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An Overview of Electricity Tariffs and Practical Optimization Approaches for Energy Billing at the University of Tipaza, Algeria

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ABSTRACT

This study focusses on increasing electrical energy utilisation to reduce energy costs, using the University of Tipaza as an example, which has seen significant increases in electricity expenditures. The main objective is to optimise energy use by analysing historical consumption data, which results in the employment of specific strategies such power analysis and tariff changes. The paper recommends strategic changes such tariff adjustments, limiting available power, and installing compensation devices in order to generate significant savings and align the energy cost with actual consumption. These programs demonstrate how energy management in institutional settings may be greatly improved, with benefits for the economy and the environment.

Keywords: Energy costs, Electricity tariffs, optimise energy, energy management .

1. INTRODUCTION

Electricity suppliers struggle with strong demand fluctuations, especially during peak hours when maintaining sufficient supply may require rationing [1]. It is hard and often not worth the effort to expand the grid to handle these short-lived peaks, like the ones that happen on hot summer days. The challenge is compounded by reliance on conventional peak-generation technologies like gas or diesel plants [2]. To cope with these constraints, public utilities deploy several strategies, including large-scale storage systems and demand response programs [2]. Many countries also complement these measures with reactive energy tariffs and energy efficiency standards to improve network performance and promote more economical electricity use [6–2].

A key strategy for improving power system efficiency is the adoption of time-of-use (TOU) tariffs, where electricity prices rise during high-demand periods and fall during low-demand hours. This encourages people to use less during peak times, which changes their habits of use [2]. Such pricing plans can help high-demand users save a lot of money by encouraging them to shift their demand to times when there is less demand or in the middle of the peak [4]. They also let suppliers compete by offering a variety of time-modulated tariff plans, which lets customers choose the ones that will help them save the most money on their electricity bills [5].

This paper looks at the problem of rising electricity prices around the world and offers a strategic framework for making institutional billing more efficient. The research indicates that substantial electricity consumers could achieve significant cost savings and reduce energy consumption by analysing tariffs and employing a systematic approach. The main goal of the project is to help the University of Tipaza use less electricity so that energy costs go down a lot. Not only will reaching this goal help the school's finances, but it will also let them quickly get back the money they spent on new technologies.

2. RELATED WORK

This literature review focusses on the large amount of research that has been done to improve the management of electrical energy through better pricing strategies and tariff structures. A lot of research looks at how electricity tariffs affect how people use the system and how well it works. Some of this research looks at cost-recovery mechanisms [6]

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and suggests ways to measure the link between different types of tariffs and how users respond [7]. The design of the best retail tariff is an important question. Studies look at the costs of making, shipping, and servicing goods [7–8], show how time-variant pricing can help lower peak demand [9], and look at how fair different tariff schemes are [10]. Welfare-based optimisation methods consider both the costs of making things and the benefits to consumers to find the best pricing models [11–12]. A lot of research also looks at how to make Time-of-Use (TOU) better. For example, cost-benefit methods that make the grid more reliable [19], models that look at how price affects electricity demand [13], and game-theory-based frameworks that take customer satisfaction into account [14–16]. Empirical evidence from multiple countries demonstrates that flexible pricing can significantly alter consumption patterns, as evidenced in Ireland [17], Sweden [18], and Germany [19]. This underscores the necessity for a deeper comprehension of how varying tariff structures motivate consumer engagement. Broader systemic studies explore how flexible demand improves overall welfare [20–21], how contract and price decisions influence distribution network performance [20], and how advanced game-theoretic models can enhance actor incentives [22]. Finally, comparative research evaluates fixed versus flexible tariffs [23] and models prosumers as decision-followers in multi-level optimization frameworks[23].

3. TARIFF SYSTEM

Electricity pricing strongly influences consumer behavior and market competition, with tariffs varying across nations and regions. Their design depends on multiple cost components, including electricity production, grid infrastructure investments, operational and maintenance expenses, and the need for a reasonable capital return [24].

Over the past decade, many pricing strategies have emerged, generally classified into two main types: capacity-based tariffs and energy-based tariffs [24]. Pricing systems are very important for Demand Side Management (DSM). TOU, RTP, and CPP are the three main price-based DSM methods [15].

The Time-of-Use tariff (TOU) is a well-liked price-based Demand Response (DR) method that gets people to use less energy during peak hours and more energy during off-peak hours. This "cuts peaks" and "fills valleys" [15].

There are four main ways that retail electricity prices can work:

- Rates that stay the same over time.
- Rates that change based on the amount, like increasing block tariffs.
- Prices that change depending on the time of day, the season, or big events.
- Prices that change in real time based on energy prices that are indexed to the market.

The rules that govern Algeria's electricity tariff system set the prices that people pay for electricity. The Electricity and Gas Regulatory Commission (EGRC) runs the system. It sets different prices for different types of customers and how much they use. It decides what rates to charge, how much to bill, and makes sure that operators get paid according to the law in their country.

3.1 THE ALGERIAN TARIFF SYSTEM

The rules that control Algeria's electricity tariff system decide how much people pay for electricity. The Electricity and Gas Regulatory Commission (EGRC) runs the system, which charges different amounts depending on the kinds of customers and how much they use. It sets all the rates that apply, figures out how much to charge, and makes sure that operators get paid according to the law in each country.

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Table 1. Active energy prices billed per kWh.

Tariff 41	**Peak** from 17:00 to 21:00	**Full hours** from 6 to 5 p.m. and from 21 to 22:30	**Night** from 22:30 to 6:00
Active energy	**872,02 cDA**	**193,76 cDA**	**102,4 cDA**
Tariff 42	**Peak** from 17:00 to 21:00	**off peak** from21h à 17h	
Active energy	**872,02 cDA**	**180,64 cDA**	
Tariff 43	**Night** from 22:30 to 6:00	**Day from** 6 to 5 p.m. and from 21 to 22:30	
Active energy	**102,4 cDA**	**428,30 cDA**	
Tariff 44	**Single poste** 24 Hours		
Active energy	**375,62 cDA**		

Algeria's two-digit electricity tariff system groups customers and rates to make sure that everyone pays the same amount. Tariffs 41 and 42 are best for big users like universities that are open from 8 a.m. to 5 p.m. because they use less energy during peak evening hours (5–9 p.m.), which keeps costs low.

4. REDUCTION OF UNIVERSITY ELECTRICITY BILL

The University can lower their electricity bills through Time-of-Use (TOU) tariffs. Key data on invoices, including the tariff code (**43**) and power supplied in kVA, remains consistent. The study's goal is to cut the University's energy costs by using analyses that help save money without penalties. This includes looking at the best prices, checking the amount of electricity available, and keeping an eye on how much energy is being used and how much energy is being used. To do this, we rely on analyses that allow consumers to savings without incurring penalties, including: **The choice of the optimal pricing** and **Evaluation of electric power available (PMD).** An analysis of electricity bills is summarized in Table 2.

Table 2. Summary of invoices for the year 2021 item 873

	Reactive energy consumption (kvar/h)	**Active energy consumption (kW/h)**	**Total AD**
January	78.035,00	45.071,00	306.366,3
February	72.111,00	38.100,00	274.214,9
March	70.592,00	36.540,00	266.480,7
April	54.833,00	23.200,00	190.773,6
May	57.366,00	25.441,00	204.340,2
June	62.060,00	29.294,00	227.468,4
July	52.392,00	21.922,00	186.287,3
August	46.144,00	13.173,00	127.196,0
September	51.198,00	21.836,00	181.265,5
October	60.401,00	27.190,00	215.629,9
November	63.250,00	33.610,00	254.795,8
December	64.990,00	31.670,00	237.690,9

4.1.Choice of optimal pricing

Selecting the optimal electricity tariff requires analyzing a consumer's specific usage profile against available pricing plans to minimize costs. Using the University as a case study. A comparison table and chart of invoice costs for the year 2021 illustrate differences between possible tariff codes (41, 42, 43 and 44) available at Sonelgaz.

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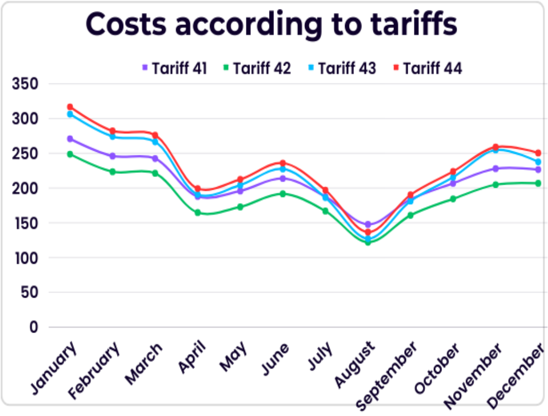

Figure 1. Graph of monthly costs according to tariffs for electrical.

The analysis indicates that tariff 42 is the optimal pricing option for the university, as it minimizes monthly electricity costs and enhances profitability. Switching to this tariff could lower yearly electricity costs from **2,577,780.34** Algerian dinars (**AD**) to **2,369,751.17 AD**, which is about **8%** less, or **0.25 million AD**. You could use this money to make your business better or grow it.

4.2. Study Of The Power Made Available (PMD)

Power Maximum Disposal (PMD) is important for keeping electricity costs down because it is linked to the power level that customers have signed up for and must not go over to avoid fines. Regularly checking PMD makes sure that the subscribed power matches the needs of the business, which helps save money and use electricity more efficiently.

The available values, as defined by CREG Decision No. D/11-13/CD of 26 September 2013, says the following::
50, 80, 120, 200, 320, 500, 650, 800, 1000, 1500, 2000, 2500, 3000, 4000, 4500, 5000, 7500, 10000, 12500, 15000.

The maximum absorbed power (MAP), which shows the highest amount of power used in a month, is important for getting the best prices. You can make changes before they happen if you monitor well. Also, knowing how much different power levels cost is important for making smart decisions about energy management. This includes looking at how PMD and MAP affect tariff structures and consumer economics.

Table 3. Presentation of tariff and their prices

Tariff 41	**PMD availability**	**Absorbed MAP**	**Fixed fee**
	25,85 DA/kw/month	**116,15 DA/kw/month**	**38 673,35 DA/month**
Tariff 42	**PMD availability**	**Absorbed MAP**	**Fixed fee**
	38,7 DA/kw/month	**180,58 DA/kw/month**	**515,65 DA/month**
Tariff 43	**PMD availability**	**Absorbed MAP**	**Fixed fee**
	38,7 DA/kw/month	**154,56 DA/kw/month**	**515,65 DA/month**
Tariff 44	**PMD availability**	**Absorbed MAP**	**Fixed fee**
	38,7 DA/kw/month	**180,58 DA/kw/month**	**515,65 DA/month**

4.2.1. PMD/MAP Analysis

Adjustment between supply and demand must be ensured for optimal efficiency and improved energy efficiency.The figure 2 show the evolution of the maximum power applied over a period of one year:

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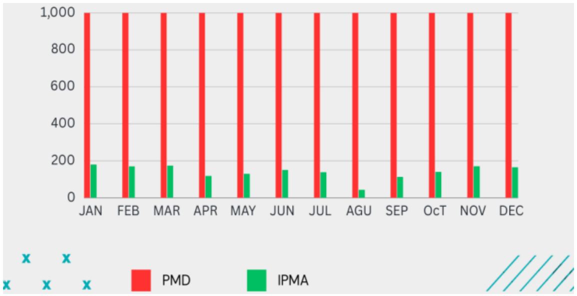

Figure 2. The evolution of the maximum power achieved during the year 2021.

The results of the analysis of the PMD and the MAP for the period from January to December 2021 reveal a noticeable disparity. The PMD for both university centre posts is significantly higher than the MAP, indicating an inappropriate choice of the PMD and thus resulting in overload. In order to address this inefficiency and optimize costs, it is recommended to adjust the PMD to a level closer to the actual MAP.
We recommend changing the PMD values, with different changes for each post:

- The power allocation (PMD) for electrical post No. 873 dropped from 1000 to 200.
- If these ideas are put into action in the right way, they could save a lot of money and get the university to use energy in a way that is better for the environment.

4.2.2. Change In Power Made Available (PMD)?

The tariff and the PMD are generally agreed during the study phase with the collaboration of Sonelgaz (Algerian company for the production, distribution of electricity) technicians. Nevertheless, it is possible to ask Sonelgaz by a customer already integrated:

Table 4: Annual cost before and after tariff /PMD change

	Tariff 43 & old PMD	**Tariff 42 & new PMD**
Cost (AD)	2.672.509,97	1.717.640,69
		- 35.27%

Results following the modification of the PMD and the tariff show substantial savings for the university centre. Indeed, these adjustments resulted in considerable financial savings, estimated at more than 0,95 million AD during the year. This resulted in a significant reduction in the total university bill, or a decrease of 35,27%. These positive results are attributable to two specific changes:

- The change from tariff **43** to tariff **42**.

- The amount of power given to both power posts (PMD) is lowered to a level closer to what is actually needed. These combined actions have clearly had a positive impact on the energy costs of the university.

5. VI. CONCLUSION

In conclusion, this study focused on improving the University of Tipaza's electricity billing system and found several key areas that need work, such as picking the wrong energy tariff, having a PMD that is much higher than the actual power used, and having too much reactive energy, which leads to fines. The suggested steps are to change from tariff 43 to tariff 42 and to change the subscribed power to what is actually needed. These results show that a targeted strategy can significantly improve the energy management of an institution such as the University of Tipaza, while offering a reproducible model for other institutions in Algeria. This approach also contributes to the enrichment of work on tariff structures and helps consumers better manage their consumption. Despite certain limitations related to available resources and external fluctuations in the energy market, research prospects remain open, particularly

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thru the conduct of complementary studies in other institutions and the integration of renewable sources to enhance energy sustainability.

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