singapore and Hong Kong" volume 127, 15 May 2017
- [9] Ghafi Kondi Akara, Benoit Hingray, Adama Diawara, Arona Diedhiou "Effect of weather on monthly electricity consumption in three coastal cities in West Africa"aims press 2021, Volume 9, Issue 3.

- [10] Aleksandra conevska, Johannes urpelainen "Weathering electricity demand? Seasonal variation in electricity consumption among off-grid households in rural India" energy research & social science, july2020.
- [11] Y.Yosef , H.Amonia , K.Ghaffari " Investigating Effect of Temperature Fluctuations on Electricity Consumption in Babolsar" / Iranian (Iranica) Journal of Energy and Environment 12(01): 93-99, 2021.
- [12] Hou, Y.-L, Mu, H.-Z., Dong, G.-T., et al., 2014. "Influence of urban temperature on the electricity consumption of Shanghai ". Adv. Clim. Change Res. 5(2), doi:10.3724/SP.J.1248.2014.074.