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SMART GRID BASED HOME ENERGY MANAGEMENT SYSTEMS

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Abstract

Now a days smart grid technology has been widely used to reduce Electricity consumption in home appliances. The smart grid aims to integrate recent advances in communication and information technologies to renovate the existed power grid. The proposed system consisting of HEM systems by using different pricing techniques. It can provide Smart & efficient way of optimizing energy usage in residential buildings. The primary objective of HEM's system includes energy saving, reducing wastage of energy ,less electricity consumption .In this paper we discuss about New pricing schemes like real time pricing(RTP),time of use rates(TOU),critical peak pricing(CPP) etc.,have been proposed for smart grid.

I. INTRODUCTION

Global energy consumption is continuously increasing and it is expected to be doubled by 2020[1].As we know that india's power grid is weakest in the world.It reaches 80% of its population.In order to improve smart grid is necessary.

Electrical power grid is the combination of generation, transmission, distribution ,monitoring & control. The integration of advances in information and communication technologies(ICT) increases the efficiency of traditional grid,which makes it capable to make fast, accurate, robust, reliable, safe efficient and increasing level of consumers effort, that becomes the smart grid. It consisting of smart meters, advanced metering infrastructure(AMI),bidirectional communication ,home automation and home area networks(HAN's).

The smart grid has the unique feature to help the consumers to save money by giving choice to each and every consumer for deciding them to manage their electricity use and choose the best time of purchase electricity. Government of India has recently formed "smart Grid forum" and "smart Grid Task Force" for enablement of Smart grid technology into Indian power distribution utilities as a part of their Smart Grid initiative to meet their growing energy demand in similar with the developed country like USA, Europe etc.,[6].The main aim of this is improving efficiency in industrial as well as residential sectors. In this situation it is vital to implement the smart grid. It would helps the utilities to get information about the electricity use by the consumers and can potentially adapt it distribution process with respect to time and quantum of power demand.

The developing country like India is now focussing on green power generation by implementing smart grid.

II.ENERGY MANAGEMENT SCHEME

In this section, a energy management scheme is presented. The main objective of this schemes is to reduce peak load management as well as energy consumption.

A)Optimization based Residential Energy Management:

We propose a linear programming model [1],to minimise the total cost of electricity usage at home. In this scheme a day is divided into time slots of equal length with different rate of electricity per unit. In this model home appliances are schedule in an appropriate time slots to reduce electricity consumption. In this model consumer requests are given as input and optimum scheduling is acheived.The objective function is defined in equation-1.

A=number of appliances
D=number of days
T= number of time slots
Ea=energy consumption from a applicant
La=Length of the cycle of the applicant
Ut=Unit price per time slot

To achieve the minimal electricity unit price the LP model always try to schedule the appliance in the minimum rate time slot.

***B.*Appliance Coordination With Feed In (Acord-Fi) Scheme**

ACORD-FI is an energy management scheme with home appliance coordination and energy feed in mechanisms. Appliance coordination has been proposed in [1].

In the ACORD-FI scheme, the consumer may turn on an appliance at any time regardless of peak hour concern. When the consumer turns on an appliance, the appliance communicates with the EMU to check for a convenient start time, i.e., suggested time. The duration between suggested time and the requested start time is computed by EMU and send back to the appliance. This interval is called the waiting time. Consumer decided whether to start the appliance right away or wait until the assigned time slot.

When a consumer presses the start button of an appliance, the appliance generates a START –REQ packet and sends it to the EMU. The main objective of appliance coordination (ACORD) algorithm is to shift the appliance from on-peak hour to off-peak hour. The consumers penetration in in the energy management system increases the efficiency of the system. As the number of consumers request increase it significantly reduce the electricity bill.

START-REQ packet is sent to the EMU by wireless sensor network. In a large house, EMU may be physically far from 456 the appliances or communication may need several hops when wireless signals do not propagate through construction materials. In this case, the home area sensor network, which have been deployed for inhabitant health monitoring or air conditioning, can be used to relay packets of appliances.

When EMU receives the START-REQ packet and it computes a convenient start time, after communicating with the local energy generation unit and the smart meter. EMU avoids to schedule start times in the peak hours or when locally generated energy is below a threshold. When there is not enough local energy and the request arrives during peak hours, EMU shifts the consumer request to off peak hours. The waiting time is sent to the appliance by STARTREP packet.

The consumer may be willing to negotiate with the EMU and wait for the suggested start time. In this case, the consumer will benefit from lower energy bills. On the other hand, consumer may need to start an appliance immediately. The decision is up to the consumer, EMU does not force an automated start time on the appliances because this could cause discomfort on the consumer side. If waiting time is above a threshold Wmax, then the appliance is started immediately. The decision is sent back to EMU in a NOTIFICATION packet.

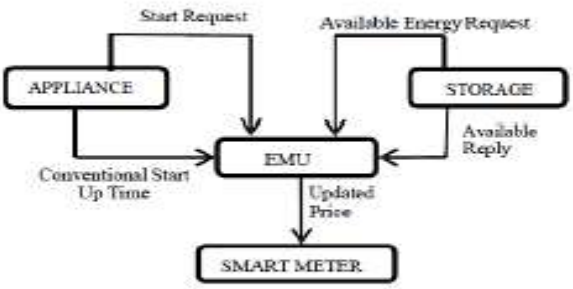

Fig:1 The flow of HEM system

Algorithm :

1.D_{max} :maximum allowable delay
2.d_i :delay of appliance i
3.S_{ti}:Request start time of appliance
4.If(Storedenergy vailable=TRUE)**then**
5.Start immediately()
6.else
7.if(S_{ti} is in peak) then
8.di $\leftarrow$ shift to off peak()
9.If (d_i>Dmax) then

11. di shift to mid peak()
12.Start immediately()
13.Else
14.Start delayed()
15.end if
19.else
20.If(S_{ti} is in mid peak) then
21. di $\rightarrow$ shift to off peak()
22.If(di>Dmax) then
23.Start immediately()
24.Else

25.Start delayed()
26.End if
27.Else
28.Start immediately()
29.End if
30.End if

After receiving the AVAIL-REP packet, EMU determines the convenient starting time of the appliance by using Algorithm .The algorithm first checks whether locally generated power is adequate for accommodating the demand. If this is the case, the appliance starts operating, otherwise the algorithm checks if the demand has arrived at a peak hour, based on the requested start time, . If the demand corresponds to a peak hour, it is either shifted to off-peak hours or mid-peak hours as long as the waiting time does not exceed , i.e., maximum delay.

The computed delay is returned to the consumer as the waiting time. prevents requests from piling up at certain intervals and create new peak periods similar to OREM.
EMU computes the waiting time as the difference between the suggested and requested start time, and sends the waiting time in the START-REP packet to the appliance. The consumer decides whether to start the appliance right away (*StartImmediately()*) or wait until the assigned timeslot depending on the waiting time (*StartDelayed()*).The decision of the consumer is sent back to the EMU with a NOTIFICATION packet that has the same format as the START-REQ packet. The start-time field of the NOTIFICATION packet denotes the negotiated running time of the appliance, i.e., it could be either the time the appliance is turned on or the start time suggested by the EMU.

This information is required to allocate energy on the local storage unit when it is used as the energy source. Since it is further possible to sell excess energy to the grid operators, the amount of energy that needs to be reserved for the appliances that will run with the local energy has to be known. EMU sends an UPDATE-AVAIL packet to the storage unit to update the amount of available energy unallocated) on the unit.

III. HEM BY USING DIFFERENT PRICING TECHNIQUE

There are different optimization techniques, schemes, algorithms have been proposed for efficient coordination of home appliances and DES to reduce peak load and electricity bill.

In paper [4], two type of HEM schemes are discussed, one is communication based other is optimization based. For example in [5], a day ahead pricing has been used in a HEM scheme to minimize the electricity charges of a consumer. The process of observing, controlling and conserving electricity usage is termed as HEM [6]. According to paper [3], more than 40% of global energy consumption is done by residential building and homes. A HEM program is presented in paper [1] with local generation facility and gives its comparative study with other schemes. It shows the cost saving behaviour of proposed work. The distribution companies follow or use different pricing schemes for consumers billing purpose. There are so many pricing schemes has been proposed so far for HEM, out of those mainly are RTP, ToU, CPP etc.

A. Real Time Pricing(RTP) :

In RTP technique, consumer is informed hourly about the electricity prices as the rate changes hourly. In paper [8], an algorithm is proposed which use RTP to reduce the energy consumption cost. This algorithm subset into three stages, namely Real Time Monitoring(RTM),Stochastic Scheduling(STS) and Real Time Control(RTC). In RTM stage, HEMS gets the current information about RTP data from utility and the working status of each appliance. Attributes of smart appliances are observed and all the data stored in HEMS.

Similarly in STS stage, HEMS figure out an ideal policy by using Stochastic Dynamic Programming (SDP) to choose a set of appliances to be controlled with an objective of minimum energy consumption cost. It use Markov Decision Process(MDP) to predict the appliances schedule to minimize the electricity bill. Now selected appliances are controlled in RTC stage. In this stage the number of control signals are reduces because of categorization of appliances in STS stage.

B. Time of Use(ToU) rates :

In this pricing technique a day is divided into mainly three time of use pricing periods i.e. the off-peak, on-peak and mid- peak hour. Off-peak hour: when electricity price is least, mid- peak: when electricity price is moderate and

on-peak: the busiest time of a day when electricity price is highest [9].Reason behind higher and lower prices are like cell phones tariff, which are cheapest when demand is lowest mainly during late nights and highest at the day time. The use of electricity is also depends on season. In summer, per unit price of electricity is highest at the afternoon time, when air conditioners running on high. Similarly, in winter on-peak hour is at the morning and at night times, whenever the environment temperature is too low.In [1],the author bifurcate the generation plants in base plant and peaker plant.

The base plant which works on renewable energy sources such as hydro,solar etc., and peaker plants which work on renewable energy sources or fossile fuels such as petrol,coal,diesel etc.,

C.* Critical Peak Pricing(CPP) *:

CPP is the electricity consumption per unit rate that applies to those customers whose electricity demand lies under a threshold value decided by the utility and whose smart electric

meter records usage data in regular interval. The period of high energy use is called peak event. The unit price is higher during peak events and lower prices during all other times.

The CPP scheme provides accurate information about energy consumption so a user can better decide how and when to use electricity. It gives more flexibility to reduce monthly energy cost [10].

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