ISSN 2278-3091
Volume 8, No.1.5, 2019
International Journal of Advanced Trends in Computer Science and Engineering
Available Online at http://www.warse.org/IJATCSE/static/pdf/file/ijatcse2781.52019.pdf
https://doi.org/10.30534/ijatcse/2019/2781.52019

Consumption energy saving of an energy audit within industry in Morocco

Imane.Chramate [1], Fouzi.Belmir [2]
[1]Laboratory LCME, High School of Technology, Sidi Mohammed Ben Abdellah University, Morocco, Imane.chramate@usmba.ac.ma
[2]Laboratory LCME, High School of Technology, Sidi Mohammed Ben Abdellah University, Morocco, Fouzi.belmir@usmba.ac.ma

ABSTRACT

The energy audit is the bedrock of the policy of sustainable reduction of consumption within the company, in order to improving energy efficiency in different industrial sectors. The products and commercializing cattle feed are an industrial sector that consumes energy in Morocco, in this article aimed at identifying energy losses in this industry. The results of the audit and the financial gain are presented as well as the analysis of the energy bill and the electrical circuit. The paper represents an action plan for better use of the energy efficiency of specific installations such as capacitors. The recommended energy efficiency measures have saved of electrical energy, which corresponds to a financial gain of 529,024 KMAD.

Key words: energy efficiency, energy consumption, reactive energy, energy audit, CO_2 emissions.

1. INTRODUCTION

The major problems that theaters our planet in the next few year is the climate change caused by CO_2 emissions, this change affects the planet and the futures generation by the rising of temperature, in this situation the effectives measures are needed in the order to limit and reduce this threat while remaining in agreement with the report [1] about the global warning of the IEA (International Energy Agency) has published in 2013.

In this context, the solutions that can helps the company to reduce their emissions of greenhouse gases are the improvement of the investissement in energy efficiency in buildings and industries proposed by IEA, but the problem remains the same because the emissions are due to fossils fuels that have a negative impact on environment.

Besides the economic development and population growth, needed [2,3] an approach of sustainable development in order to improvement the energy efficiency in the industrial sector, for this raison Moroccan government has obliged for the industrial company to carry out energy audits, this obligation as clearly stated in Law N°47-09 on Energy Efficiency for the industrial sector, in order to establish the objectives targeted by 2020 and which have between 12% And 15%. Morocco has to meet energy demand (about 7% per year), to this end a new strategy presented by the ministry, of energy in the objective to reduce the energy consumption in this sector.

Nomenclature

AEP	average electricity price (excluding taxes) [MAD/kWh]
P	active power [kW]
AP	apparent power [kVA]
Q	reactive power [kVAr]
Apm	monthly maximum apparent power [kVA]
SP	subscribed power [kVA]
DPF	displacement Power Factor [-]
PSP	subscribed power price [MAD/kVA]
PUHT	Unit price excluding tax (MAD)
Do	Power Overload (MAD)

The majority of the greenhouse gas emissions are presented in industrial sector, or this sector [4] represents 30-70% of energy consumption, to this end the different studies have been recently carried out as in to reduce the emissions [5,6] by the improving of energy efficiency.

Indeed, energy auditing helps industrials companies to reduce their energy consumption, and at the same time putting at their disposal an efficient and sustainable method in order to realize a better profitability in the industrial process.
In this context, the results presented were, according to a case study carried out in an industrial company localized in Fez, the different steps of production are presented in Figure 1.

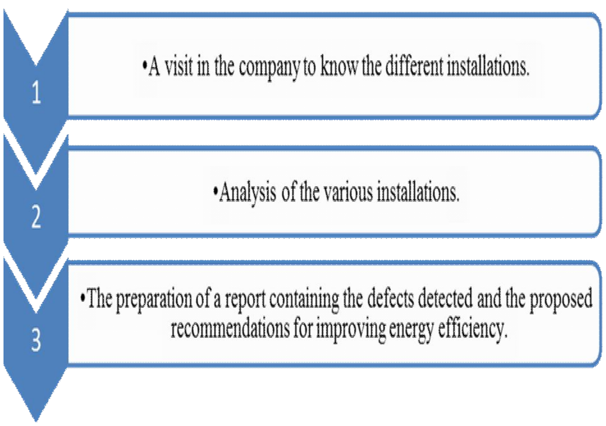
Figure 1. Factory Production Process in the site

The mismanagement of electrical energy in this site requires an analysis of the energy consumption in order to identify the losses in energy, a new methodology has been established in order to improve the energy efficiency in the site

Indeed, this new methodology is based on the analysis of the electrical network by the analyzer (Chauvin Arnoux Qualistar +), and subsequently the determination of energy losses.

2. METHODOLOGY

The method followed in this paper is described in the three steps:



2.1 The parameters of the energy bill

The majority of the Moroccan industrial companies are supplied by the national electricity office and they use the medium voltage, in this case we will analyze the energy bill of the year 2015.

2.2 Consumption fee

Consumption fee is differentiated from one period to [7] another as shown in Table 1. This load can be calculated by the addition of the different energy consumptions and multiplied by the price of electricity associated with each period.

2.3 Unit price of electricity excluding tax

The price of the kilowatt proposed by the ONE is associated with the need of the company and according to the 3 levels of consumption:

¬ Consumption in normal hours;
¬ Off-peak consumption;
¬ Consumption in peak hours.

Table 1: The price of electricity according to the different period in Morocco

Description	Peak hours	Normal hours	Off-peak hours
Period			
October-March	[22h-07h]	[07h - 17h]	[17h- 22h]
April -September	[23h-07h]	[07h - 18h]	[18h - 23h]
Billing			
Electricity price (MAD/KWH)	0,5363	0,8135	1,1646
Price of subscribed power (MAD/KVA)	466,02		

.

2.4 Penalty for power factor less than 0.8

According to the current tariff structure in Morocco, large industrial consumers are penalized by additional charges on their electrical rating [8] if the average monthly power factor is less than 0.8. The amount of the penalty represents 2% of the total amount of the consumption charges for each one-hundredth [9,10] of insufficiency, compared to 0.8 of the observed power factor.

2.5 Analysis of the Factory Energy Bill

Table 2 shows the energy bill for the year 2015, which is divided into three levels according to normal, peak and off-peak hours, and as shown in Table 1, the Kilowatt price is high in the peak hour period and which results in an increase in the energy bill as clearly seen for the months (January, May, June, July) or the energy bill has been raised to 680918.92 MAD.

Table 2: Characteristics of the energy bill for the year 2015

Months	Energy-consumption in normal hours (Kwh)	Energy-consumption in peak hours (Kwh)	Energy-consumption in off	Price in MAD
January	245470	234750	140180	609574,54
February	235410	214240	123260	565240,27
March	237210	223800	115160	562000,24
April	269320	186130	98120	547110,53
May	275570	216660	122860	606547,03
June	280190	219780	135740	632075,21
July	313080	237890	138010	680918,92
August	260270	211950	102400	561699,55
September	215030	170800	38510	411307,81
October	235250	204370	88570	513168,83
November	222810	219770	113080	543542,94
December	240700	206160	93430	525600,75

Indeed, the monthly consumption varies between 411307, 81 MAD and 680918, 92 MAD (with an average of 463724, 91 MAD) of which it is represented in figure 2.

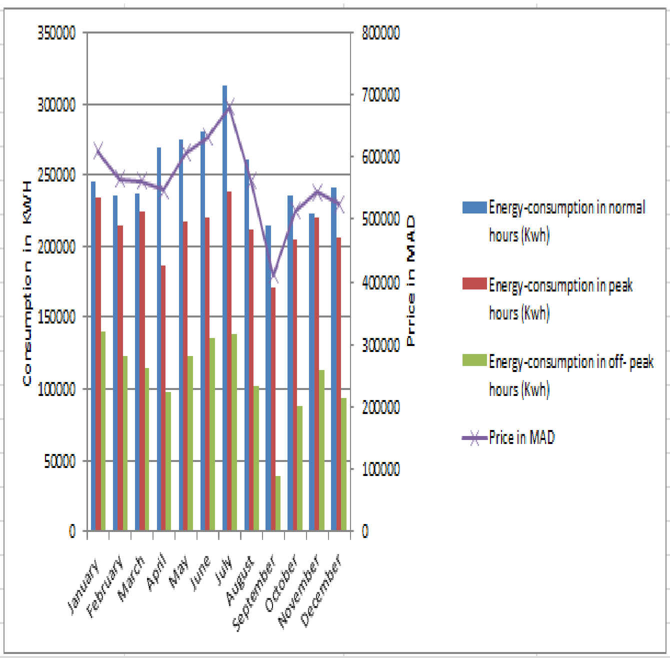


Figure 2: Consumption of the year 2015 by month and price.

3. RESULTS AND DISCUSSION:

3.1 Diagnostic

The correction of the energy-consuming industrial installations [11,12] is carried out by a battery of automatic capacitors and a power bill controller which allows the DPF value to be entered after an analysis of the operation of the capacitor Fig.3) by The network analyzer (chauvin arnaux), it was found that the DPF is lower, which gives the obligation to diagnostic the system of energy compensation.

3.2 Power factor

The concept of power factor is important for understanding a cost-effective use of electrical energy. A low power factor in an installation leads to an increase in the losses of the electrical network.

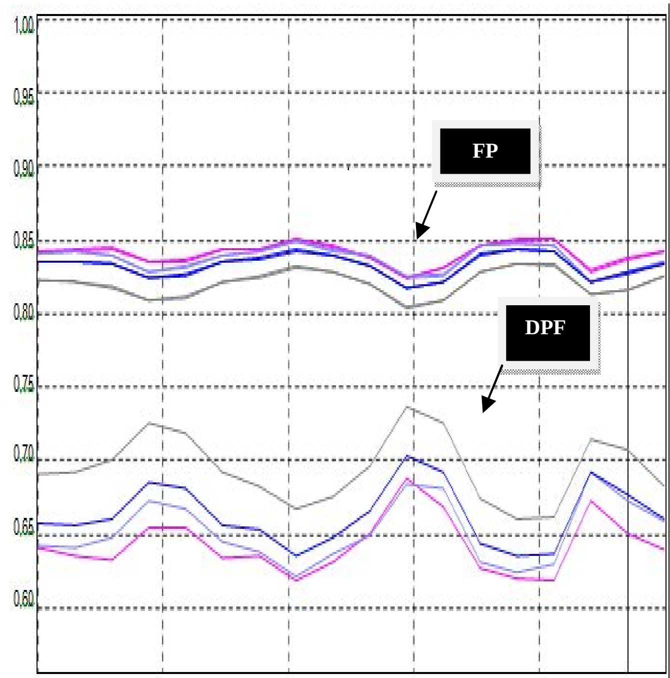


Figure 3: The variation of the power factor and of the DPF.

FP and DPF measurements indicate a need for reactive energy compensation in order to obtain better gain and loss reduction. The definition of the reactive energy compensation cabinet must be as accurate as it is essential to avoid over compensating.

The power factor can also be defined by the following relation:

$$FP = P/S$$

Indeed, overcompensation means that we inject reactive power called capacitive and that would be counted in the apparent power, so the capacitor battery must have a neutralizing effect of the reactive energy consumed by the installation while benefiting from maximum of available power.

3.3 Reactive energy compensation

Electrical energy is mainly distributed to users in the form of alternating current through high, medium and low voltage networks.

The active energy consumed (kWh) results from the active power P (kW) of the receivers. It transforms completely into mechanical power (work) and heat (losses).

The reactive energy consumed (kvarh) serves essentially to supply the magnetic circuits of electrical machines. It corresponds to the reactive power Q (kvar) of the receivers. The apparent energy (kVAh) is the vector sum of the two previous energies. It corresponds to the apparent power S (kVA) of the receivers, vector sum of P (kW) and Q (kvar) (Fig.4).

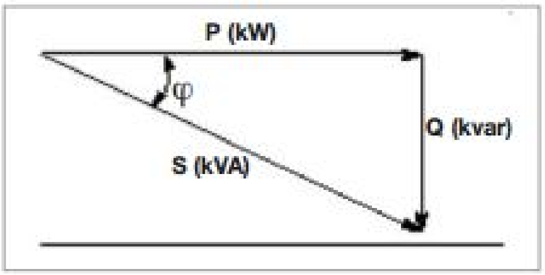


Figure 4: Vector composition of powers.

The objective of reactive energy compensation is to reduce the current on the network. The reactive energy is supplied by capacitors, as close as possible to the inductive loads. Over a given period of time, therefore, due to a so-called larger current, the circulation of the reactive energy on the distribution networks entails:

- Transformer overloads,
- Heating of the power cables,
- Additional losses,
- High voltage drops.

Indeed, for reactive energy compensation to be effective, the cosφ which is the quotient [13,14] of the active energy on the apparent energy must have a value close to 1, in another way decrease the reactive power vector the maximum possible.

After an analysis of the reactive energy in the plant, we have obtained the following results (Fig.5), which shows that the mean of the quotient of P on S equals a cosφ = 0.83 and an increase of the value of So it can be said that the installation of a new compensation cabinet is necessary in order to reduce the reactive energy consumed by the installation.

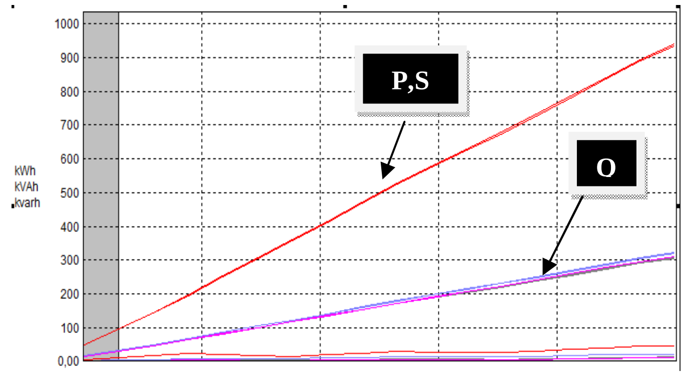


Figure 5: Recording the power profile (figure caption).

3.4 Results

3.4.1 Installation of capacitors for power factor improvement.

As a result of the commissi[illegible] of the new compensation cabinet, the latter has r[illegible] the reactive power consumed by the installation, as shown in the record (Fig. 6,7), the reactive power amounts to a negl[illegible] value close to 0, and the cosφ set point is set to 0.99.

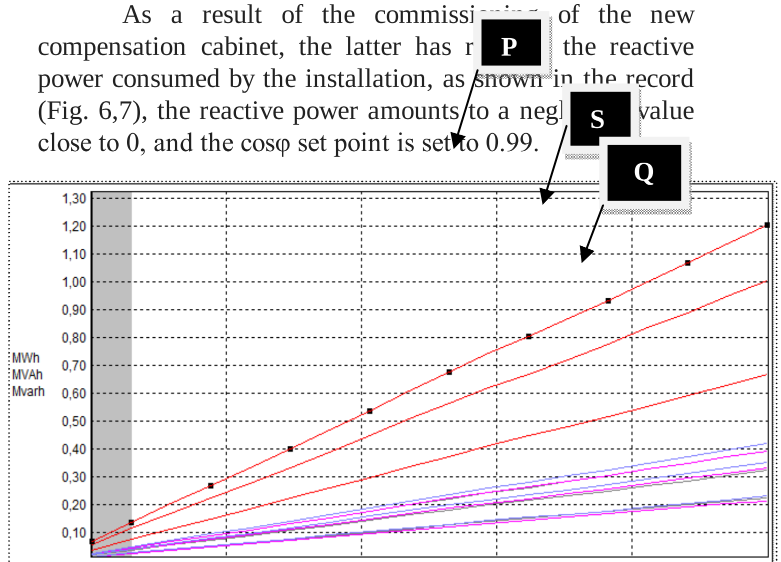


Figure 6: Recording the power profile with the new Compensation (figure caption).

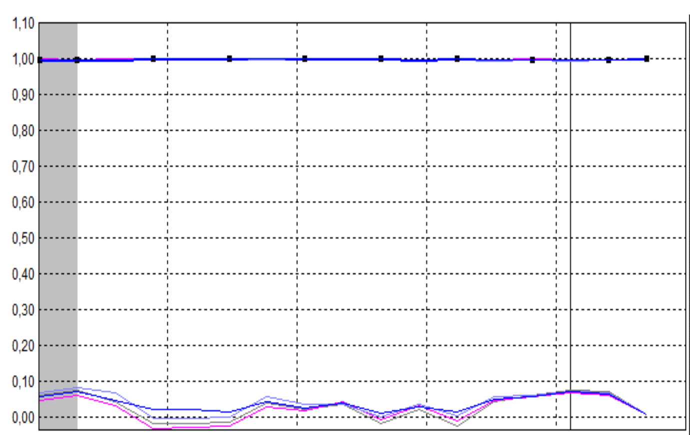


Figure 7: Recording the cosφ (figure caption).

Reactive energy compensation offers several advantages as shown in the results obtained, whose reactive energy value was decreased from 36.75 Kvarh to 12.50 Kvarh, and the active and apparent energy increased respectively From 55.82 KWh to 95.35 KWh and from 66.85 KVa to 96.21 KVa.

This reduction in the reactive energy could improve the power factor from 0.83 to 1 this improvement results from a loss reduction of 30%, a reduction of the energy bill of 26 760 kWh / year, A financial gain of approximately 529024 MAD / year and with a return on investment of less than 2 years.

Finally, it can be said that an improvement in the power factor to a monthly average exceeding 0.8 offers energy savings, a penalty avoided and financial gain on the energy bill.

4.CONCLUSION

This case study was carried out in an industrial society in Fez, the methodology and the capacitors changed have been described in the results obtained were evaluated economically and environmentally, the main results obtained were:

- The Mismanagement energy and a low power factor are the major problems that were identified during the analysis of the energy bill of the year 2015
- The installation of a capacitor for improving the power factor has reduced reactive energy and reduced the energy bill by 26760 kWh / year.
- For a value of 0.99 of cosφ in a company we can have an energy saving of 529024 MAD annually.

REFERENCES

1. A Allouhi, Y El Fouih, T Kousksou, A Jamil, Y Zeraouli, Y Mourad, **Energy consumption and efficiency in buildings: current status and future trends**. J Clean Prod 2015;109:118e30. https://doi.org/10.1016/j.jclepro.2015.05.139
2. M Christenson, H Manz , D Gyalistras, **Climate warming impact on degree-days and building energy demand in Switzerland**. Energy Convers Manag 2006;47(6):671e86. https://doi.org/10.1016/j.enconman.2005.06.009
3. World Energy Outlook 2013-International Energy Agency.
4. E Worrell, **Energy efficiency improvement and cost saving opportunities for the US iron and steel industry an ENERGY STAR (R) guide for energy and plant managers**. Lawrence Berkeley National Laboratory; 2011. https://doi.org/10.2172/1026806
5. A Allouhi, Y El Fouih, T Kousksou, A Jamil, Y Zeraouli, Y Mourad, **Solar domestic heating water systems in Morocco: an energy analysis**. Energy Convers Manag 2015;92:105e13. https://doi.org/10.1016/j.enconman.2014.12.055
6. T Xu, **Development of bottom-up representation of industrial energy efficiency technologies in integrated assessment models for the iron and steel sector**. Lawrence Berkeley National Laboratory; 2011.
7. SB Viklund, MT Johansson. **Technologies for utilization of industrial excess heat: potentials for energy recovery and CO2 emission reduction.** Energy Convers Manag 2014;77:369e79. https://doi.org/10.1016/j.enconman.2013.09.052
8. E Worrell, P Blinde, M Neelis, E Blomen, E Masanet, **Energy efficiency improvement and cost saving opportunities for the us iron and steel industry**. Berkeley, CA: Ernest Orlando Lawrence Berkeley National Laboratory. University of California; 2010. LBNL-Report No. 4779E. https://doi.org/10.2172/1026806
9. Recommended Practices and Requirements for Harmonic Control in Electronic Power Systems. IEEE Standard 5191992. New York; 1993.
10. M Thirugnan, M Hasanuzzaman, R Saidur, MB Ali, S Rajakarunakaran, D Devaraj, et al. **Analysis of electrical motors load factors and energy savings in an Indian cement industry**. Energy 2011; 36(7): 4307e14. https://doi.org/10.1016/j.energy.2011.04.011
11. M Dongellini, C Marinosci, GL Morini. **Energy audit of an industrial site: a case study.** Energy Procedia 2014;45:424433. https://doi.org/10.1016/j.egypro.2014.01.046
12. F Belmir, **"QSE management and sustainable développement"**, Ph D. thesis, Sidi Mohammed Ben ABDELLAH University, Fez, Morocco