Effect of using electrical smart metering system and time of use tariffs application in (General Electric Company Of Libya)

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Abstract

Smart metering system is an integrated system of smart meters, communication networks, and data management system that enables two-way communication between utilities and customers. The system provides many important functions that were not previously possible or had to be performed manually, smart metering also enables utilities to offer new time-based rate programs and incentives that encourage customers to reduce peak demand and manage energy consumption and costs, smart meters is the main core of smart grid system where it acts as a link between electric companies and customer`s appliances.

The objective of this paper is present a clear vision of ability using this system in General Electric Company Of Libya (GECOL), the paper focuses on one of the important smart metering applications which is Time Of Use application (TOU), and apply this feature in GECOL large customers to reduce the network peak load.

The outcomes of the paper will serve as a basis for making a decision on how the metering tariffs will use to reduce GECOL energy peak load.

Keywords: General Electrical Company Of Libya**(GECOL)** , In-Home Display **(IHD)** ,Meter Data Management System **(MDMS**), **SM** Smart Meter, Smart Metering System (**TOU)**

الملخص

نظام العدادات الذكية هو نظام متكامل يظم العدادات الذكية وشبكات الاتصالات وأنظمة إدارة البيانات و يعمل على نقل البيانات في اتجاهين بين شركات الكهرباء و المستهلكين و يوفر النظام العديد من الوظائف المهمة التي لم تكن ممكنة في السابق أو كان يجب تنفيذها يدويًا ، كما يتيح النظام لشركات الكهرباء أيضًا تقديم برامج وحوافز وأسعار جديدة تستند إلى الوقت وتشجع العملاء على تقليل الطلب على الطاقة في أوقات الذروة وإدارة استهلاك الطاقة وتكاليفها و هي أيضا احد مكونات الشبكات الذكية من حيث كونها حلقة الوصل بين شركات الكهرباء ومعدات المستهلكين .

تهدف هذه الورقة إلى تقديم رؤية واضحة لإمكانية استخدام هذا النظام في الشركة العامة للكهرباء للتغلب على كافة مشاكل النظام التقليدي والرفع من مستوى الاداء وتركز الورقة على أحد أهم تطبيقات القياس الذكية (تعريفات وقت الاستخدام) وتطبيق هذه الميزة في شرائح المستهلكين لتقليل أحمال وقت الذروة للشبكة الكهربية. يمكن الاعتماد على نتائج هذه الورقة في اتخاذ القرار بشان كيفية استخدام التعريفات المرتبطة بالزمن للحد من الطلب على الطاقة في اوقات الذروة.

1.Introduction

In a world where technology is present in our day to day life, we should be following technology development to make our life and business easier than before and save money and time.

In the early phase of household technology, delivery of electricity is completely depended on traditional energy meters, these meters play a key role in measuring the consumption of electrical energy in individual households, the major problem of traditional meters are arises when costumers are unaware of their daily behavior, mmonthly feedback given to the consumers is not sufficient as the consumers will not know how much energy does, [1]

So with the tremendous development of communications and technology the use of smart meter systems become the solution to the problems of traditional systems.[2]

This paper will identify the benefits of the smart metering system and the impact of using the time of use by the number of tariffs to balance the network loads to help decision-makers understanding this kind of systems.

2. Problem statement

Most electricity companies are facing major problems as a result of the steady increase in energy demand and using weak systems that do not meet their needs and this reflects negatively on their performance,General Electricity Company Of Libya(GECOL) has some problems in its billing and collection system [3] ,such as (difficult of reading the meters- increase of Non-technical losses-increase in energy demand-huge costs of meter reading, collection, and measurement-using load shredder-unbalanced load-no information about customer consumption data)

3. Smart metering system

3-1 Smart meters and Smart metering system

Smart Meters are electronic measurement devices used by utilities to communicate information for billing customers and operating their electric systems [4],the combination of the electronic meters with two-way communications technology for information, monitor, and control is commonly referred to an Advanced Metering Infrastructure (AMI) as same as the smart metering system(SMS).[5]

3-2 Smart Metering System Benefits

Smart Metering systems benefits are numerous for many different stakeholders of the systems[4] ,Table (3.1) mentions some of the major benefits for utility stakeholders.

Stakeholder	Benefits
Utilities	Better access and data to manage energy use Accurate data and timely billing Fast outage detection and Power quality data Energy losses Calculation and knowledge of where a bouts Improve the relationship between utilities and customers

Customer Service	Reduced cost of meters reading Remote disconnects /reconnects and power limit Remote detection of meter tampering and theft Eliminates billing errors and estimated
Transmission and Distribution	Improved transformer load balance and provide more data for improved efficiency, reliability of service, losses, and loading Improved data for efficient grid system design and power quality data for service and analysis
Customers	Monitor consumption by display units Encourage energy conservation and limit visiting premises at different times to take readings and distribute invoices Time of Use tariff and savings on electricity bills

table (3.1) smart metering system benefits[6]

3-4 Smart metering system and smart grid

Smart Metering System (SMS) is the main mechanism for the realization of other smart grid applications to deliver operational and business benefits across the utility, SMS is the system that collects and analyzes data from smart meters using two-way communications between user domain and utility domain, and gives intelligent management of various power related applications and services based on that data [7] figure (3.1) show more details about smart grid structure.

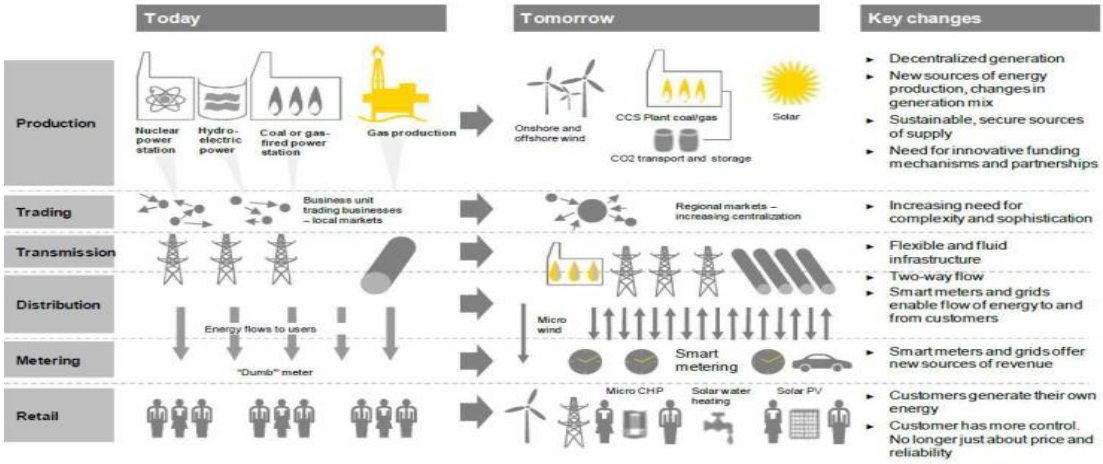

Figure (3.1)The turnaround in energy policy is accelerating the transformation of the energy sector[8]

3-5 Smart metering system and customer behavior

GECOL current system based on a one-way communication data flow, in the direction from company to users,[9] But the challenge is to change this out-of-date

method of communication, by developing one where the client can also decide, choose and report their incidents to electrical energy supply in real-time, figure (3.2) show example of customer load.

People‘s behavior is termed as the behavior of consumer on appliance consumption in a household, If the consumption of the customer is high then we can empathize that their usage of devices is also high, which means the cost is directly proportional to the product of several uses and the corresponding durations,these factors play an important role in influencing the behavior of the customer, the better understanding of the people‘s behavior is only achieved through analyzing how they use their energy. The consumers should be influenced smartly while accessing their appliances.[1]

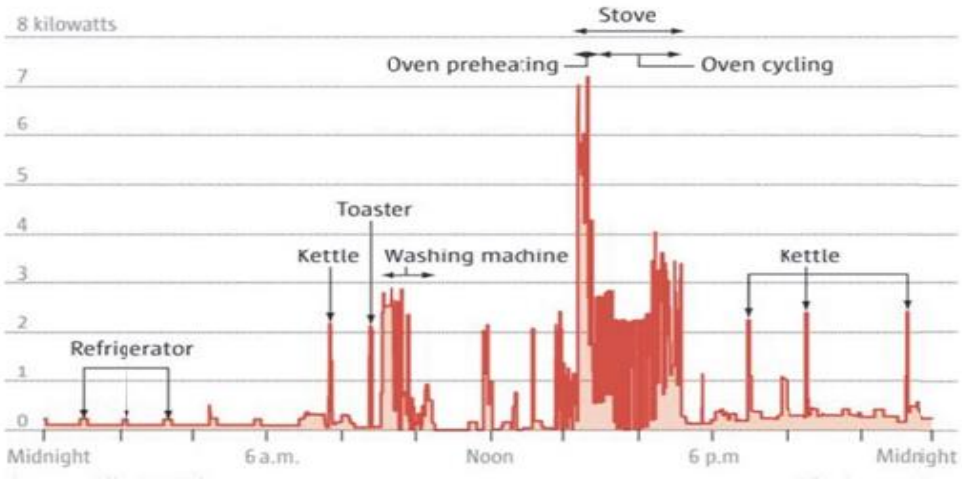

figure (3.2) example of customer load source[10]

3-6 Smart Metering System Components

the mart metering system technical scenarios shown in figure (2.3)

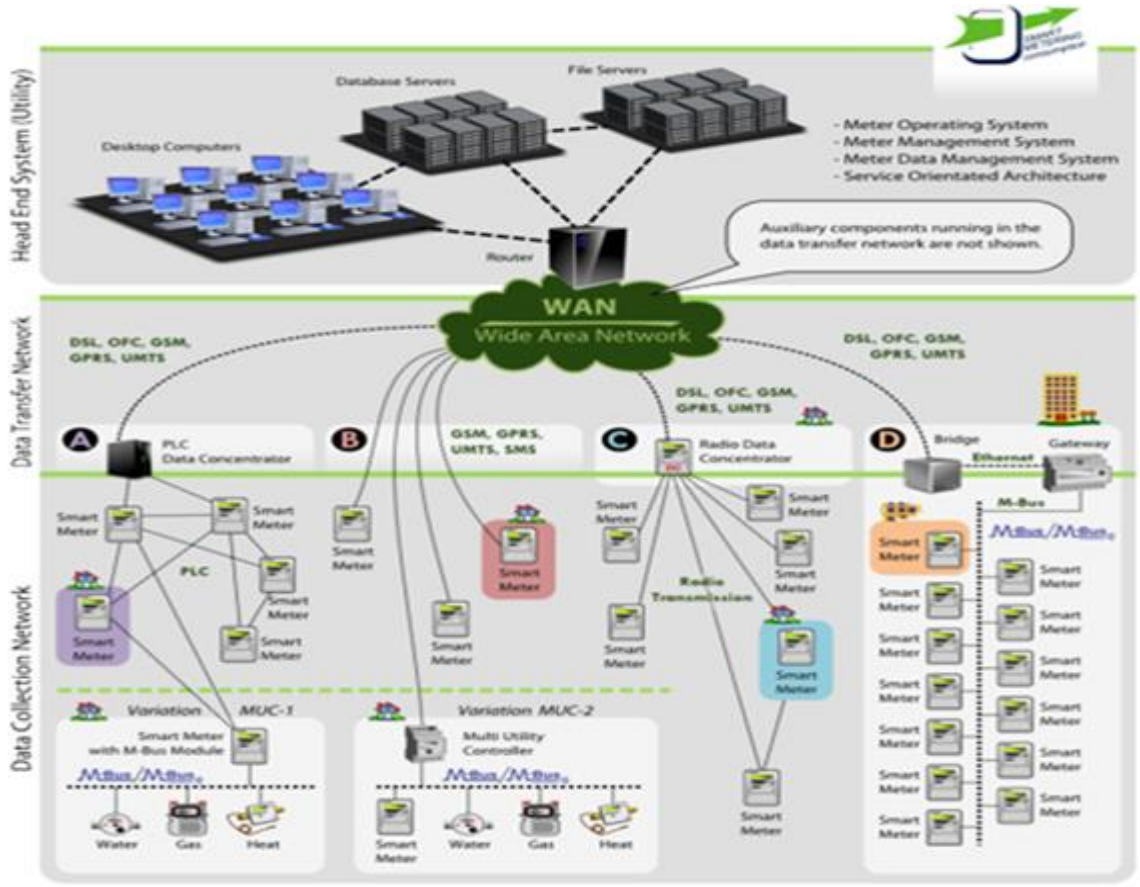

Figure (3.3) example of smart metering system components [11]

4. Time Of Use application (TOU)

4-1 Time Of Use (TOU)Tariffs

Time of Use (TOU) or Seasonal Time of Day (STOD), metering involves dividing the day,week, month, season and year into tariff slots and with higher tariff rates at peak load periods and low tariff rates at off-peak load periods. While this can be used to automatically control usage on the part of the customer (resulting in automatic load control). [12]

4-2 TOU Tariff design

TOU tariff structure in which different rates are applicable for the use of electricity at a different time of the day. It means that the cost of using 1 unit of electricity will be different in mornings, noon, evenings, and nights [12],a sample of TOU structure is shown in table (4.1).

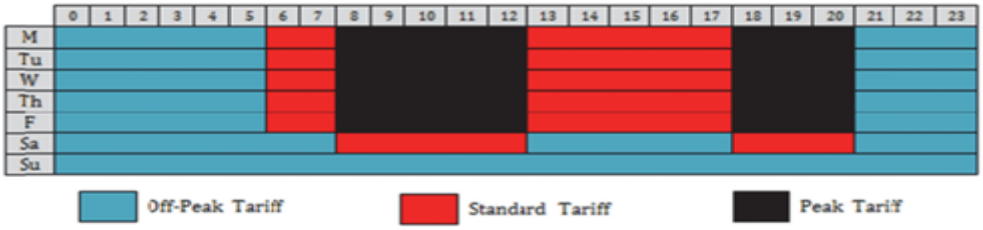

table (4.1) example of daily TOU tariffs [10]

To shift or reduction customer consumption by TOU application you should be design anew tariffs with different prices , GECOL load curve in April 2021 the daily peak hours are (17:00-18:00-19:00-20:00) and off-peak hours are (5:00-:6:00-7:00-8:00) ,in this paper we have estimated four tariffs (peak load tariff , off peak load tariff ,standard load high tariff and standard load low tariff) as shown in table (4.2) where X equal GECOL estimated tariff price

TOU tariffs estimated

24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	H
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Price MWH/LYD			commercial	Public lighting	Hose hold	Light industrial	Heavy industrial	Public facilities	Small agricultural	Big agricultural
	T1	X	68	68	20	42	31	68	30	32
	T2	1.15X	78	78	23	48	36	78	35	37
	T3	1.25X	85	85	25	52.5	38.75	85	37.5	40
	T4	1.5X	102	102	30	63	46.5	102	45	48

Table (4.2) estimated TOU tariffs for GECOL

4-3 Load Shifting, Through Time-Of-Use Tariffs

With time-of-use tariffs, energy consumption is more visible and help you shift your energy demand at times when tariffs are more advantageous or pressure on the grid is lower, that incentive for consumers to shift their energy consumption from periods of a high price to low price, which is typically times of high demand and/or low supply.[13]

4-4 Energy Consumption Reduction(demand management **)**

Smart metering system have the potential to lead to reductions in energy consumption through a number of channels. such as continual salience of energy use. In particular, through the in-home display, web portals or smartphone apps .[13]

4-5 GECOL load shift by customers consumption

GECOL able to reduction beak load and increase off beak load by shifting some loads from peak to off peak when applying time of use TOU program as shown in figure (4.1)

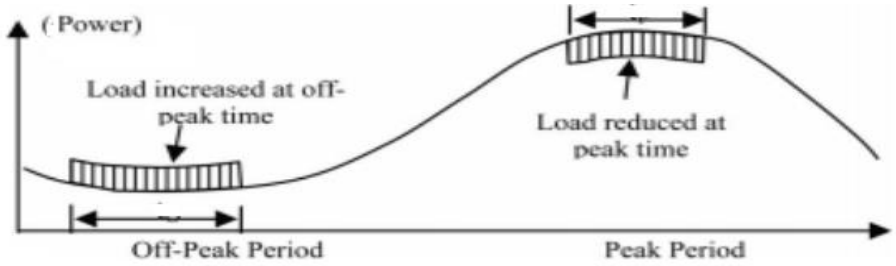


figure (4.1) load shift method[4]

GECOL have eight consumption type as shown in figure (4.2) every consumption type has unique tariff

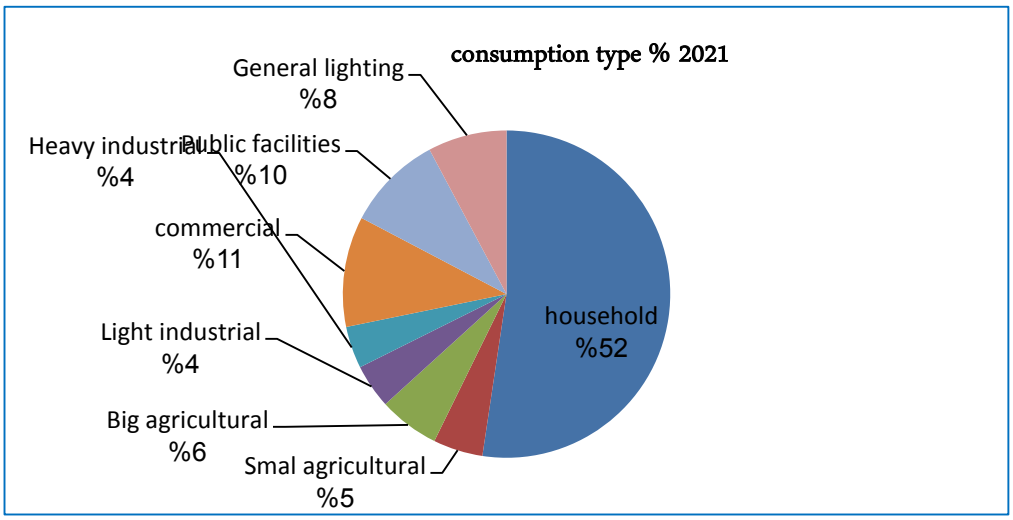
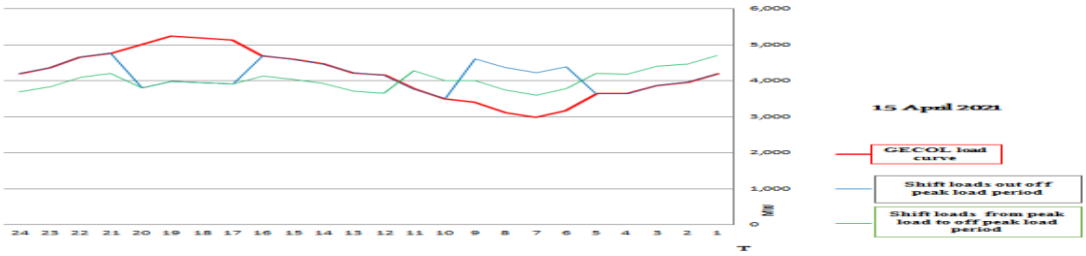


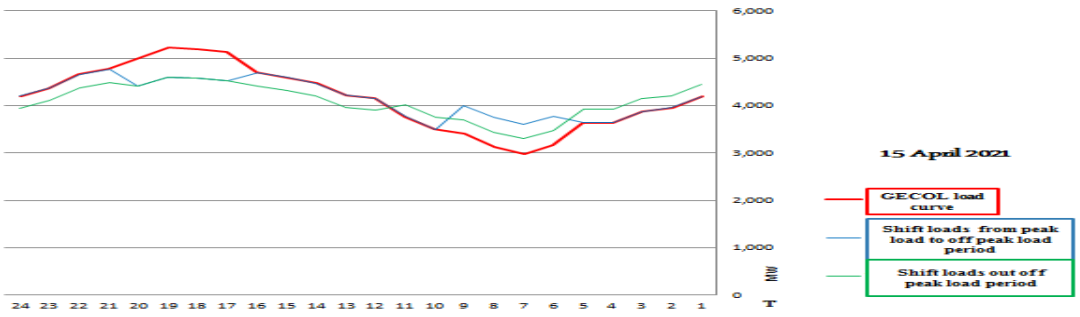
Figure (4.2) GECOL consumption percentage and type in 2020 [3]

GECOL should install smart meters for all customers and apply the time of use program for customers (except hose hold consumption) as a first stage this application able GECOL to amount of power from shift peak load to off peak load

in, In this paper we suppose two scenarios for how many power can shift ,the result of these scenarios as shown in figures (4.4)(4.4)



Figures (4.4) show shift 50% of customer loads(except hose hold) 1200MW from peak load to off peak load period in15 April



Figures (4.5) show shift 25% of customer loads(except hose hold) 600MW from peak load to off peak load period in15 April

4-6 consumption conservation

Smart metering system have the potential to lead to reductions in energy consumption through a number of channels. such as continual salience of energy use. In particular, through the in-home display, web portals or smartphone apps .[14]

In this case we are working in the same two scenarios as mentioned above

The result estimated conservation shown in table (4.3).

total value of comsumpotion with current tariffs MWH/LYD	no conservation			consumption conservation		currest tariff	consumption %	consumption type
	value of comsumpotion with estemated tariffs MWH/LYD	value of comsumpotion with current tariffs MWH/LYD	total consumption 15/4/2021 MWH	conservation 25%	conservation 50%	MWH/LYD		
1,286,964	247,172	1,039,792	51,990	10,876	22,638	20	52%	hose hold
925,279	177,429	747,850	10,998	2,301	4,602	68	11%	commercial
673,181	129,290	543,891	7,998	1,673	4,978	68	8%	general lighting
841,477	161,613	679,864	9,998	2,092	4,008	68	10%	general facilities
185,620	35,650	149,970	4,999	1,046	2,092	30	5%	small agricutural
237,593	45,632	191,962	5,999	1,255	2,510	32	6%	big agricultural
235,149	67,183	167,966	3,999	837	1,673	42	4%	light industrial
153,446	29,471	123,975	3,999	837	1,673	31	4%	heavy industrial
4,538,710	893,439	3,645,271	99,980	20,916	44,175		100%	total
			MW	MW	MW			
			4,166	872	1,841			

table (4.3) consumption conservation by using TOU application

5. Conclusion

GECOL spends more money and time for reading meters and has a big non-technical losses (more than 50% of total energy generated every year). Also GECOL used a load shredder method to face the growing demand for energy, that leads to a bad relations between GECOL and its customers,.

Moreover the smart metering system provides a number of important functions that were not previously possible or had to be performed manually, such as the ability to automatically and remotely measure electricity use, disconnect and reconnect service ,power limit, detect tampering, identify and isolate outages, monitor electrical network .

Also, the smart metering system enables utilities to offer new time-based rate programs and incentives that encourage customers to reduce peak demand by using time-of-use application.

In case of customers don't respond to the load shift program, GECOL will get more revenue than before by increasing peak load tariff price. That means using the time-of-use application is profitable in both cases.

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