DEMAND SIDE MANAGEMENT IN SMART ENERGY HUB

Major Project Report

Submitted in Partial Fulfillment of the Requirements for degree of

MASTER OF TECHNOLOGY

IN

ELECTRICAL ENGINEERING

(Electrical Power Systems)

By

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Certificate

This is to certify that the Major Project Report (Part-II) entitled "DEMAND SIDE MANAGEMENT IN SMART ENERGY HUB" submitted by **Mr. Bhavik J. Parmar (RollNo: 14MEEE12)** towards the partial fulfillment of the requirements for Semester-IV of Master of Technology (Electrical Engineering) in the field of Electrical Power System of Nirma University is the record of work carried out by him under our supervision and guidance. The work submitted has in our opinion reached a level required for being accepted for examination. The results embodied in this major project work to the best of our knowledge have not been submitted to any other University or Institution for award of any degree or diploma.

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I, Bhavik J. Parmar (Roll No. 14MEEE12), give undertaking that the Major Project entitled "DEMAND SIDE MANAGEMENT IN SMART ENERGY HUB" submitted by me, towards the partial fulfillment of the requirements for the degree of Master of Technology in Electrical Engineering (Electrical Power Systems) of Nirma University, Ahmedabad, is the original work carried out by me and I give assurance that no attempt of plagiarism has been made. I understand that in the event of any similarity found subsequently with any published work or any dissertation work elsewhere; it will result in severe disciplinary action.

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Abstract

Today the Smart energy hubs and the advancement in smart grid technologies have motivated system planners to deploy intelligent multicarrier energy systems entitled smart energy hub (S.E. Hub).The model of smart energy HUB on load side and integrate all this model and manage it by demand side management. By using centralized algorithm Demand Side Management (DSM) can happen. For demand side management (DSM) optimisation technique can use. Energy hub is important feature of implemented power system called smart grid. Which contains various storing device, Converting device, and direct connecting device with input and output port. These energy Hub device control extra energy consume by load by different metering device.

Nomenclature/Abbreviations

DSM .... Demand Side Management

LAN .... Local Area Network

UC .... Utility Company

$MSMP$ .... Multi Source And Multi Product System

ECS .... Energy Consumption Schedular

DRM .... Demand Response Management

$PHEV$ .... Plug In Hybrid Electrical Vehicle

WAN .... Wide Area Network

ECS .... Energy Consumption Scheduler

CC .... Cloud Computing

DRM .... Demand Response Management

DR .... Demand Response

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Chapter 1

Introduction

Smart grid is an improved power system to meet the load demand and a new challenges in transmission system. Power produced by various plants which are either conventional sources or non-conventional sources. Where power generation cost is too high in conventional sources because of fuel cost and installation cost.so,renewable source is most probably used in smart grid system to generate the power. Power generation in renewable sources is by solar panels, wind farms etc.

Small distributed power generation system installed nearer to load side to maintain the voltage and system stability. Storage device available for load during peak hours cause of cost ratio is too much high at that period. Distributed power generation system contain small renewable plants which generate the power either in islanding mode or in normal mode.

1.1 Energy Hub

Energy hub is a model in which energy are stored, converted, and distributed to fulfill the load demand. In energy hub various transformers, CHP plants, some cooling devices and some heating devices are present to fulfill the different type of energy to consumers. Size specification of energy hub is not proper .so, hub size should either consider as small city or small energy storage device. [1]

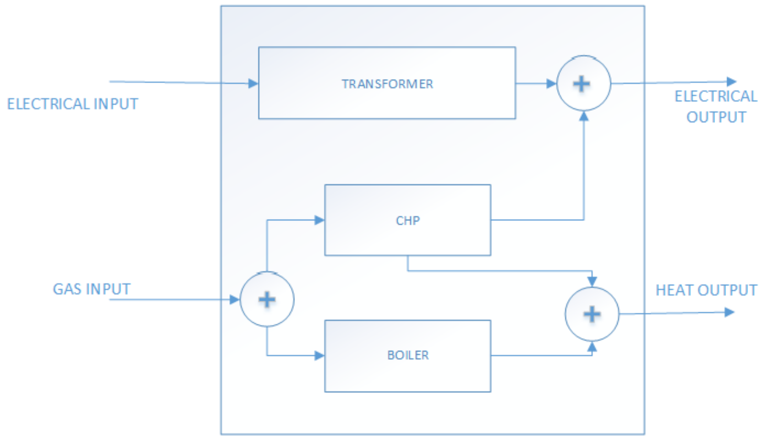

Figure 1.1: Energy hub structure

Benefits of Energy Hub

- Improve Reliability
- Load flexibility
- Maintain voltage stability
- Improve power quality

1.2 What is Demand Side Management?

The energy which consume by the residential, commercial, or industrial load and it manage by some programme or by some Intelligence technique called demand side management.[1]

Chapter 2

Literature Survey

[1] Mohammad Rayati,Aras sheikh,Ali Mohammad Ranjbar and Shahab Bahrami"Integrated Demand Side Management Game In Smart Energy Hub" March 2015. [1]

This paper gives information about demand side management in energy hub.Demand side management refers a programs in residential sector implemented by utility suppliers.The load is variable load or fixed load, by using some storage device we stored the energy which is supplied by utility company .And this stored energy used during peak hours to manage the peak to average ratio. For a particular energy carrier demand side management used. Demand side management technique is not mostly used for must run load like fans, light, etc...Heavy load could operate during night period when peak to average ratio is low .dish washer, washing machine, etc....are flexible loads. The communication between utility company and consumer by cloud computing.LAN is used to communicate between sending end and receiving end. Energy hub has a many input and output ports depends on require energy consumers.Peak to average ration depends on total loads.

Various Energy Hub Structure

- UC (Utility company)-hub structure

  In this structure the interaction only between the utility company and consumer.To Maintain the peak to average ratio consumer shifts some load which are heavy loads during off peak period .In this structure communication only between utility company and consumer.

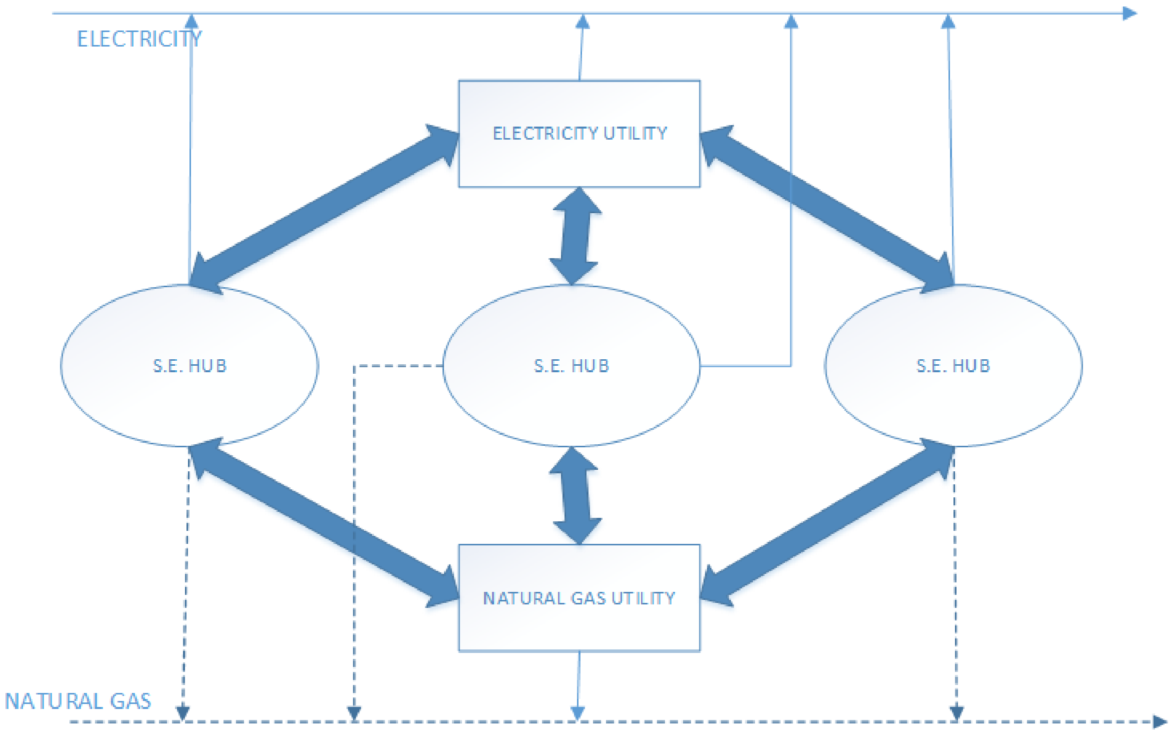

Figure 2.1: UC-Hub structure

- Hub-Hub structure

  This structure is also same as hub to utility communication but in this hub also communicate with each other and manage the energy consume by the appliances.

[2] A. M. Ranjbar,A. Sheikhi,M. Mahmoodi,F. Safe"CHP Optimized Selection Methodology for an Energy Hub System"2011. [2]

This paper gives information about what should be the optimize size of CHP for require application to consume the power. CHP is one of the most important distribution technology. CHP provide power for different load. What should be the

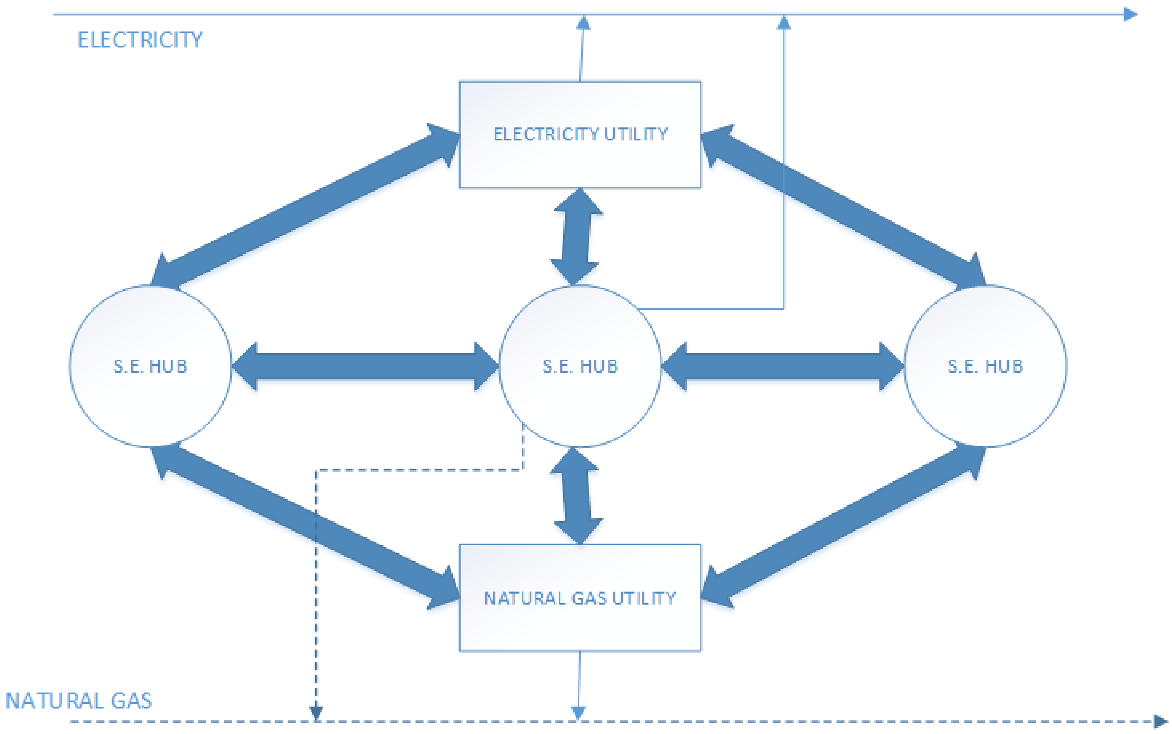

Figure 2.2: Hub-Hub structure

optimize size of CHP for require application to consume the power. CHP improve the power reliability, reduce the power losses in distribution sources. Cost of CHP is depends on efficiency of plant ,size and capacity of plant.

Two main content of energy hub are follow

- DIRECT connection

  In this connection energy produce by utility company is directly link with the various loads through energy hub.

- CONVERTERS

  In this connection energy produce by utility company is converted by converting device and fulfill the load demand.

[3]Alberto Leon-Farcia and Hazem M.Soliman"Game Theoretic Demand Side Management With Storage Device for the Future Smart Grid"May 2014. [3]

In this paper two main game approach are described

Non-cooperative game approach

In this the game played only between different energy consumers.

Stackelberg game approach

In this the game played between the different energy consumers and utility company. Demand side management used for various applications, energy convergence, efficiency of power delivery, load management of residential and commercial sector, fuel substitution.

[4] Mohammad Moradi Dalvand,Ali Shahmohammadi,Ahmad Salemnia,Mohammad Sadegh Ghazizadeh, "Energy Hubs' Structural And Operational Linear Optimization With Energy Storage Element". [4]

This paper gives information about Multi source and multi product system (MSMP).It has same concept as a smart energy hubs. Which having multiple input source and multiple outputs. With using coupling matrix energy transfer between two different ports of energy hubs. Energy storage device also present in energy hub.it is nearer to input and output ports.

$$\begin{bmatrix} L_a \\ L_b \\ : \\ L_z \end{bmatrix} = \begin{bmatrix} C_{aa} & C_{ab} & .. & C_{az} \\ C_{ba} & C_{bb} & .. & C_{bz} \\ : & : & & : \\ C_{za} & C_{zb} & .. & C_{zz} \end{bmatrix} \begin{bmatrix} P_a \\ P_b \\ : \\ P_z \end{bmatrix} \tag{2.1}$$

[5] Emmanuel Manasseh, Shuichi Ohno, Toru Yamamoto, Aloys Mvuma"Autonomous Demand side Optimization with Load Uncertainty". [5]

Paper gives information about Demand side management. It gives important decision to consumer that how much energy will consume by the load to maintain the peak to average ratio. If the controllable load appliances are more than the energy saving will be more, because the controllable load to be shifted on off peak period and maintain the cost ratio. Energy consumption scheduler (ECS) function put into smart meter to maintain the demand side management. ECS function run by centralized algorithm in smart meter and find the best cost ratio as well as best peak to average ratio.

[6] Jiming Chen,Bo Chai, Senior Member, IEEE, Zaiyue Yang, Member, IEEE, and Yan Zhang,Senior Member,IEEE "Demand Response Management With Multiple Utility Companies: A Two-Level Game Approach"2014.
[6]
This paper gives information about Demand side management(DSM) and Demand response Management (DRM).It is a key component of the future smart grid that helps to reduce power peak load and variation. This paper includes DRM with different-different utility companies. In a First case,the interaction between residential users and utility companies is model as a two-level game. That is, the communication among the residential users is created as an evolutionary game while the competition among the utility companies is created as a non-cooperative game.

Chapter 3

Renewable Resources

3.1 Micro CHP

For the betterment of Power generation capacity, the co-generation phenomena is better option. In that, the electricity and heat both are co-generated from single micro CHP plant. Here, the element known as heat exchanger is used to recover waste heat and the produced energy is fed back to the main grid for betterment of all over capability of power generation. The units having capability >50 kW and small scaled co-generation are known as micro co generation. The type of micro-CHP systems are systems which all are having capability ,<15 kW are generally used in living areas such as, houses, small business areas, motels and guest houses.

The CHP used in residential applications is one of the most reliable application for Solid chemical compound (SOFC) and compound membrane solution (PEMFC) fuel cells, which sound into total 15 lacs gas connected local boiler and chamber exchange throughout the year.

These type of systems are fuelled by wide range of gas and applied to grid and synchronized AC power for heating of area and domestic applications. When we consider the fuel cells for domestic scale oriented distributed generation, the estimated amount for industry based plant is 35000 INR per kWh, for having facility of extra alternative parts at a same cost.

3.2 Solar power generation

The overall pricing of a rooftop solar PV system put on roof of building has decreased drastically over past years, and it will increase more in next years, as additional house holders have started communicating in intercommunicate star style. So, as a result the demand become hyperbolic and also have prompted some utilities to produce and distribute such star elements having a top standard of quality and at very reduced rate, and we should be thankful to the hyperbolic competition for that.

One of the most important factor of not having house hold solar plant is the price of the plant. But the pure truth is, over the future of time, a solar rooftop can pay for itself, and also beneficial by means of electricity tariffs, tax incentives. Before choosing that, we have to have thorough knowledge about various advantages and disadvantages of PV rooftops.

Consumer requires 1 kW of solar panel(s) costing 3300 Rs/each. Consumer has to pay the electricity tariffs every month. So if consumer is going to pay 6000Rs for their electricity per month, they must be going to require 4 kW solar power and so panel system. Now, each solar panel is rated as 250 to 300 W, so for having a 2 kW rooftop system, consumer needs 8 panels at a total, and so for a 4 kW system, he/she needs 16. Consumer should also be careful about available space at roof, to have a solar rooftop plant, according to the requirements.

Once they got solar rooftop plant working, they receive the additional taxes by government around of 30 percent of the total cost of installation of rooftop PV. But only within time of 8 to 10 moths only, most of the solar panels pay off the total cost of installation as well as the additional taxes. Not only the financial benefits, but also we have to consider the environmental benefits also, which all we have got and saved our environment from the unusual certainties, which would have caused by use of fossil fuels for power generation.

If our installed solar PV system is not able to generate that much of sufficient power according to our total requirements, then in that case, additional back-up power is provided by utility grid. But, in reverse case, if the generated power from solar PV exceeds the total requirement of household load, then this additional power is feedback to grid. This metering of power requirement is usually done by arrangement known as net metering. It is one of the most efficient arrangement, below this, the utilities pay the worth for power fed into grid.

A moderate capacity solar rooftop, is also sufficient and reliable to feed household load. Additionally, rooftop PV is most advantageous in the area(s), where there is dead possibility to supply power by means of conventional transmission lines. As, PV panels use the direct sunlight from the sun to produce electricity and India is naturally very rich in solar irradiance, rooftop PV is the ample solution for household works. However the quality of electrical power generated by the PV plant depends on the proportion of suns irradiance. The simplest design of PV array consists plate and some PV modules.

PV array a lightweight structure, having neither of moving elements, nor any other additional instruments. So does they are appropriate for the application at several locations and different residential rooftops. The PV is incorporated as a optimum solar irradiance position on rooftop.

3.3 Wind power generation

For customers who all need to produce the green power by their own, having a little turbine is also a possibility. These type of small wind turbines are the electrical generators which all use the energy extracted from wind to generate green, clean and emissions- less power for individual residents, farms and small scale industries. With this type of easy and prolonged technology, consumers will generate their own energy and cut their energy tariffs, which all are the beneficial to surroundings also. Not like the main utility turbine, the small scale generation turbines will also be suitable to use on some acre of land and in almost all areas of country.

These type of small scale generations will be connected to the electricity/energy distribution system. These are known to as the grid integrated systems. These type of grid integrated turbine will cut down the consumers total consumption from utility based energy for lightning and other appliances. Even if the small turbine is failed to deliver the needed energy, the utility makes up the distinction. Once the small wind turbine produces the additional electricity than the household load, this additional energy is fed back to the utility, which is known as surplus energy and in reverse case, if the small turbine is failed to fed the household load, the energy is fed by grid, that time.

Wind power is additionally used as a back-up option along with the PV system, which is known as Hybrid System. Wind power is often utilized as a part of hybrid power, for off and on load grid connection. According to some scientists, this type of hybrid power system offers more advantages comparing to single PV/Wind. As the wind is more powerful during winters and sun is less radiant during winters, exactly reverse for summers.

So, both of them are used alternatively. Many a times there is lack of wind or solar irradiance, so that both resembles each others in that case. Additional storage batteries are used as a energy storage elements. In case of uncertainty in wind/irradiance, which is very obvious.

Chapter 4

Modeling

In present days,there are improved developments of applications related to Smart Grid and energy hub concepts. Activity results of the coupling between gas and electricity infrastructures, and approaching energy systems to the smart grid surroundings results in introduce a replacement resolution. This resolution is name as a Smart Energy Hub (S. E. Hub). The smart energy Hub models a multi-carrier energy system in an passing best grid surroundings. The evolution of the smart grid heavily depends on utilization and therefore integrate up to date knowledge technologies. Therefore,It is counsel that the information technology trade need to be concerned to facilitate the knowledge management among the smart grid. extra specifically,It tend to explore but cloud computing, a next generation computing paradigm, will serve the information management among the smart grid.[7]

4.1 Mathematical model

If associate energy hub placed at intervals the good atmosphere and equipped with communication infrastructures and smart meters(for every fuel and electricity networks) then we have a tendency to tend to name as a smart energy hub (S. E. Hub).[7]

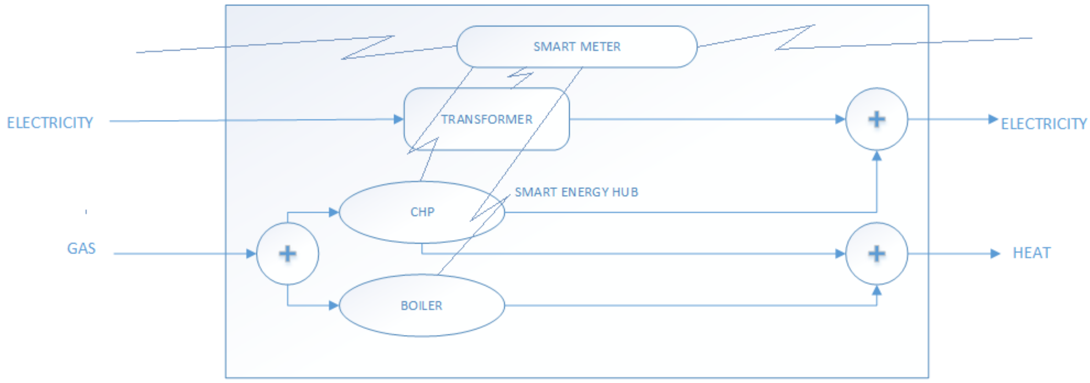

Figure 4.1: DSM in smart energy hub

$$\begin{bmatrix} P^i_{output(e)} \\ P^i_{output(h)} \end{bmatrix} = \begin{bmatrix} \eta^i_T & \lambda^i \eta^i_{c(e)} \\ 0 & \lambda^i \eta^i_{c(h)} + (1-\lambda^i)\,\eta^i_{b(h)} \end{bmatrix} \begin{bmatrix} P^i_{input(e)} \\ P^i_{input(g)} \end{bmatrix} \tag{4.1}$$

Where,

P$^i_{output(e)}$ is power output in form of electricity,

P$^i_{output(h)}$ is power output in form of heat,

P$^i_{input(e)}$ is power input in form of Electricity,

P$^i_{input(g)}$ power input in form of Natural gas

η^i_T is Efficiency of Transformer,

$\eta_{c(h)}$ is efficiency of CHP in form of heat

$\eta^i_{c(e)}$ is efficiency of CHP in form of electricity

λ^i is distribution factor of CHP

$(1-\lambda^i)$ is distribution factor of Boiler

$$P^i_{input(c)} = \lambda^i P^i_{input(g)} \tag{4.2}$$

$$P^i_{input(B)} = \left(1-\lambda^i\right) P^i_{input(g)} \tag{4.3}$$

Equation (3.2) and (3.3) rewright as follow

$$P^i_{output(e)} = \eta^i_T P^i_{input(e)} + \eta^i_{C(e)} P^i_{input(c)} \tag{4.4}$$

$$P^i_{output(h)} = \eta^i_{C(h)} P^i_{input(c)} + \eta^i_B P^i_{input(B)} \tag{4.5}$$

4.2 Communication between various smart energy hub

Here fossil fuel and electricity utilities unit of measurement shared by many S. E. Hubs, every of that's furnished Associate in nursing energy consumption scheduler (ECS).The energy consumption scheduler utility is placed inside the smart meters.The smart meter is placed in the home and connected with the grid line wire which are coming from the different energy carrier,and it square monitor and measure the energy consumption during the required time period. All smart meter is also connected to each others through a Wide Area network (WAN) which is shown in Figure .The energy consumption scheduler with smart meters modification customers to list out the simplest consumption ways. [7]

In smart grid various measuring, monitoring, metering and control device produce extensive data. This extensive data require scalable, high costly and computing infrastructure to processing the required data. To overcome this high and costly infrastructure we are using next generation storage and computing method cloud computing (CC). CC has large data storage space and computation facility operate and control by cloud providers. Which are work as a utility and deliver storage and computing service. [7]

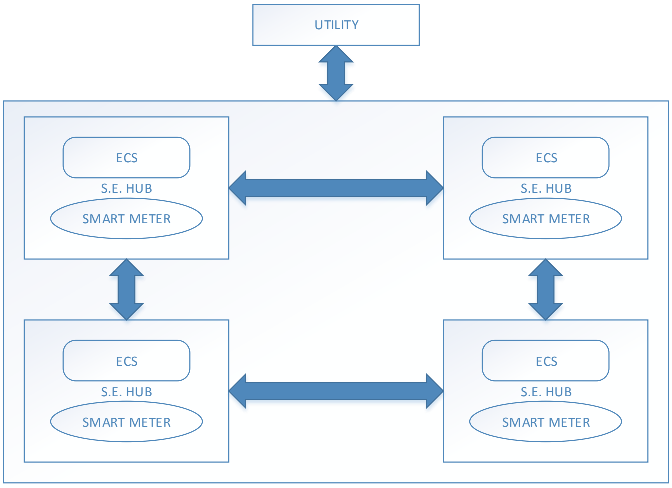

Figure 4.2: WAN for DSM

This varied style reducing the value of deployment,information system vogue,upgrade, maintenance throughout the lots of data transformation to the smart grid in gas and electrical utilities. This massive data level information integration in CC. It will increase the potential to spice up operations, quality of choices, and data utilization in S. E. Hubs.[7]

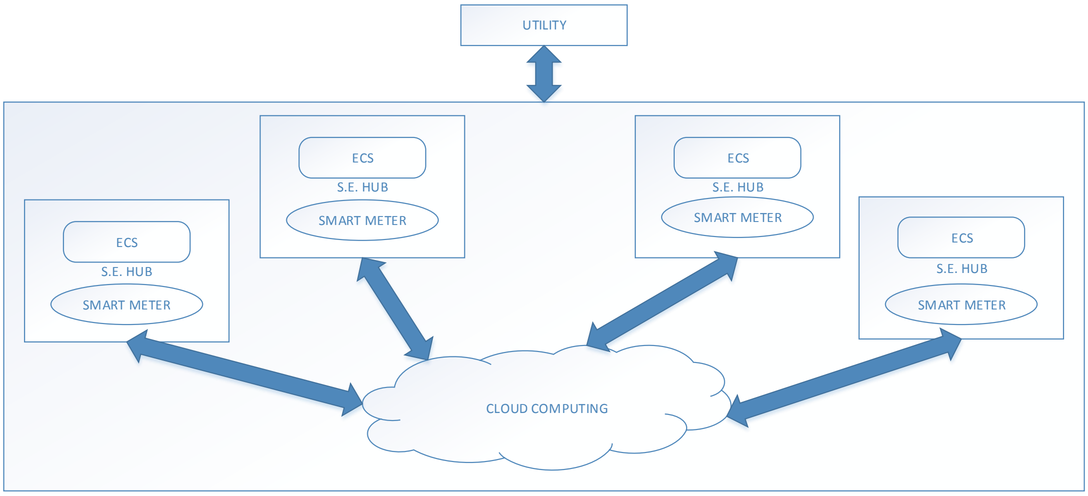

Figure 4.3: CC configuration

4.3 Demand side management in smart energy hub

Previous section mentioned however EHs performance is improved within the Smart Grid surroundings. One among the foremost vital S. E. Hub application is within the Demand Side Management program. All customers are model as a smart energy Hub and it has two different levels of Demand Side Management at the same time,that is each input (level I) and output ports (level II).[7]

Customer has only must run load then that person may not participate in demand side management. If customer having equipped communication facilities and CHP then the customer get energy from CHP during high tariff rate of electricity and this infrastructure called as S.E. HUB .Then level 1 demand side management will applicable. In this condition customer satisfaction and load profile per day will be same, cause of demand of electricity is same as before.[7]

Now suppose if customer has more flexible load then level 2 demand side management will applicable. In this condition customer shift their load during low peak period of electricity to reduce the total cost of consuming energy at a time. And in this condition load profile will change.[7]

4.4 Demand side management price mechanism

For the customer which are using the level 1 demand side management the total energy bill in one hour calculated as follow.

$$J^i = P^i_{input(e)}\,(R_e) + P^i_{input(g)}\,(R_g) \tag{4.6}$$

Where J^i is total energy bill for i^{th} bus.[7]

4.5 System modeling

Take N={1,.,.,.,.,.,n},are the set of smart grid. Here,n users that share an different energy sources.And take a different time slot in a same manner,H={1,.,.,.,.,.,h}.For example, in a daily operation of the grid,each time slot may take one hour and we have H=24. At each hours h∈H.The cost of a power generation is formulated using a cost function C(L),where L≥0 defines the total load in the system at hour h. [8]

4.6 Achieving Fairness

Smart grids as well as renewable energy resources will yield important economic and environmental edges. The Smart grids ability to enhance safety and potency, create higher use of existing assets, enhance reliableness and power quality, cut back dependence on foreign energy, and minimize environmental impacts could be a market force that has substantial measure.water heaters, Space heating/cooling systems, refrigerators, dishwashers, dryers, lighting, and preparation ranges area unit the foremost common appliances within the residential sectors. [8]

In case for optimality, it is not clear but we tend to may measure each customers contribution in achieving the system-wide vogue objectives like minimizing the general power generation value inside the system. Thus, we first address endeavor this challenge and then we use the results to purpose however users ought to be charged to assure fairness.[8]

4.7 Billing Mechanism for users

For the autonomous DR Consider the following billing mechanism,

$$B_n = \frac{E_n}{\sum_{m=1}^{N} E_m} \times \sum_{h=1}^{H} C(\sum_{n=1}^{N} x_n^h) \tag{4.7}$$

Where B_n is the bill of n users.
E_n denote the energy needed to complete the overall operation of user for ns time shiftable appliance.
E_m denote the energy needed to complete the overall operation of user for ms time shiftable appliance.

However,this asking mechanism doesn't appear to charge users supported their contributions in achieving minimum power generation value within the system. In fact, from, any 2 users with equal total load pays equally on their bills despite the shape of their load profiles. This is not withstanding one user participates in DR and an- other user doesn't participate in DR, or perhaps if each users participate in DR however they have different load flexibilities.[8]

user ns daily electricity bill is calculated by following equation.

$$B_n = \sum_{h=1}^{H} \frac{x_n^h}{\sum_{m=1}^{N} x_m^h} \times C_h(\sum_{m=1}^{N} x_m^h) \tag{4.8}$$

we can see that the charge theme in incorporates the precise hour-by-hour load profile of each user. It charges users at the next rate if they schedule their load at peak-hours and at a lower rate if they move their load to off-peak hours. In different words, the hour-by-hour various charge mechanism takes into consideration each total load and load flexibility. Therefore, we tend to expect that it will improve fairness.[8]

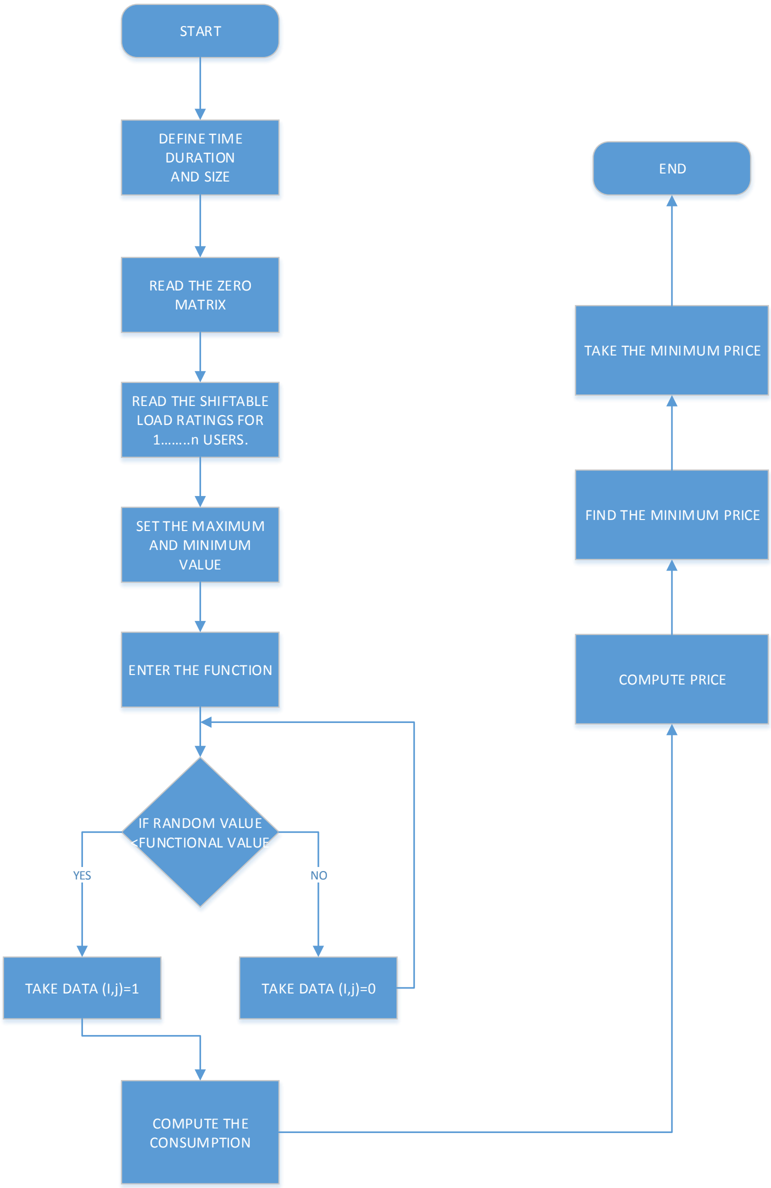

Figure 4.4: Flow chart to find minimum value of tariff rates

Chapter 5

Results

Take one smart energy hub having different types of load and equipped with micro-CHP,solar and wind power generating station for 2 kW of average load. Here, two types of level are considered. Customer consumes the electricity from grid which is supplied by the utility company. That electricity tariff rate for electrical power from grid is very high during peak hours of a day. So, to minimize the energy bill,demand side management can be used an apllication to solve said problem.

In level 1 of demand side management customer consumes the minimum electricity tariff. That electricity is produced by the micro-CHP or solar or wind,which energy is used during peak hours. The different types of tariff rates are shown in fig-5.2 . The whole day load curve of smart energy hub also shown in fig-5.1 . The different-different energy bill per day is also shown in fig-5.3 .In this condition load pattern during a day will not be change.

In level 2 of demand side management,customer shift their high rating load which consumes more energy in low peak period. Results are shown in fig-5.4 . so that customer can reduce their overall energy cost per day. In this condition load pattern per hour will be changed because of shift of some load in low rate tariff period from high rate tariff period. The comparison of different energy bill during various condition is shown in fig-5.5 .

For average 2 kW of generation plant installation cost of micro-CHP is around 1,90,000 Rs. ,for wind plant it is around 3,90,000 Rs. ,for solar plant it is around 2,50,000. Note that maintenance cost is not included in this cost calculation.

Using these two level of demand side management the pay back period of the micro-CHP or solar or wind are as shown in fig-5.8 . How much saving in Rs. while we applying a two different types of demand side management are shown in fig-5.7 .

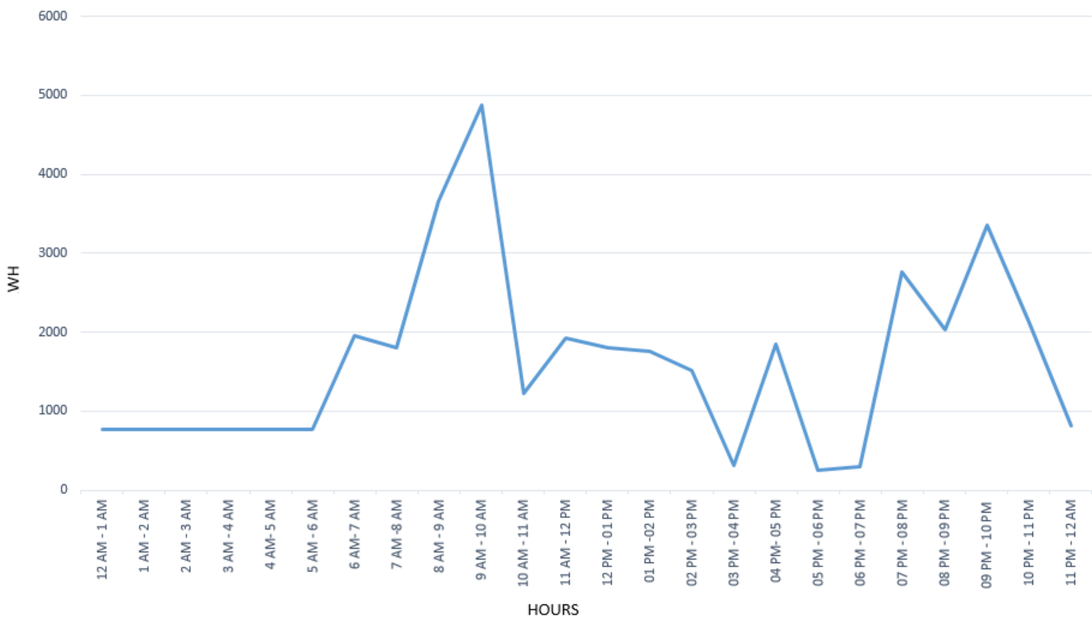

Figure 5.1: Load pattern during day

While take a constant tariff rate of renewable per year bill of customer is shown in fig-5.9 . By applying two different types of demand side management how much savings in year is shown in fig-5.10 . Plant installation payback year are shown in fig-5.11 .

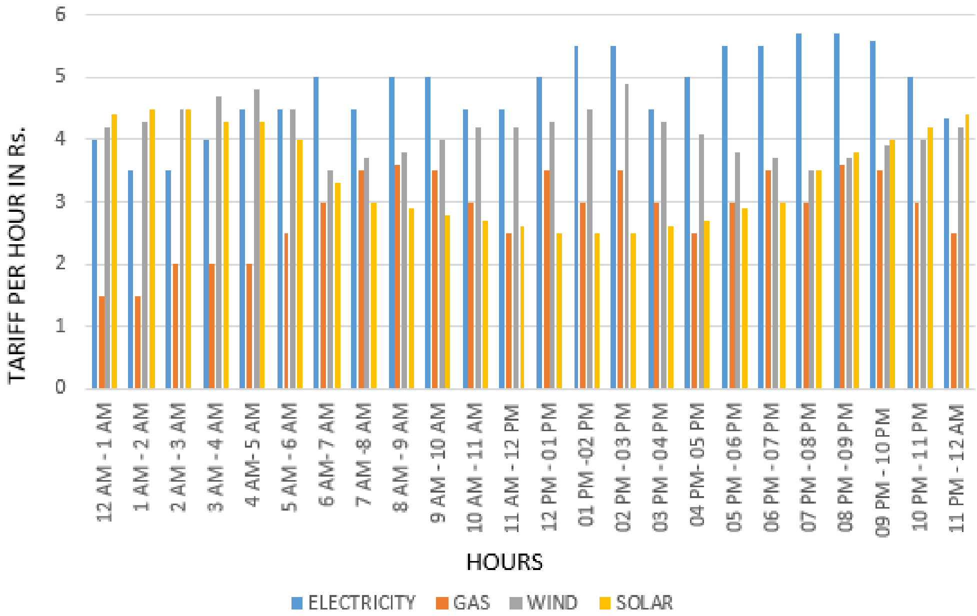

Figure 5.2: Different tariff rate during hours

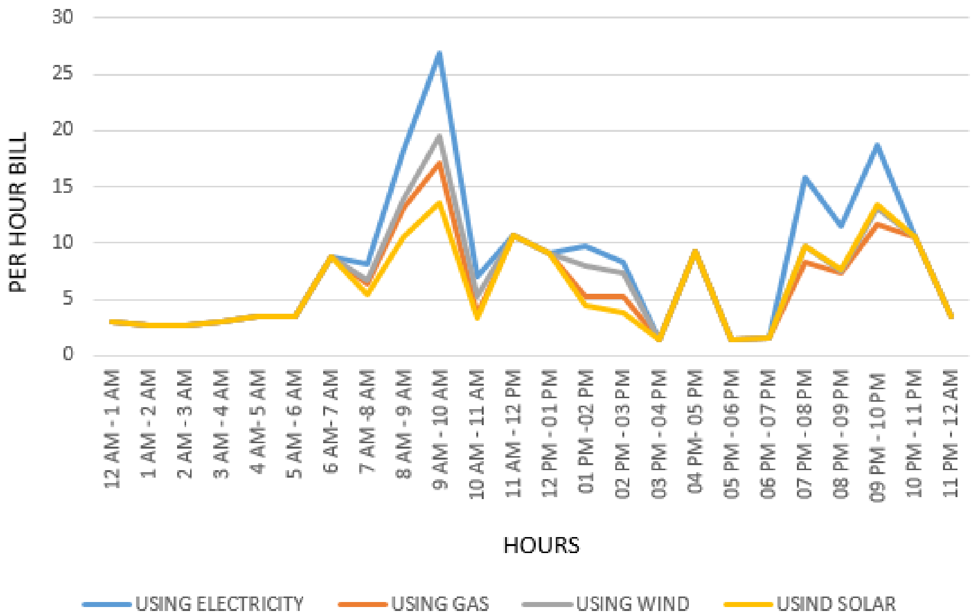

Figure 5.3: Per hour billing during level 1 DSM

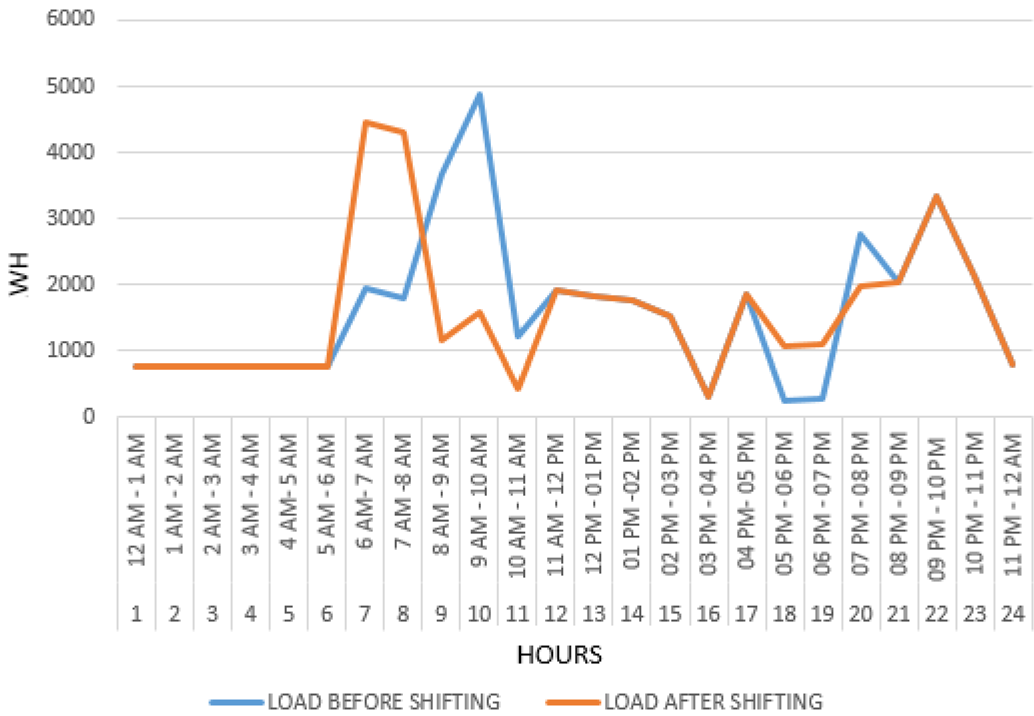

Figure 5.4: Load pattern during level 2 DSM

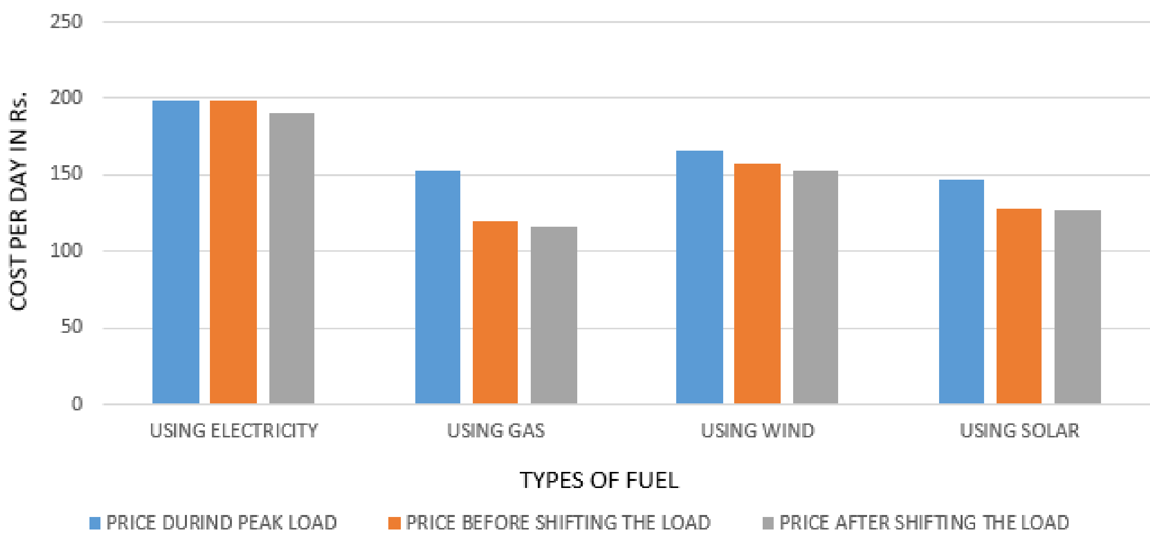

Figure 5.5: Cost per day

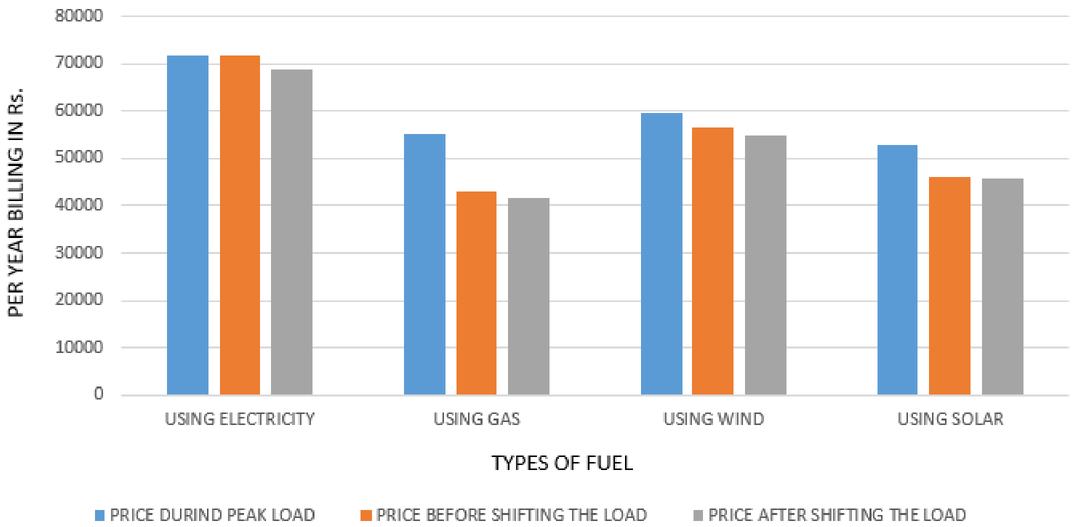

Figure 5.6: Per year bill

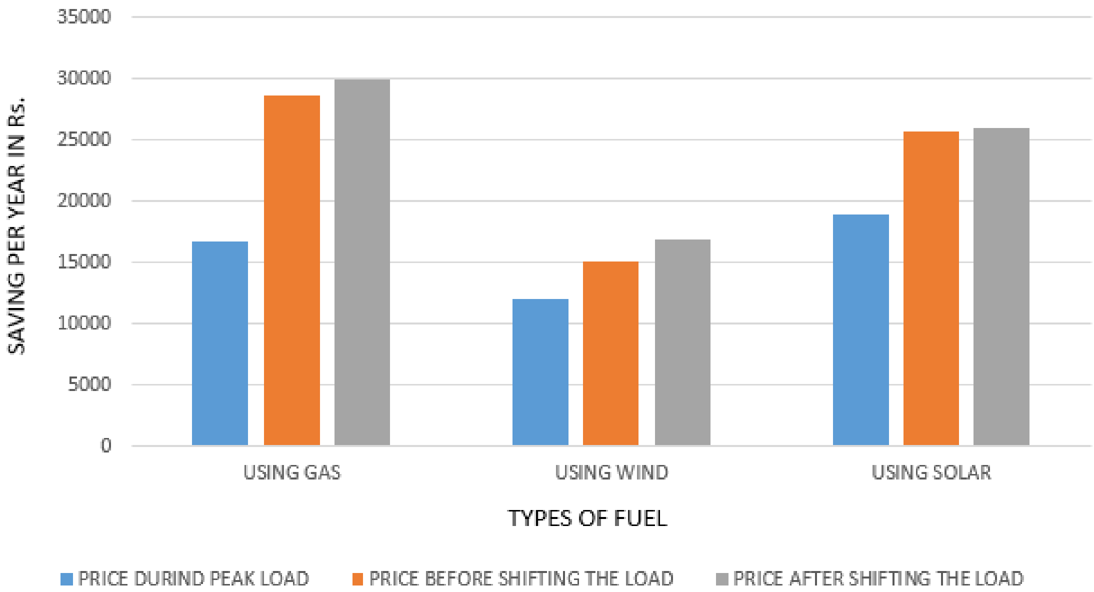

Figure 5.7: Saving while using the renewable

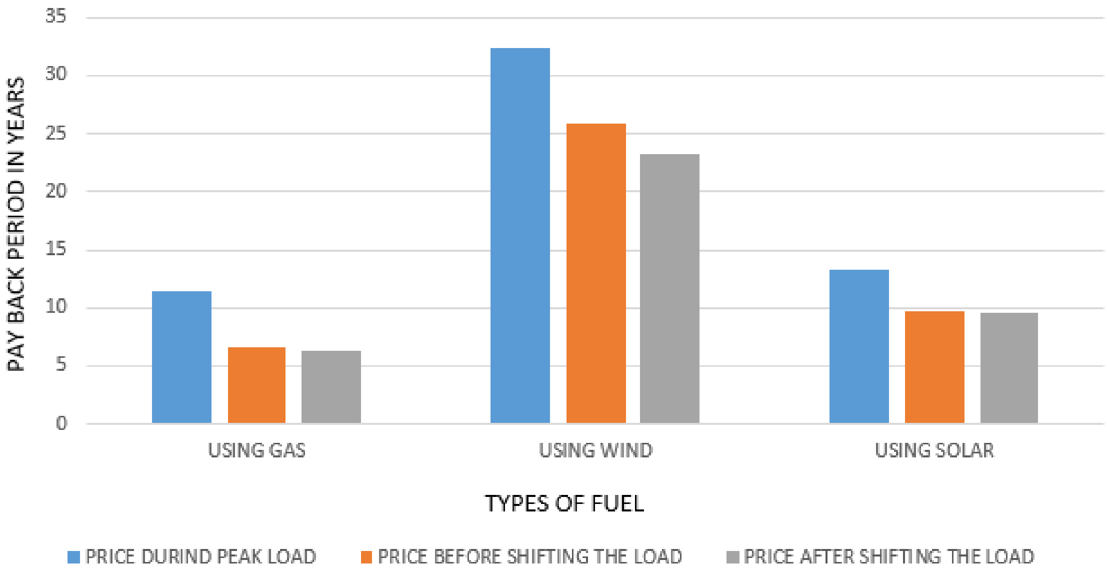

Figure 5.8: Payback years

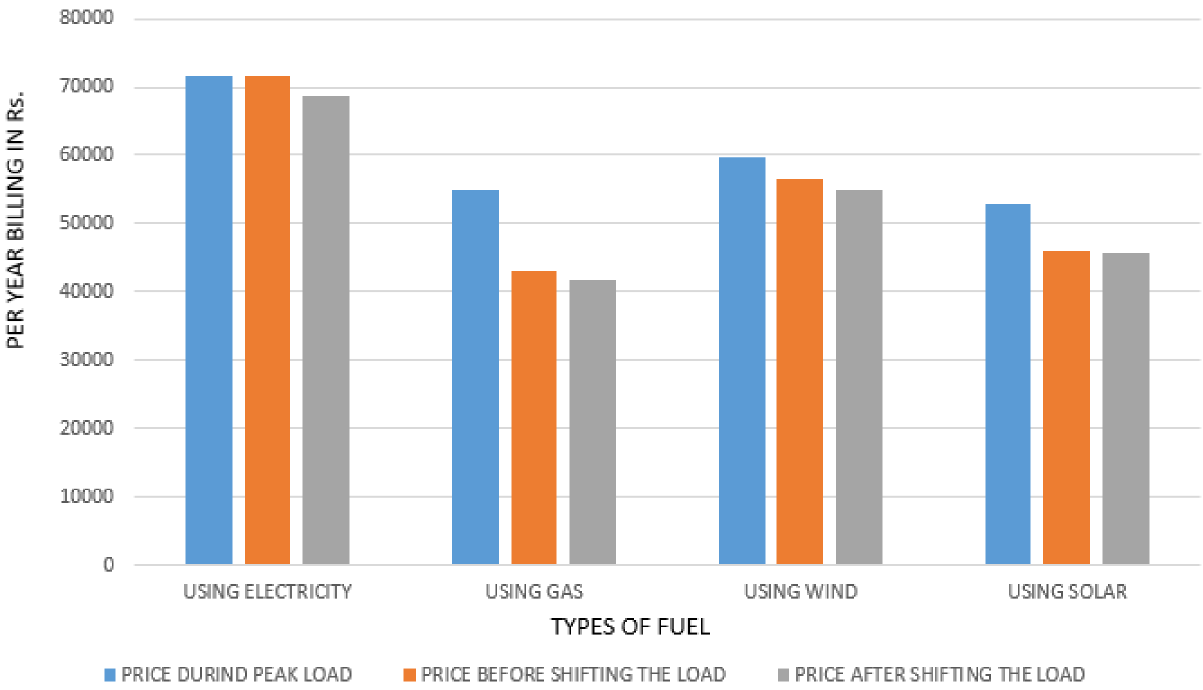

Figure 5.9: Per year bill while tariff rate is fixed

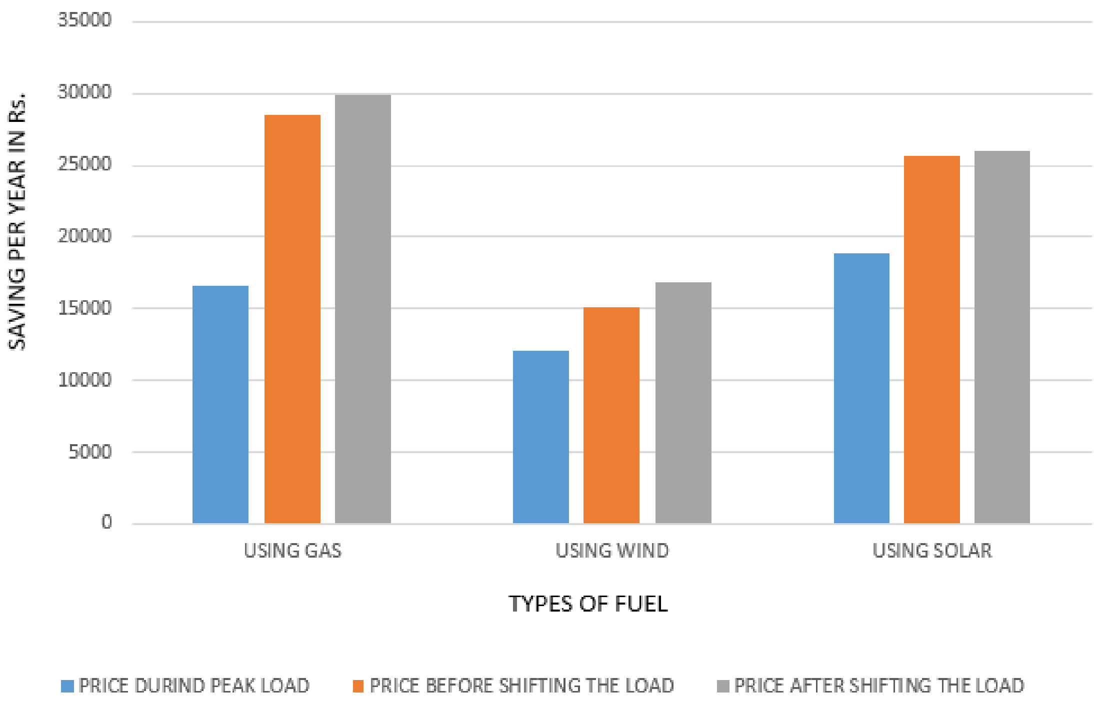

Figure 5.10: Saving while using the renewable for fixed tariff rate

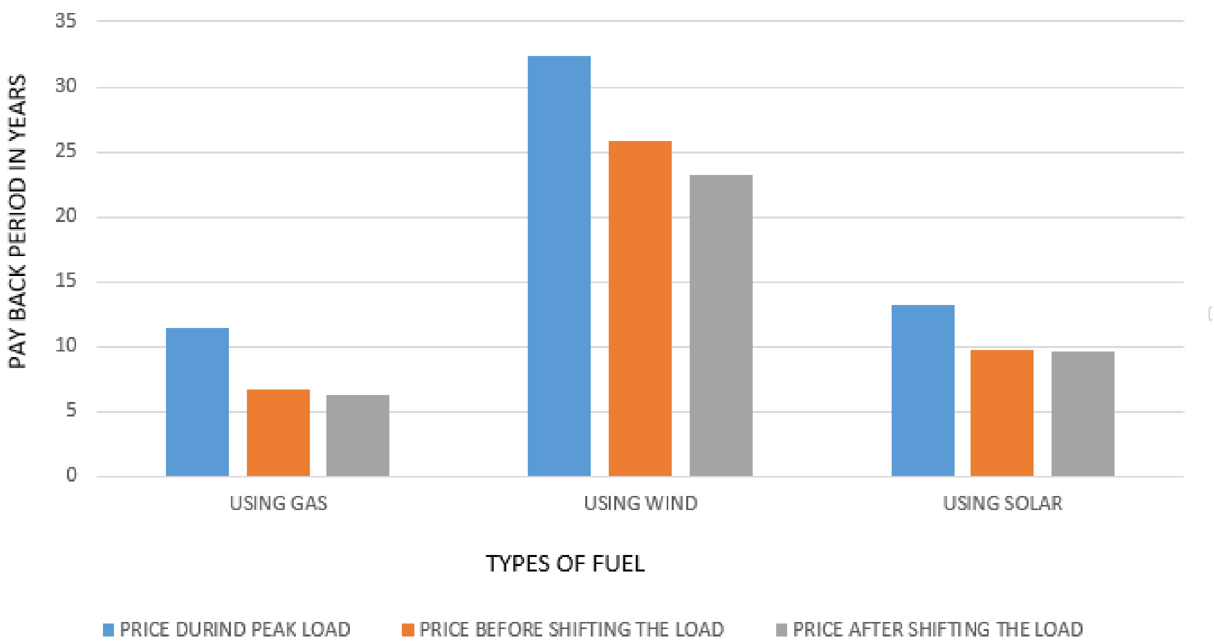

Figure 5.11: Payback years for fixed tariff rate

Chapter 6

Conclusion and future work

6.1 Conclusion

Energy hub is a device which contains the various energy carriers which are either convert energy or directly give to the load without any conversion. And various device are present in smart energy hub to maintain the energy consumption as well as stored in storage devices like PHEV, battery,etc .In non-renewable sources cost ratio is high to overcome this problems renewable sources are used in grid as well as in distribution generation. During peak hours energy consumption cost is too high so for that shift some controllable load in to off peak period to reduce the energy consumption cost and maintain the demand management.

Work represented in this report contains load scheduling for smart energy hub in a day.Various mode of demand side management are applied to the energy hub is equipped with micro CHP,solar and wind which is use as a alternate sources of energy while during peak hours to reduce energy cost and requirement of initial cost by utility without changing load demand pattern.For second stage of demand side management customer are assume to have flexible load which can be operate under given constrains there by reducing the cost of consumption and system peak considering time of use tariff as a tool for a demand response floated by utility.

6.2 Future work

The work to be carried out in future is proposed to have renewable energy sources with a maintenance cost and use of soft computing technique for optimization.Complaxity of problem will be increased while incorporating more interactive smart energy hub in the system for optimization problem.

References

[1] Aras sheikh, Mohammad Rayati, Shahab Bahrami and Ali Mohammad Ranjbar "Integrated Demand Side Management Game In Smart Energy Hub" March 2015.

[2] A. Sheikhi, A. M. Ranjbar, F. Safe, M. Mahmoodi "CHP Optimized Selection Methodology for an Energy Hub System"2011.

[3] Hazem M.Soliman and Alberto Leon-Farcia "Game Theoretic Demand Side Management With Storage Device for the Future Smart Grid"May 2014.

[4] Ali Shahmohammadi, Mohammad Moradi Dalvand, Mohammad Sadegh Ghazizadeh, Ahmad Salemnia "Energy Hubs Structural and Operational Linear Optimization With Energy Storage Elements".

[5] Emmanuel Manasseh, Shuichi Ohno, Toru Yamamoto, Aloys Mvuma "Autonomous Demand side Optimization with Load Uncertainty".

[6] Bo Chai, Jiming Chen, Senior Member, IEEE, Zaiyue Yang, Member, IEEE, and Yan Zhang,Senior Member,IEEE "Demand Response Management With Multiple Utility Companies: A Two-Level Game Approach"March 2014.

[7] A. Sheikhi, M. Rayati, S. Bahrami, A. M. Ranjbar "Demand Side Management in a group of Smart Energy Hubs as price anticipators; the game theoretical approach".

[8] Zahra Baharlouei, Student Member, IEEE, Massoud Hashemi, Member, IEEE, Hamed Narimani, Student Member, IEEE, and Hamed Mohsenian-Rad, Mem-

ber, IEEE "Achieving Optimality and Fairness in Autonomous Demand Response: Benchmarks and Billing Mechanisms.