DEMAND RESPONSE MANAGEMENT, PASSING THROUGH THE CHALLENGES

Morteza Moghaddasian

Mashhad Electric Energy Distribution Company (MEEDC), Iran
moghaddasianm@gmail.com

Mohammad Hossein Yaghmaee

Mashhad Electric Energy Distribution Company (MEEDC), Iran
yaghmaee@ieee.org

ABSTRACT

Using electricity is an active part of our daily life. We consume the electrical energy for many reasons like medicine, industrial activities, education, home appliances, producing clean air and fresh water. The energy itself would be produced from various sources, some are renewable like solar wind powers and some are non-renewable like gas and oil fuels. The challenge is that the energy providers should produce energy based on the network demand to reduce their costs and operations. On the other side, consumers should pay for the volume of their usage. Therefore, it is the producer that should balance its operations based on the network demand. With this in mind, here we proposed a method that the producers will be provided with their price of services before they sell them and they will be provided with more real data of consumer's usage pattern that can be led to better demand response management. This will bring ease of control and more customer satisfaction. More over with this method of energy distribution and using some innovative ranking algorithm besides, the energy can now be distributed regionally from low usage area to high usage area to bring the cost of operations down and to better manage the produced energy. In this way the economic challenges of network growth and the problem of services outage would be solved to an increased level.

KEYWORDS

Demand response management, CBS method, ranking algorithm, energy profile.

INTRODUCTION

Our daily life is so dependant to the energy services. Home appliances, computers and network devices, electronic vehicles, medical treatments, city and industrial services are all a big part of our daily needs to the electrical energy. Electrical energy itself is a big industry to develop. At first the electricity will be produced by using other energy sources and then the produced energy will be transmitted to the end users using the distribution and transmission networks. This operation is so costly and would involve so many activities. On the other side, other industrial and human civilization activities will be so dependant to the energy infrastructures of the country or involved regions.
So here is two different challenges. One is the challenge of demand and response which is always control by the consumers of electrical energy. It means the demand response process operations are based on the network volume of demands for energy. [2] With this in mind the power producers can decrease the cost of their operations by detecting the correct volume of network demands.
Another one is the challenge between network services cost of operations and the accurate price that consumers of the network will be paid for that. It means how accurate the price of supplier services is and how beneficial will it be for the power suppliers.
In many countries and regions people will be charged after they will consume the energy and the price for their services is counted using the average rate of their consumption in a specific period, like a month. In this way power suppliers should provide some services at first and then will take the price for their services which may have significant impacts on the network economic statue. On the other side, the average consumption pattern does not accurately show the consumption pattern of the network consumers. Imagine that one will consume energy with low level profile for 25 days and high level profile for 5 days, then the 5 days of high level energy consumption will affect the rest and increase the price that one should pay but in reality the consumer did not consume that much energy. [1, 2]
After that many providers bring dual or triple tariffs for the price of their services. Like dual tariffs for high demand hours (beginning of the night up to 10 P.M.) and low demand hours. They also pursue the consumers by setting low prices for low demand hours. [1] Again the same problem for all the policies mentioned above is that people are using energy at first and then will pay for that which may have great impacts on the economic statue of the network operations and also because in many countries the grid is not controlled globally, so there is no way to take the advantage of power produced in some area that may not be consumed there while some other areas may need it.
In this way the cost of operations will be increased due to the incomplete demand response management and inconsistent economic statue of the network. However if the grid will be smart enough to manage the demand response process then the cost of operations will decrease significantly [3, 4] and also if the power suppliers will be provided by the more accurate energy consumption data then they will determine how they should sell their services.

PROPOSED PLAN

As we mentioned before the economic statue of the power grids is greatly affected by the so called procedure. Here before we proposed our plan we show you a glimpse of what is going on in other service providers' economic statue. For the example we choose the mobile service providers. They broadcast their

services using mobile technology and people can use their services to connect to others and surfing internet which is much like the power grid services. In this way people will use their services every day but will pay for their services in different ways. Some will use static plans in which they use services provided by the service providers and then will pay for it monthly or periodically. Some other use dynamic plans in which they charge their profile and then use it. In this way they have better control on their service usage patterns and providers will be paid before they provide their services which bring the better economic statue and of course better quality of services.

The same might be true for the power suppliers. If they will take the price of their services before selling them, then they can provide their services with better quality and manage to broaden their services. So with this in mind here we proposed a plan for the power suppliers to improve their economic statue and also to have better control on the process of demand response management. The proposed plan will begin with the price collecting process and take care of different aspects of the network operations.

In this plan anyone who wants to use the services provided by the service providers is a registered user of the network. Users will receive smart cards including their id and network information. On the other side the energy meters inside the home or place of consumption will be utilized to detect and read the information of the cards. [2] Once the card is inserted to the meter, the services is available for the users. Users of the network now will make their plan of consumption and then charge their energy id card before consumption. They can do it every time by connecting to the internet and using the suppliers' website. Once the account will be charged, then the consumer can take the advantage of the services provided by the grid. This is called the Cash Before Sale (CBS) method that cause the providers to take the price of their services before they would provide them. Now the providers can increase the quality of the services by setting engineered and qualified plans.

More over the providers of services now have more accurate data of consumers' usage patterns. In this way

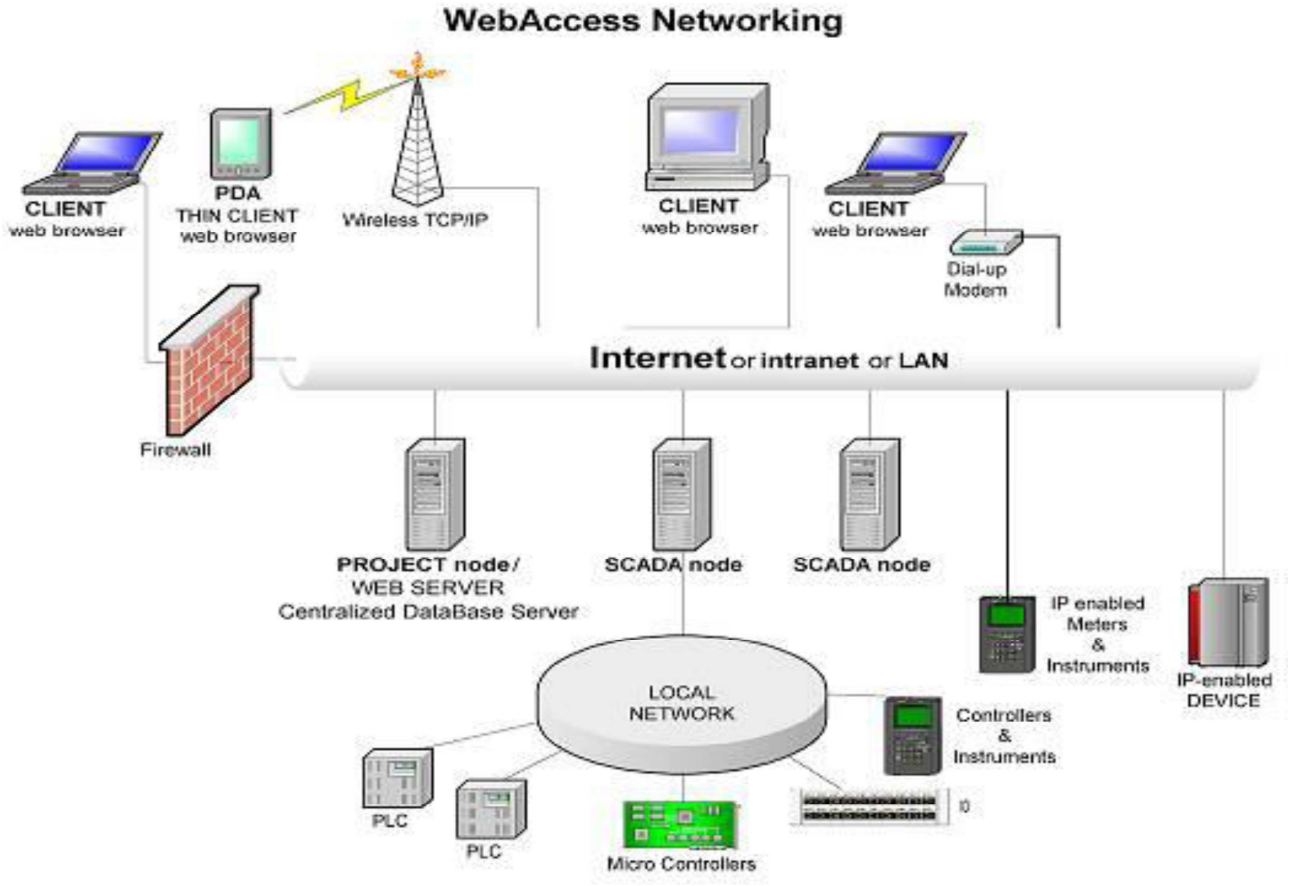

Figure 1. Consumer to Provider Communication

they can decrease their cost of operations by using the information taken from the energy usage patterns of consumers. [2] Up to now the first step of the proposed method is to use the CBS method of payment to take the price of the services. Now with this move the network economic statue will change a lot and the providers can manage the future plans more seriously. A very important part of this change is that it causes a lot of benefits for the better management of the demand and response process and also it will produce specific and more real data of consumers' usage patterns that can be used to determine the price of the services more accurately.

Now users or those consumers that have the energy smart card can go online and choose the plan that bests fit their needs as it is shown in figure 1.

On the other side usage plans would also be introduced by the providers using the data provided by the consumers' usage patterns. When a user choose a plan then he may use his plan whenever inside the grid. The grid can automatically detect the user and the plan that had been set by him. In this way any user of the grid can plan for a good energy consumption plan that would meet its needs.

However it is totally clear that the price of services would be determined based on different aspects and would be different in different areas of the grid. [4] But providers can now tell the users of the grid exactly the costs of their services regionally and they can provide the users by how best is the plan chosen by the users based on the consumer energy usage data.

In this way in a short period of time the users of the grid can choose the best plan for themselves based on their needs. On the other side the energy providers can now produce electricity exactly as the grid volume of demands. [2] Furthermore it causes the less price of services for the consumers and the better demand response management. There would also be different options for the users to change or promote their usage plan and also there would be no deadline to consume the energy that the user have paid for that before. It means once you charge your profile, you can consume it whenever and wherever inside the grid you like.

Besides as it is mentioned before that when a user change its place inside the grid the costs involved in new place will be set for it and the user can see its usage pattern and its account balance in real mode by logging to its profile. [1] It is also amazing that with this management system one can sell electricity to the providers if they will have some capabilities of power production like using solar cells and it can be done through its profile.

The next step is also defined for the providers of the electricity to collect the data provided by the users of the network by defining suitable data collecting algorithms and also use that data to analyse the grid functionalities for the better demand response management. It means now the providers have the abilities to understand how much electricity should be produced in a region based on the plans of usage chosen by the registered users of the grid and they can manage to produce as it is needed and also some more for emergency situations.

So the rest of the electricity produced by the providers can now be transmitted to other regions or if it is not needed, providers may have no more plan for the production of electricity or they might sell it to other providers. As it is shown here everything can be done in automation. Even turbines can be on or off by the management system based on the network demands. [3] It means everything will start by the users of the grid and then the whole thing will be managed by the grid itself and this would make some activities for both demand and response sides as it is shown in figure 2.

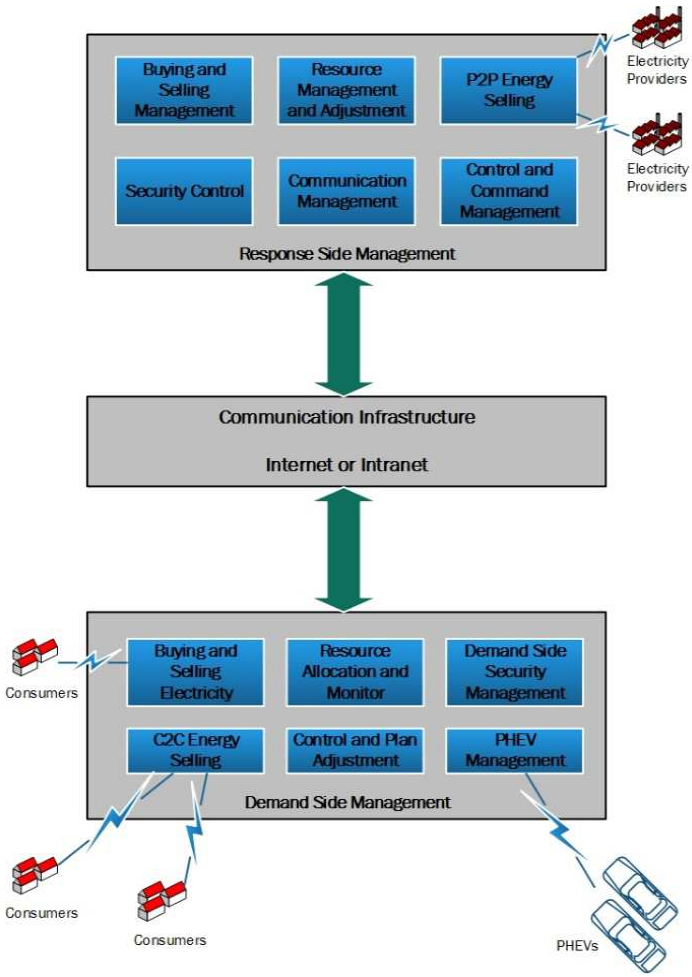

Figure 2. Introduced Management System Activities

These activities would involve management and monitoring of the resources on the both sides and economic aspects of the network. There are also some other activities regarding the security of the grid which are designed to monitor and collect the data regarding

anonymous activities on the grid and act as a preventive in front of the network attacks. [3, 4] More over providers can now more accurately detect the network electricity thefts and terrorism attacks.
One more thing is that now it is possible for the grid to transmit the electricity from low usage areas to high usage areas using smart electricity switching methods which are a part of the grid instruments. [5] In this way electrical energy in one area will be transmitted to other areas in automation and the activity will be monitored by the providers of the network. [5]
Moreover it is possible that if the grid has more than one provider, the proposed plan will manage the grid with different providers and control the activities inside them. It means when the plan is installed for controlling the network, all the providers will be registered to the grid management system and the whole resources will be managed by the system itself.

PROS AND CONS

As it is shown here the proposed plan will focus on the economic potential of the grid and also the ability to operate itself based on the economic procedures defend inside the network operations. From the above the grid is defined by two different entities. One is the users of the grid and another is the providers of energy. Due to the nature of the grid, any active procedures of the grid is highly dependent to the users' demands for the power consumption. Because it is really hard to understand the volume of demand, it is better to predict it by using prediction algorithms. So the proposed plan have different potentialities as follows:

1- It will provide the producers by their cost of service before selling them by introducing CBS payment method.
2- It will classify the consumers in a grid regionally and in a country based on their usage patterns in order to set a good consumption level as an attribute of payment.
3- Setting the prices of services by defining different attributes based on the users choice of plans.
4- Users can now produce some electricity and sell it back to the producers like using solar systems.
5- It is possible for both users and providers to sell to or buy energy from other users or providers who are registered in the network.
6- Any user of the grid can now donate electricity to any other users of the network by directly using its online profile.
7- It will smoothen the demand response process by the use of collecting data from the users.
8- By setting this plan, there is no need to produce bills for the places of consumption.
9- Now the grid management system can better utilize itself and even users can use smart control systems inside their homes to better control their power consumption patterns.
10- The online accessible system makes it easy for the consumers (registered users of the grid) to interact with the grid and manage their services in fairly anytime and anywhere by just having accessed to the Internet.

There are also some challenges regarding this plan that most of them will focus on the security of the network activities. [4] Because people or better say users can go online and have some interactions with the grid which will arise some security issues. In this way a very important issue is that how secure this plan could be?
For many it is clear that the internet is not regarded as a safe infrastructure of communication. Many security threats like viruses, energy theft and many more may threaten the network activities and users. But there also be many ways of having more security over network functionalities and procedures. Using security keys, encryption algorithms, secure network connections, isolated sub systems, some implementations of hardware security frameworks defined by the manufacturers and more which all will make a more secure situations. [3, 4] However there are a lot toward the security issues that should be discussed solely.
There are also some other challenges like the cost of revolution of the grid, designing and producing necessary instruments and hardware, designing and implementation of algorithms. But with the plan proposed here, it is clear that the whole costs of the revolution will be back by the decrease of unnecessary operations of the network activities and energy theft. What we think is that a big move is less costly and more effective than small rather changes in a long period of time.

CONCLUSION

As it is shown here, we have proposed a method that will consider the full automation of the grid demand response management system from the economic side of the grid. Users or the consumers of the network services will use their energy smart cards and have their own id on the grid for any further contractions with the providers.

On the other side, smart meters will be used to read the information on the smart cards and send its information to the providers' servers. [2] Providers now can manage their services by collecting more real and accurate data of the usage patterns of the consumers. Users can go online and buying some services by choosing a suitable plan for their consumption pattern. Users will also pay once and consume the energy whenever and wherever

they like inside the grid. It is also possible for the consumers of the grid to change or upgrade their usage plan if they want to do so.
Therefore the proposed plan will cause the consumers to pay less and consume as they needed and also will cause the providers to earn more and cost less. In this way providers can broaden their services by more money they make and the less costs they involve.
There are also some issues regarding the security of the network communications which some of them can be handled using network security and encryption methods. [4] There are also some implementations of security frameworks on the hardware devices that are used in the grid but they are just being defined by the hardware manufacturer and are not mostly standardized. It is important to notice that security is very important and we should say that there may be some serious activities regarding the security issues of the grid communications that should be managed and considered wisely.
Finally the plan will make so many new functions like selling the power back to the providers, selling power to other users or donating power to them, all being done directly from the users' online profile. The online profile will also provide a means for the consumers of the grid to connect to the grid and interact with the system in fairly anytime and anywhere by just having accessed to the Internet.

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