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Management Demand Side By Regulating Charging And Discharging Of Energy Storage System and Utilizing Renewable Energy

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Abstract

The Energy demand management, also known as demand- side management (DSM) or demand-side response (DSR) is the modification of consumer Demand of electrical power. the goal of demand-side management is to encourage the consumer to use the energy during peak hours, or to movethe time of energy use to off-peak times such as nighttime and weekends. The evolution in microgrid technologies as well as the integration of electric vehicles (EV), energy storage systems (ESS) and renewable energy sources (RES) will all play a significant role in balancing the planned generation of electricity and its real-time use. We propose a real-time decentralized demand-side management (RDCDSM) to adjust the real-time residential load to follow a pre-planned day-ahead energy generation by the microgrid, based on predicted customers aggregate load. A deviation from the predicted demand at the time of consumption is assumed to result in additional cost or penalty inflicted on the deviated customers. We propose a real-time decentralized demand-side management (RDCDSM) to adjust the real-time residential load to follow a pre-planned day-ahead energy generation by the microgrid, based on predicted customers' aggregate load. A deviation from the predicted demand at the time of consumption is assumed to result in additional cost or penalty inflicted on the deviated customers.

(such as demand-side management or DSM) is to deploy the current capacity more efficiently without modifying the existing grid infrastructure.

I. Introduction

We Demand Side Management (DSM) is an essential property of the smart grid systems. Along with increasing expectations from the customers about power quality, and as new types of loads.

The He rapid surge in demand for electricity is considered as one of the most significant problems that are facing the power grid. To achieve higher reliability, robustness, and stability today's power grids are designed to serve peak demands rather than the average load. Power system planners are therefore facing a pressing challenge to meet their customers surging demands while ensuringelectricity systems integrity. Numerous methods have been proposed to alleviate problems of uncertainties in power

1. DSM of Residential Smart Microgrid block diagram and its working principle

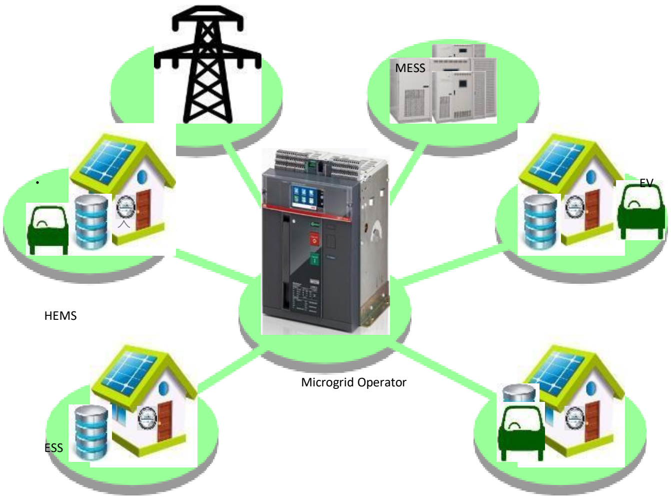

Fig. 1: Residential Smart Microgrid.

II. System Model

We consider a grid connected residential micro grid (shown in Fig. 1) which comprises a set of customers. Each of the customers may be equipped with a RES with an ESS and an EV. To formulate a mathematical model for RDCDSM, we investigate the prediction of residential loads, RES energy generation, ESS features, as well as the EVs driving schedules and distances. For simplicity, we illustrate the consumption pattern of each of the componentsof the residential home. We present the mathematical model of each of the elements before formulating the RDCDSM problem

A. Residential Load

Most useful load forecast models are based on offline schemes, where predictions are conducted in advance. The uncertainty of prediction increases withthe growth of the forecast time. The STLF is thus more accurate than MTLF (mid-term load forecast) or LTLF (long-term load forecast) [9]. Currently, several STLF techniques exist, but aside from their varieties, these methods mainly depend on historical demands, weather forecasts, and other variables to estimate the aggregated demand of all consumers. However, the efficiency of any prediction depends not only on the accuracy and time horizon of the forecast but also on its capability to reduce the complexity, cost, and memory needed for predicting the customer demand. In the proposed system, we suppose that each residence is connected to a HEMS. These HEMSs are enabled to assist consumers inforecasting their load based on an average household demand refine and send the data over a data network to other customers and the operator.

B. Renewable Energy

The data from various countries reveal that households contribute up to 40% of the electricalenergy demand. As compared to commercial or industrial usage, electrical energy demand in households varies. This is largely due to environmental, economic, behavioral and geographic factors. In developed and industrial nations, households use a large part of electrical energy for the purpose of heating or cooling, followed by process devices like washing, drying refrigeration etc. The RES provides a great promise for significantly improving the efficiency of distribution, and residential renewable energy generation is becoming more popular as the installation cost is decreasing, and prices are rising. Hence, several stochastic models have been developed to forecast the energy generation over time, and thereby, to enhance RESs exploitation and penetration in smart grids. In our proposed system, the customer decides whether to store the energy generated by the RES or to supply it to other clients, according to the power demands in every real time slot.

C. Energy Storage System – ESS

The introduction of new types of batteries with higher storage capacities has encouraged ESS to emerge as a way to improve the power management in smart grid ESSs play a vital role in matching the generation with demand which leads to an increase in the efficiency and reliability of the system against uncertainties. Some technologies provide short-term energy storage, while others can endure for much longer. Bulk energy storage is currently dominated by hydroelectric dams, both conventional as well as pumped. Energy storage involves converting energy from forms that are difficult to store to more conveniently or economically storable forms. Energy storage is capture of energy produced at one time for use at a later time to reduce imbalances between energy demand and energy production. A device that stores energy calledan accumulator or battery.

III. Problem statement and contribution

We consider a residential microgrid which is connected to the grid and purchases electricity from it according to its customers aggregated day-ahead predicted demand. Each client predicts its load a day-ahead and sends it to the operator. Upon receiving this information, the microgrid operator plans to purchase electricity for the next day (to satisfy its users' demands) and determine the energy cost accordingly. At the time of operation, however, the actual user's demand may change, and the renewable power generation may vary, which results in discrepancy and instability in power delivery and thus increases the cost. The user consumption behavior, the quality of the prediction method and electricity usage by the user may further aggravate the deviation. The customers will play the game in each time slot as long as a change in demand concerning fine grain predicted load is detected for the current and future time slots. Finally, the system will penalize i.e. Higher rate charge each of deviated users with the proportion of the total deviation determined by the operator.

We use a short-term forecasting of the electricity demand over 24 hours, seven days, which is better known as short- term load forecasting (STLF). The microgrid is also expected to have a large centralize Dess (MESS) to store extra power generated by the RES, and it is used (discharged) when thereis a shortage. Each EV is capable of V2G (vehicle to grid) which charges to a target amount of energy before going to next drive. The customers will play the game in each time slot as long as a change in demand concerning fine grain predicted load is detected for the current and future time slots. The main contribution of this paper is then to design a novel cooperative strategy (RDCDSM) between the residential consumers and their energy suppliers. In this cooperation, the operator asks each household to submit and adhere to its fine-grain forecast of electricity usage a day-ahead.

Each customer optimizes its predicted load and communicates its fine grain predicted demand for next 24 hours with the microgrid operator. The microgrid operator is responsible for planning and controlling the flow of electricity among users in the network. Le be the amount of electricity purchased from the main grid at time *t* to support the fine-grain projected demands of at *t*. At consumption time, customer compares its real demand with the proposed predicted demand.

IV. Problem formulation

We assume the microgrid operator plans its energy production and purchase a day ahead, based on the aggregate predicted demand it received from its users. However, the actual user's consumption and need for energy during the day may vary from its predicted demand. The frequent changes in demand may force the microgrid to produce a variable amount of power which either may not be possible, or expensive, on a short notice. Moreover, the start or shut down of a generator to match the user's variable demands involves substantial cost and time. Thus, our system will helpthe microgrid operator aswell as the users to close the gap between the real time and instantaneous actual and predicted aggregate demands. The integration of ESS, EVs, and an intelligent energy management system will be exploited to help in mitigating the problem and thereby reduce the electricity costs and instability in power generation.

We address these issues and design an intelligent solution (i.e., RDCDSM) to reduce the electricity costs by first flattening the predicted demand (or load curve) at the start of a day. The system then delivers electricity to the customers according to their actual demands, such that the deviation between actual and predicted demands is minimized. The RDCDSM has two consecutive phases: (i) prediction or planning phase and (ii) allocation phase.

1) Prediction phase: Each day, each home predicts its load, forecasts its renewable energy generation, EV arrivaland departure times and target energy. Next, all customers individually optimize, and flatten, their consumption pattern to reduce the cost, and then sends the resultant predicted load to the operator.

Each time a customer sends its load profile to other clients when the change of its previous strategy is profitable. Upon receiving the load profiles from other clients, customer determines its next strategy to increase the payoff.

2) Allocation Phase: The uncertainties household demands, RES generation, arrival and departure times of EVs and their target energy may vary at the time of consumption from the predicted one. household demands, RE generation, arrival and departure times of EVs and their target energy may vary at the time of consumption from the predicted one.

Each customer needs to adjust its electricity usage at timeof consumption to mitigate the gap between the actual and the predicted demand. Otherwise, the microgrid will respond by purchasing the extra extra cost (or penalty) proportional to the deviation between the actual and predicted demand of electricity. Let us assume that the current time slot is Each customer re-forecasts its demand i.e. modified demand) for the period from Since there may be some gap between the actual and the predicted demand for this time slot the customer will try to mitigate this difference by exploiting MESS, ESS and EV as well as the customer'snew forecast of RES, taking into account the constraints imposed by EV's departure times as well as target energy. A strategy is decided where to discharge energy from or where to store the excess of energy.

3) Centralized Allocation Model with Original Prediction: In the centralized method, the microgrid operator makes decision on behalf of its customers. Namely, in each time sloteach customer will send its actual load (for this time slot) as well as the re-forecast of the projected demand and its modified prediction of the energy generated from renewable sources.

Now, similar to the distributed method, the operator will attempt to mitigate the difference between actual and originalpredicted load by exploiting the energy storage systems (MESS, ESS and EVs) taking into account the constraints (e.g., for EVs departure times and target energy) transferred by the users. The centralized method does not shift loads to flatten the load curve and hence does not lower electricity price. the objective function for the centralized model is, raw predicted load sent by the customers (original prediction). keep a balance between energy production and consumption.

V. Numerical evaluation

I. Simulation Setup

We consider grid connected microgrids with 100, 200,300,1000 homes and Industrial Load connected with each other through an electrical and a data network. Each customer has an energy management system (HEMS) which is responsiblefor forecasting the load, RES generation, EV arrival and this departure times and target energy level, and for sending (and receiving)information about energy, load, and other control information to other HEMSs. Each HEMS runs thee n e r g y optimization (RDCDSM) model to optimize the energy usage of the owner. A data network carries load and control information from one HEMS to other HEMSs as well as to the operator.

B. Numerical Values

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A) Industrial Load

The industrial load demand is increases day to day ismore and management of demand side power is difficult in previous day but now days demand side management play important role to fulfill of demand of customer for satisfaction with the help of DSM system.

Power supply is demanding to every electrical system. Poweris graded at which an amount of energy is used to complete the work. In the Industries, a higher power consumption than the constricted one can lead to severe penalties. Industrial load consists of load demand by various industries. It includes all electrical loads used in industries along with the employed machinery. Industrial loads may be connected during the whole day.

Different types of loads exist in circuits: capacitive loads, inductive loads and resistive loads. These differ in how they consume power in an alternating current (AC) setup.Capacitive, inductive and resistive load types correspond loosely to lighting, mechanical and heating load. due to this all types of load demand of electrical power is increases.

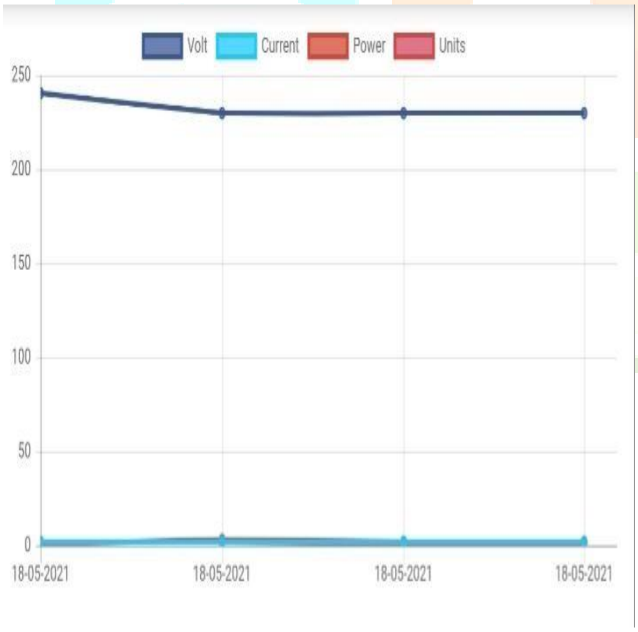

Fig A- Industrial Load all Properties

2) Residential Load

The Load of Residential is less than Industries and Also Demand of power is Very less as compare to the industrial load. Load of residential is fixed in commercial areas theydo not very. that is the reason of power demand is less in commercial areas.

Management of residential electricity consumption is one of the important issues for energy efficiency and future smart grid systems. Demand response implementation in residential sectors is a recent effort to improve efficiency of the electricity market and stability of the power system.the two main aims of these applications are to reduce electricity peak demand and to match the demand with renewable energy.

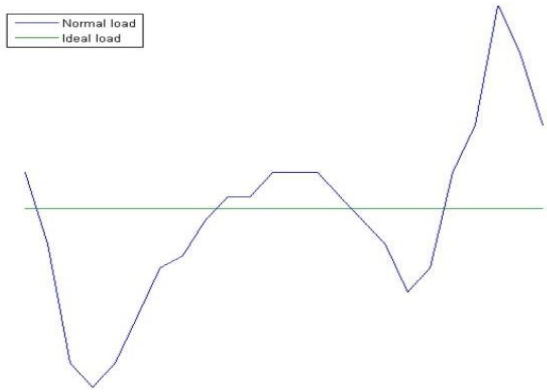

Fig B- Daily load diagram

Therefore, we present a novel online smart residential load management system that is used to online monitor and control power consumption of the loads toward optimizing energy consumption, balancing electric power supply, reducing peak demand, and minimizing energy bill, while considering residential customer preferences and comfort level. electrical load by adjusting or controlling the load rather than the power station output. Load management allows utilities to reduce demand for electricity during peak usage times (peak shaving), which can, in turn, reduce costs by eliminating the need for peaking power plant.

Above the graph shows the normal load is vary as per load of residential load. Residential load is a term which is used to describe the amount of electricity entering a residence at any given time. The amount of electricity a residence can accessis typically limited by the amount of its service drop. When homes are constructed or electrical systems are renovated, an electrician must perform a number of calculations to estimate maximum residential load to determine how the system should be laid out, with the goal of preventing electrical problems caused by overloading the system. This system is designed to promote energy efficiency and to keep the grid operable. Electricity bills usually break down energy usage for their customers and may include measurements of peak residential load so that people can see when they were using the most energy.

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Fig C-Residential Load all Properties

The Load of Residential is Small and demand of power is easy to be monitoring. The concept of shaping residential loads can be an effective way of controlling the load profile of a distribution company. Flat energy rates do not provide incentives to customers to use power as would beoptimal from a utility point of view. With the restructuring ofthe power industry it is expected that prices will fluctuate in any give.

Real-time electricity pricing models can potentially lead to economic and environmental advantages compared to the current common flat rates. In particular, they can provide endusers with the opportunity to reduce their electricity expenditures by responding to pricing that varies with different times of the day.

Vi. Conclusion

We developed the electrical power management System for monitoring the power and regulate the electrical energy and real time distributed energy management RDCDSM system to mitigate the intermittent nature of the RESs and fulfill the demand of a residential microgrid. The proposed RDCDSM processes the raw predicted load to produce a predicted load curve, balanced throughout time, for the microgrid and allocates electricity in real time in an intelligent way which reduces the gap between the predicted and distributedamount of power. Hence, the proposed system forces customers to collectively produce a flat load profile and stick to that profile at the time of actual consumption by means of a penalty. RDCDSM eases the integration of ress with the grid by exploiting esss and evs.

We also developed a centralized allocation method to allocate electricity according to the day ahead simple prediction method to evaluate the performance of RDCDSM. The RDCDSM system took less time (less than a minute) to produce the results whereas the centralized scheme needs days (and sometime weeks) to provide a solution for a large microgrid. The proposed system requires more sensible equipment (HEMS) whereas the centralized system required a less intelligent system in the user premises. The centralized system however needs detailed information of consumption from users which may violate their privacy.

Mitigate the energy demand with the help of microgrid system and provide regulate power supply without break the power or without load scheduling. This all work done for customer satisfaction and maintain the reliability.

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