

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 to present a clear vision of the possibility and ability of 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)

I. 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 arising when costumers are unaware of their daily behavior, monthly feedback given to the consumers is not sufficient as the consumers will not know how much energy consumption.[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.

II. 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 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].

A. 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].

B. Smart Metering System Benefits

Smart Metering systems benefits are numerous for many different stakeholders of the systems [6], Table (1) mentions some of the major benefits for utility stakeholders

TABLE I
Smart metering system benefits [6]

Stakeholder	Benefits
Utilities	<p>Better access and data to manage energy use</p> <p>Accurate data and timely billing</p> <p>Fast outage detection and Power quality data</p> <p>Energy losses Calculation and knowledge of where a bouts</p> <p>Improve the relationship between utilities and customers</p>
Customer Service	<p>Reduced cost of meters reading</p> <p>Remote disconnects /reconnects and power limit</p> <p>Remote detection of meter tampering and theft</p> <p>Eliminates billing errors and estimated</p>
Transmission and Distribution	<p>Improved transformer load balance and provide more data for improved efficiency, reliability of service, losses, and loading</p> <p>Improved data for efficient grid system design and power quality data for service and analysis</p>
Customers	<p>Monitor consumption by display units</p> <p>Encourage energy conservation and limit visiting premises at different times to take readings and distribute invoices</p> <p>Time of Use tariff and savings on electricity bills</p>

C. 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, smart metering system also an integral part of the smart grid infrastructure in data collection and communications [7]. figure (1) shows more details about smart grid structure

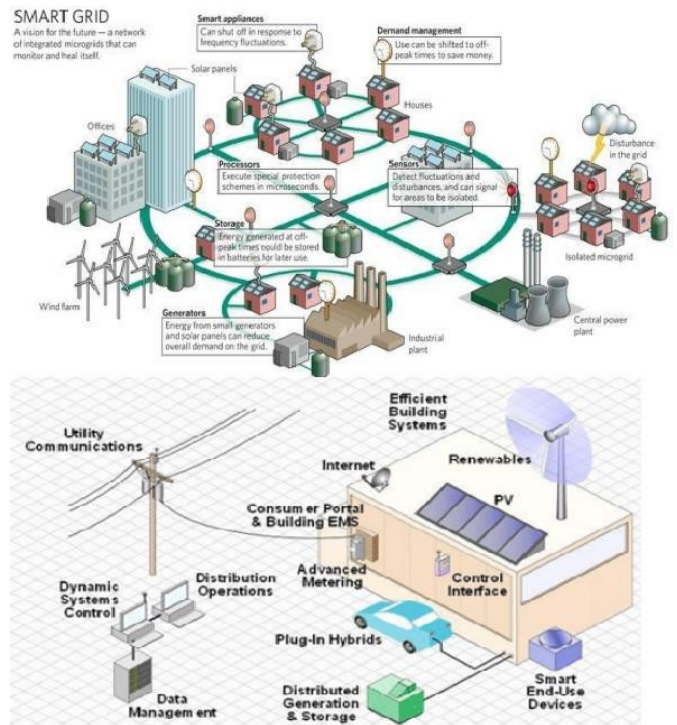


Fig (1) smart meters in smart grid system [8]

D. Smart Metering System Components

across both columns. Any table or figure that takes up the smart metering system technical scenarios and components shown in figure (2).

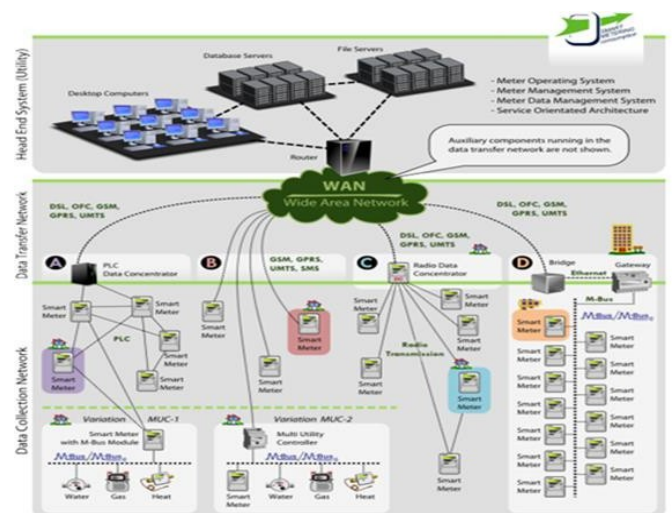


Figure (2) example of smart metering system components [11]

III. TIME OF USE APPLICATION (TOU)

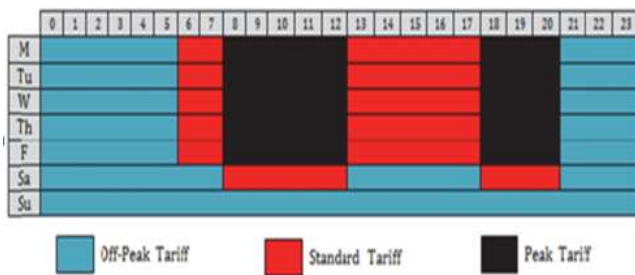
a. Time Of Use (TOU) Tariffs

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].

b. 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 (2)

Table (2) example of daily TOU tariffs [13]



To shift or reduce customer consumption by TOU application you should design a new tariff 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 (3) where X equal estimated tariff price.

Table (3) estimated TOU tariffs for GECOL

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
Blue	Blue	Blue	Blue	Red	Red	Red	Red	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Blue	T
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															

c. 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 [14]

d. GECOL load shift by customers consumption

This paper demonstrates the ability to shift large electrical loads to off peak periods and optimize Time of Use periods to benefit in the form of cost savings.

GECOL able to reduce 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 (3).

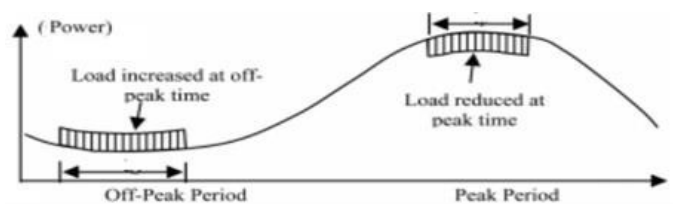


Figure (4) load shift method [3]

GECOL have eight consumption type as shown in figure (4) every consumption type has unique tari

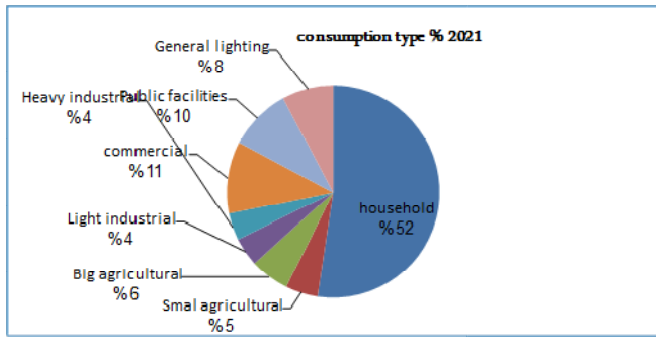


Figure (4) GECOL consumption percentage and type in 2020 [3].

GECOL should install smart meters for all customers and apply the time of use program for customers (except household 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 (5&6).

e. consumption conservation

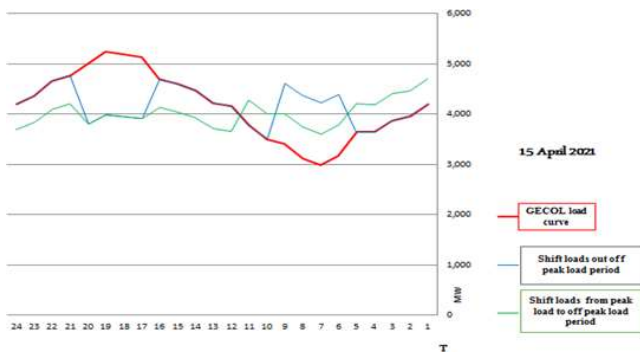
Smart metering system have the potential to lead to reductions in energy consumption through a number of channels, such as in-home display, web portals or smartphone apps [13].

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

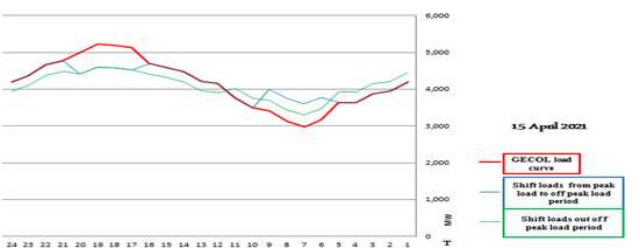
The result estimated conservation shown in table (4).

Table (4) consumption conservation by using TOU application

total value of consumption with current tariffs MWH/YD	no conservation		consumption conservation		current tariff MWH/YD	consumption %	consumption type
	value of consumption with estimated tariffs MWH/YD	value of consumption with current tariffs MWH/YD	total consumption 15/4/2021 MWH	conservation 25%			
1,286,964	247,172	1,039,792	51,990	10,876	22,638	20	house hold
825,279	177,429	747,850	10,998	2,301	4,602	68	commercial
673,181	129,290	543,891	7,998	1,673	4,978	68	general lighting
841,477	161,613	679,864	9,988	2,092	4,008	68	general facilities
185,620	35,650	149,970	4,999	1,046	2,092	30	small agricultural
237,583	45,632	191,952	5,999	1,255	2,510	32	big agricultural
235,149	67,183	167,966	3,999	837	1,673	42	light industrial
153,446	29,471	123,975	3,999	837	1,673	31	heavy industrial
4,538,710	893,439	3,645,271	99,980	20,916	44,175		total
			31W	31W	31W		
			4,166	872	1,841		



Figures (5) show shift 50% of customer loads (except household) 1200MW from peak load to off peak load period in 15 April



Figures (6) show shift 25% of customer loads (except household) 600MW from peak load to off peak load period in 15 April

IV. CONCLUSIONS

GECOL spends more money and time for reading meters and has a big non-technical loss of energy ,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, The smart metering system suggested 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 and save money.

In case of customers don't respond to the load shift or conservation 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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