

Energy Audit as a Mechanism for Measuring the Amount of Electricity and Gas Lost under the High Energy Crisis Applied Study Distribution Directorate of Ghardaia

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Abstract:

This study aimed to recognize energy auditing and its role in measuring the quantities of electricity and gas lost. To address the problems of the study, we analyzed statistics from the Directorate of Distribution with a Ghardaia showing the quantities consumed by electricity and gas for the period 2018-2020 in order to know the quantities lost and their causes. The study found that the Department of Electricity and Gas checks and checks the quantities of lost electricity and gas for technical and non-technical reasons. The amount of electricity lost in three years will cover approximately 41125 customers, while the gas is estimated at 1853 customers.

Keywords: Auditing; lost energy; global energy crisis; electricity; gas.

Jel Classification Codes: G32, M31, M41, M42, O16.

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1. INTRODUCTION

Energy is an essential element of a nation's economy. The evolution of the world economy depends on the abundance and conservation of energy sources to meet the economic and social needs for energy security. This necessitated a robust audit, which serves as a process of monitoring, analyzing and recording the characteristics and features of all devices and equipment used for power conversion. to measure and track the amount of energy consumed.

Energy audit is the first step to reduce energy expenditures and prevent and process leaks by reviewing ageing devices and wiring carriers as well as other factors. All these factors lead to waste and loss of energy and increase their consumption bills in larger quantities. It works to achieve high efficiency in rationalizing energy consumption and reducing environmental damage concerns.

Against this background, energy audit has become a source of interest at the global economic level and international organizations, with the International Organization for Standardization ISO issuing the 50001 standard, which seeks to improve performance efficiency and reduce carbon emissions. Algeria, like other States, has been interested in the preparation of government programmers and the issuance of implementing decrees Nos. 05-495 and 13-424 on the energy audit of enterprises with energy consumption of electricity and gas, which is a strategic step to improve operational efficiency and determine the quantities of energy lost and the factors that cause them. In this paper, we will try to address the following main problems:

Problematic:

How much energy auditing contributes to determining the amount of electricity and gas lost at SONELGAS of ghardaia in the global energy crisis?

Based on the main problems, we ask the following sub-questions:

- Who carries out the energy audit of electricity and gas at SONELGAS Distribution Company?
- What types of lost electricity and gas are found in SONELGAS Distribution Company?
- How to calculate the amount of electricity and gas lost in the company?
- **Main hypothesis:** To answer the problem, we propose the following hypotheses

-The power audit practiced by the Electricity Department and the Gas Department contributed to the quantification of electricity and lost gas in Sonelgas Distribution Company.

- **Sub-hypotheses:**

- The energy audit of lost electricity and gas is carried out by both the Electricity Department and the Company's Gas Department.
- There are two types of technical and non-technical lost
- The amount of electricity and gas lost is calculated by comparing purchases and sales.

- **Study curriculum:**

The analytical descriptive curriculum was based on the different theoretical aspects of the topic by providing various concepts and definitions. The applied aspect of the study included a case study analyzing the data submitted by the institution in question.

- **limitations of the study:**

- **Spatial Limits:** Directorate of Electricity and Gas Distribution in Ghardaia.

- **Time limits:** Period from 2018 to 2020.

- **previous studies:**

- **study (Sharma, Surender Reddy Salkut, & Seong-Cheol, 2021)**

- A study aims to identify methods of auditing energy calculations for more efficient use in the economy, quality and density of energy in the industrial, commercial and population sector. The highest operating costs have been found to be materials, machinery and manpower. The implementation of an audit enhances its efficiency and reduces energy waste and bills.

- **Study (Sharma, R. Mahajan, & Y. Sharma, 2018)**
-aimed at analysing Indian energy auditing policies and programmes based on data and data collected from the organization's sites. The study found that the most important abundances in commercial and non-commercial buildings as well as the lack of energy auditing tools and a gap between Indian and global energy auditing practice.
 - **Study (kumar, Shashi Ranjan, M.Bharath Kumar Singh, Priyanka Kumari, & L.Ramesh, 2015)**
The study explains the audit of smart electrical power at home under the Vision Initiative Forum recommended the use of ETAP programs with the use of new equipment with low-cost technologies to achieve high efficiency for energy users while relying on renewable energy sources for the most beautiful cleaner environment.
 - **Study (Ghadi & Ali M Baniyounes, 2018)**
- Aiming to learn about energy scrutiny under the tropical climate, the study found that the cost of electricity on CQ University's Rock Hampton campus increased by 7-8% while the total rise in energy consumption was about 2-3% in 2015 compared to 2014. High energy use is associated with external air temperatures and relative humidity in the air. It can also be reduced by improving HVAC control techniques and lighting system.
- to comment:** The current study is similar to that of energy auditing, whose goal was to reduce energy bills. While the current study differs as it focused on auditing sales and purchases of the Directorate of Distribution in Grenada to identify lost quantities and identify the reasons for their loss. And how many customers you cover.

2. Concepts of Energy Auditing

2.1 Definition of energy auditing

"An energy audit consists of various jobs that can be carried out, which depends on the type of energy audit and the purpose of the energy audit facility. The energy audit can start with a review of the electricity bill

which shows energy consumption. The energy audit has been carried out by various researchers in different ways for the energy consumption has been presented in, and it states that energy audit in the residential house and the provided recommendation for the energy can be used in proper utilization (Sharma, Surender Reddy Salkut, & Seong-Cheol, 2021)" .

"Examination of energy consumption in all its forms, wastes and irrational use, and develop appropriate technical solutions to improve efficiency and minimize waste. (Official Journal Palestinian, 2022, p. 30)."

2.2 The functions of the energy audit

- an energy audit can reduce energy consumption;
- an energy audit can reduce the energy bill and save the money;
- an energy audit can improve the comfort level;
- an energy audit can reduce the carbon footprints;
- an energy audit can reduce unnecessary waste and pollution;

The energy audit is the great and most valuable step to save energy consumption and save money. It may seem that an organization's energy audit provides a point of reference for managing the consumption of energy and also it provides a better plan for the essential use of energy in an organization. (Sharma, R. Mahajan, & Y. Sharma, 2018, p. 767).

2.3 Types Of Energy Audit:

The energy audit provides the best solution to reduce energy bills and energy consumption whether it is a commercial or non-commercial sector . (T. Xiao & C. Geng, 2020, p. 127) The type of energy audit that needs to be performed depends on,

- to what extent the penetration and depth required for the final inspection are.
- the industry used: its function and type.
- the size of the audit and the desired amount reached.

There can be three types of energy audit, and they are walk-through energy audits, target energy audits, and detailed energy audits. (Kontokosta, D. S. Feld, & S. Papadopoulos,, 2020, p. 309)

2.4 International Organization for Standardization

Utilizing energy productively enables associations to save money and in addition preserving resources and tackle atmosphere changes. ISO 50001 supports organizations in all sectors to use energy more efficiently, through

the development of an energy management system. ISO 50003:2014 identifies requirements for competence, consistency, and impartiality in the auditing and certification of energy management systems for bodies providing these services. ISO 50002:2014 indicates the procedural prerequisites for completing an energy audit in relation to energy execution. It is appropriate to an extensive variety of establishments and organizations, and a wide range of energy and energy usage. It shows the standards of finishing energy audits, essentials for the fundamental systems in the midst of energy audits, and desires for energy audits. It doesn't address the necessities for assurance and evaluation of the ability of bodies giving energy audit organizations, and it doesn't cover the auditing of an affiliation's energy management structure, as these are defined in ISO 50003. ISO 50002:2014 also gives instructive direction on its utilization. (The International Organization for Standardization)

2.5 Various International Standards used To Conduct The Energy Audit

According to the ASHRAE standard 100-2006, energy audit technique have three assessment stages in order to discover the management opportunities or energy opportunities.

Stage1: inspection

Stage2: survey and data analysis and

Stage3: is capital management opportunities serious modification is provided .The key purpose of this stages is to find out the potential improvement that will save energy, save cost without affecting the output. ISO 5002:2014 has the new standards for the energy audit. The international standard organization introduced the recent document and international standards to conduct the energy audit which is also the part of the ISO 5001 family for management of Energy system. As indicated by the British Standard Institute (BSI), an energy audit is a systematic inspection and examination of energy utilities and energy utilization of a site, building, framework or association with the expectation to distinguish energy streams and the potential for energy efficiency improvement and reporting them.

British Standard Institute introduces the European standards in 2012 for energy audit BSI 16247-1:2012. It describes the energy audit in stages:

- A. Preliminary audit
 - B. Kick-off meeting
 - C. By Executive Decree Collection of data
 - D. Field visit E. Analysis
 - F. Report writing
 - G. Final meeting. (Sharma, R. Mahajan, & Y. Sharma, 2018, p. 769).
- 2.6 Algeria's energy audit legal framework:** By Executive Decree
- Executive Decree No. 05-495 of 24 Dhul Qadah of 1426 corresponding to 26/12/2005.
 - Executive Decree No. 424-13 dated 15 years 1435 Approved 18 December 2013.

The objective of the energy audit is to study and monitor the energy performance of equipment and equipment for industrial installations and other installations in order to maximize their level of operation to limit the energy audit periodicity to three (3) years for industrial enterprises and transport installations and five (5) years for service plants.

The Energy Development and Rationalization Agency informs the institutions concerned of the list of certified energy auditors, certified offices and their audits. (Official Gazette of the Republic of Algeria, 2013, p. 17).

3. Audit of Lost Power from Electricity and Gas State of Ghardaia

The Sonelgas complex consists of three heads of a production branch, a transport branch, a distribution branch containing a different directorate, including the Directorate of Ghardaia Distribution. The state directorates purchase electricity from GRTE and gas from GRTG after the purchase is sold to customers of all kinds.

For the purpose of searching for the amount of electricity and gas that is not used, we will calculate the amount lost by comparing purchases and

sales for the years 2018, 2019, 2020, as shown in the tables below which contain:

3.1 Table components

-**Months:** From January to December for the years 2018, 2019 and 2020;

b-**Number of customers:** the number of customers consuming electricity and gas during the months in question;

C-**Procurement:** It is the quantity purchases of electricity from a branch of GRTEO and gas from GRTG before it is sold to customers;

D-**Sales:** Actual quantity sold to customers from purchased gas electricity;

F-Difference **Ecart:** the difference between the quantity of electricity and gas purchased and the quantity sold;

e. **Rate,** which is the percentage of electricity and gas lost compared to what was purchased

J. **Lost quantity:** Lost power from electricity and gas, which is not used by the company, there are several reasons for electricity loss, including technical and non-technical reasons (pertes):

- **Lost current for technical reasons:** accurate calculation of lost current is technically difficult, but SONLGAS, after conducting tests of the quality of electrical wires and their thermometry, has developed a certain percentage (taux) applied monthly and is considered lost energy due to technical, out of pronunciation is uncontrollable. Theoretically, lost electricity is calculated from the following relationship:

Pertes technique = $R \times I^2$ (lost electricity current of technical purity). Note that:

R: is resistance unit measured OEM (Ω).

I: Power Supply Amp Measurement Unit (A).

- Electrical power lost for non-technical reasons: a current that is lost due to controllable interference by one means or another to reduce or at least reduce it and divided into.

a-Orientation or electricity theft (fraud): Often through some customers, an infringement of the company's assets is deemed to be by indiscriminate connecting from the grid directly without the company's knowledge or by deliberately disabling the meter for the

purpose of not counting the amount consumed by electricity and gas, allowing the company to prosecute the perpetrator as an infringement of its ownership;

b-Damaged meters (copnture grade) Sometimes the meter may disrupt the calculation of the amount of electricity consumed by the customer that will deprive the company of certain returns, especially mechanical meters due to disturbance within the meter or the end of the user life specified for it (total depreciation of the meter);

c- Reading error: an error that may occur by costly aid during field loading of electricity consumed by customers.

3.2 Calculation of lost electricity and gas for 2018 Values in tables(GW)

Table 1. shows the quantity of electricity and gas purchased and sold during 2018

2018										
electricity						Gas				
Month	Number of customers	Sales (GW)	Purchases (GW)	Ecart (GW)	Rate %	Number of customers	sales (MEGA THERMIE)	purchases (MEGA THERMIE)	Ecart(MEGA THERMIE)	Rate %
january	116480	56,23	58,00	1,77	3,04	65038	206,80	206,96	0,16	0,08
february	116741	50,12	51,17	1,05	2,05	65474	178,01	178,94	0,93	0,52
march	117285	45,20	46,56	1,36	2,91	65963	115,01	115,13	0,12	0,10
april	117617	46,20	48,10	1,90	3,95	66192	47,40	47,59	0,19	0,41
may	118101	60,24	61,35	1,11	1,81	66386	33,01	33,74	0,74	2,19
june	118589	81,00	82,19	1,19	1,45	66691	32,00	32,26	0,26	0,80
july	118884	69,89	108,57	38,68	35,63	66807	27,40	27,56	0,16	0,57
august	119565	79,79	105,29	25,50	24,22	67067	30,60	30,66	0,06	0,19
September	119880	73,64	75,14	1,50	2,00	67303	30,00	30,88	0,88	2,86
October	120375	49,20	50,48	1,28	2,54	67535	43,32	43,74	0,42	0,96
November	120675	40,98	46,73	5,75	12,30	67869	69,61	69,62	0,01	0,01
December	121187	46,45	56,73	10,27	18,11	68284	158,00	158,13	0,12	0,08
annual total		698,94	790,31	91,37	11,56		971,16	975,21	4,04	0,41

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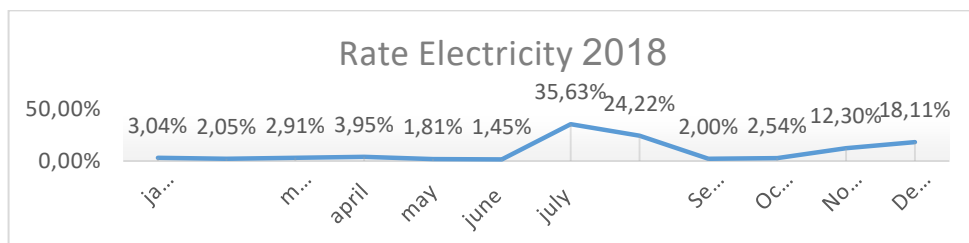
Source: From the preparation of researchers based on information provided by the company

From the table we note that the quantity of electricity purchases in January was 58.00 GW while the enterprise sold 56,23 an estimated loss of 1,77, an amount of gas purchased 206.96 and a sale of 206.80, a difference of 0.16.

- While in the month of February the amount of electricity purchases 51,17 while the amount sold is 50,12, a difference of 1,05,
- March 46,56 were purchased and 45,20 were sold with an estimated loss of 1,36,
- April 48,10 purchased and 46,20 sold, an estimated loss difference of 1,90.
- May month 61,35 purchased and 60,24 sold, 1.11 difference,
- June Month 82,19 purchased and 81,00 sold, a difference of 1,19.
- July month 108,57 purchased and 69,89 sold with an estimated difference of 38,68.
- August 105,29 purchased and 79,79 sold, an estimated loss difference of 25,50.
- The month of September was bought 75, 14 and sold 73, 64 , 1.50 lost.
- October 50, 48 purchased and 49, 20 sold, 1.28 lost.
- November 46, 73 purchased and 40, 98 sold, 5, 75 lost.

Finally in December 56,73 were purchased and 46,45 sold, 10,27 lost difference The amount of lost gas during 2018 is very small compared to the quantity of electricity, as well as the percentage of lost electricity varies compared to the quantity of purchases from one chapter to another, where we note as shown in the following curve:

Fig.1. Rate Electricity 2018



Source: From the preparation of researchers based on information provided by the company, 2018

Through the curve we note that the summer season is the most lost for electricity and the peak of loss reached in July month with 35% of the value of purchases and then decreases relatively during September and October to 2.00% and 2,54% respectively to rise again during November and December.

3.3 Calculation of lost electricity and gas for 2019

Table 2. shows the quantity of electricity and gas purchased and sold during 2019 "Values in table GW"

2019										
electricity						gas				
Month	Number of customers	sales	purchases	Ecart	Rate %	Number of customers	sales	purchases	Ecart	Rate %
january	121508	54,01	55,89	1,88	3,36	68758	164,00	165,99	1,98	1,20
february	121979	49,65	50,16	0,51	1,02	69215	143,02	144,97	1,95	1,35
march	122706	51,01	51,41	0,41	0,80	69650	119,00	120,00	0,99	0,83
april	123166	47,20	48,33	1,13	2,33	70001	49,21	49,88	0,67	1,34
may	123840	59,02	60,94	1,92	3,15	70311	44,40	44,54	0,14	0,31
june	124461	90,25	100,62	10,37	10,31	70727	29,53	29,57	0,04	0,14
july	124567	99,30	115,92	16,62	14,33	70764	30,00	30,07	0,06	0,22
august	124752	88,87	114,11	25,24	22,12	70915	26,00	26,13	0,13	0,49
September	125057	75,53	87,49	11,96	13,67	71180	31,00	31,20	0,20	0,64
October	125684	54,00	54,06	0,06	0,12	71445	34,79	42,65	7,85	18,42
November	126229	49,00	50,00	1,00	2,00	71907	53,00	54,05	1,05	1,94

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December	126480	57,00	57,50	0,50	0,87	72458	181,00	183,28	2,28	1,24
annual total		774,84	846,43	71,59	8,46		904,98	922,32	17,34	1,88

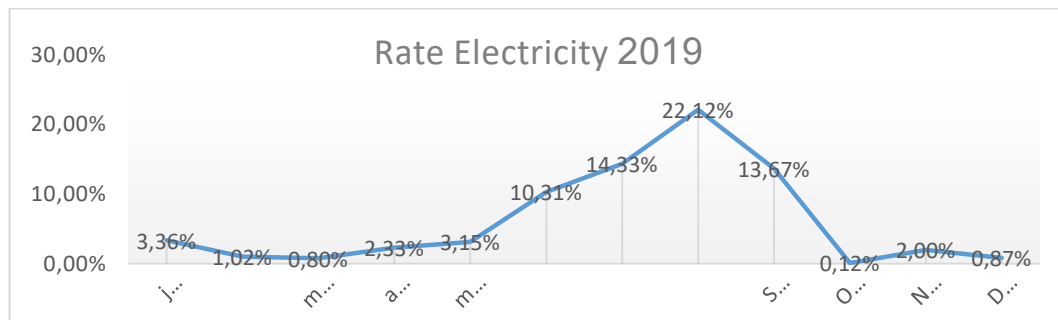
Source: From the preparation of researchers based on information provided by the company

From the table we note that during January the company purchased 55,89 of electricity while it sold 54,01, an estimated difference of 1,88,

- While in February 50,16 was purchased and 49,65 sold, an estimated loss difference of 0.51 The month of March was bought, 51,41 and sold 0.41, an estimated loss difference of 0.41, The month of April 48,33 was purchased and 47,20 sold, a loss difference of 1,13 During May 60,94 were purchased while 59,02 were sold by a difference of 1,92, In the month of June 100,62 was purchased, 90,25 sold with an estimated loss of 10,37, In July 115,92 purchased 99,30 sold, an estimated difference of 16,62 The month of was bought 114,11 and sold 88,87, an estimated loss difference of 25,24, the largest loss rate during the year 2019, During September 87,49 were purchased and 75,53 sold, an estimated loss difference of 11,96 In October, 54,06 were purchased and 54,00 sold, an estimated loss difference of 0.06, November 50,00 purchased and 49,00 sold with an estimated 1,00 loss difference Last December, 57.50 was purchased and 57.00 sold, an estimated loss difference of 0.50, the lowest lost value recorded during this year.

We also note that the amount lost of gas during 2019 similar to 2018 is very small compared to the amount of electricity,

Fig.2. Rate Electricity 2019



Source: From the preparation of researchers based on information provided by the company 2019

Through the curve, electricity loss increases as summer approaches at the beginning of June 10.31% and then climbs to 14.33% to a peak in UT of 22.12%, and then descends to 13.67%.

3.4 Calculation of lost electricity and gas for 2020

Table 3. shows the quantity of electricity and gas purchased and sold during 2020 "Values in table GW"

2020										
electricity						gas				
Month	Number of customers	sales	purchases	Ecart	rate%	Number of customers	sales	purchases	Ecart	Rate %
january	121037	62,65	64,12	1,47	2,29	73028	264,00	267,39	3,39	1,27
february	121682	48,07	50,68	2,61	5,16	73662	157,00	157,13	0,13	0,08
march	122211	48,21	50,53	2,32	4,59	74046	80,24	80,41	0,17	0,22
april	122905	49,09	50,09	1,00	2,00	74440	56,03	56,35	0,32	0,57
may	122995	69,06	72,49	3,43	4,74	74544	36,24	36,64	0,41	1,11
june	123487	90,23	102,21	11,98	11,72	74752	29,50	29,97	0,47	1,56
july	123519	88,86	117,87	29,01	24,61	74858	31,02	31,86	0,84	2,64
august	123777	91,92	114,82	22,90	19,95	75106	32,15	32,82	0,67	2,05
Sept	124354	79,4	80,90	1,50	1,85	75422	42,16	42,35	0,20	0,46
October	124942	50,01	51,41	1,40	2,72	75809	44,15	44,52	0,37	0,84
November	125110	51,13	52,98	1,86	3,50	76127	119,02	119,55	0,52	0,44%
December	125745	57,23	62,72	5,49	8,76	76756	250,07	252,71	2,63	1,04

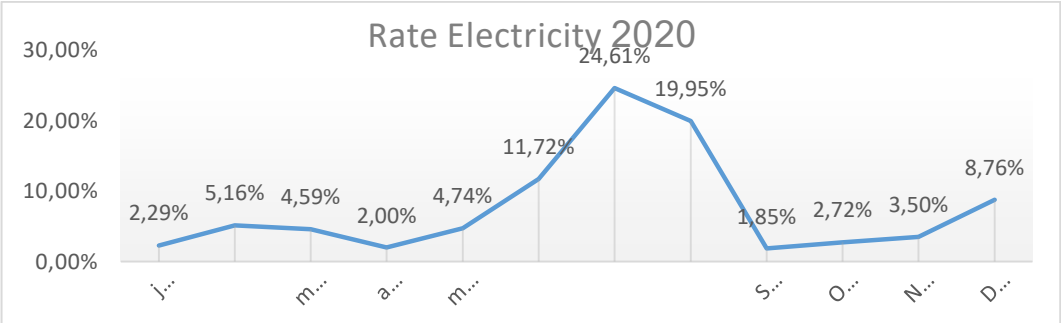
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annual total	785,85	870,83	84,98	9,76		1141,57	1151,70	10,13	0,88

Source: From the preparation of researchers based on information provided by the company

From the table, we note that during January the company purchased 64,12 while it sold 62,65, a difference of 1,47. The number of customers exploiting this amount is estimated at 12,1037 customers While during February month 50,68 were purchased and 48,07 sold, an estimated difference of 21, In March 50,53 were purchased while 48,21 were sold, an estimated difference of 2,32 During April 50,09 were purchased while 49,09 were sold with an estimated difference of 1,00, May was bought 72,49 and 69,06 sold, an estimated difference of 3,43 In the month of June 102,21 was purchased and 90,23 sold, an estimated difference of 11,98, In July, 117,87 were purchased and 88,86 sold, an estimated difference of 29,01, the largest difference in 2020. The month of August was bought 114,82 and sold 91,92, an estimated difference of 22,90, September purchased 80.90 and sold 79.40 with an estimated difference of 1,50 The month of October was bought 51,41 while 50,01 was sold, an estimated difference of 1,40, November 52,98 purchased and 51,13 sold, an estimated difference of 1,86 Finally, December 62,72 was purchased and 57,23 sold, an estimated difference of 5,49.

Fig.3. Rate Electricity 2019



Source: From the preparation of researchers based on information provided by the company2020

Through the curve we always note that the consumption peaks of June, July, and August, we also note that the loss rate in Joan was 11.72% to rise to 24.61% during the month of July, to decrease relatively in the month of August to 19.95.

4. CONCLUSION

Through the comprehensive inspection of the quantity of electricity and gas buyers and sellers for the years 201820192020, we conclude the following:

- There are several reasons why electricity and gas, especially electricity, are lost, including technology such as the high temperature of electrical wires, and the quality of used electrical wires, including non-technical reasons such as the theft of electricity or gas.

- The rate of loss of electricity and gas varies from year to year and from month to month,

- In the summer, there is a peak loss of electricity due to the high temperature, which will increase the heat of the wires, and the loss has been raised on the one hand, and on the other hand because the desert area is dishonest consumer is looking for all the twisted roads such as electricity theft.

- In terms of gas, the peak consumption is in the winter month of November, December, January and February.

- The electricity loss rate is very large compared to gas;

- The number of electricity customers at the end of 2018 was about 1211,187 with an estimated annual consumption of 698,94. An estimated annual loss rate of 91,37. Assuming that 698.94 covers 100% of the

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estimated 12,1187 customers for 2018, the amount of loss for 2018 of 91,37 will cover 13.07%.

Which percentage of customers will be covered during 2018 from lost electricity is: $\frac{121187 \times 91.37}{698.94} = 15842$ The lost amount of electricity during 2018 can cover 15,842 customers within one year;

- During 2018, the number of gas customers reached approximately 68,284 with an estimated annual consumption of 971,16 "MEGA", while the amount of loss during the year amounted to 4,04 MEGA, assuming that 917.16 "MEGA" covers all 68,284 customers.

$\frac{404 \times 68284}{917.16} = 284$ Customer, the lost quantity of gas during 2018 can cover 284 Customer within one year;

-At the end of 2019, the number of electricity customers was 126,480 with an estimated annual consumption of 774,84 and an estimated loss of 71,59. Assuming 774,84 covers 126,480 customers, the amount of loss for 2019 of 71,59 will cover approximately. $\frac{126480 \times 71.59}{774.84} = 11685$ Customer within one year.

- The number of gas customers as of the end of 2019 was about 72,458 and the total quantity of gas consumed in the same year was about 904,98 "MEGA" while the amount lost during the year was 17,34 "MEGA" and if we looked for the amount that could be covered by this quantity would be $\frac{72458 \times 17.34}{904.98} = 1388$ Customer within one year.

- During 2020, the number of electricity customers reached 125,745 with an estimated annual consumption amount of 785,85 GW and an estimated loss amount of 84,98. Assuming also that the amount of 785,85 covers 125,745 customers, the amount lost for 2020 of 84,98 will cover approximately $\frac{125745 \times 84.98}{785.85} = 13598$ Customer within one year.

- As for gas, the number of gas customers at the end of 2020 was 76,756, the amount consumed by gas per year is estimated to be 1141,57 "MEGA", while the amount lost during the same year was 10,13 "MEGA", and if we search for the amount that this quantity can cover, $\frac{76756 \times 10.13}{1141.57} = 181$ Customer within one year.
- So through the foregoing, the amount of electricity lost during the three consecutive years can cover 41125 electricity customers, 15842 + 11685 + 13598.
- As well as the lost amount of gas during the three consecutive years, it can cover 1853 customers in electricity, 284 + 1388 + 181.

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