GREEN CLOUD COMPUTING: A NEW APPROACH TO REDUCE ENERGY CONSUMPTION IN CLOUD DATA CENTER

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering

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APPROVAL

This Project/internship titled **'' GREEN CLOUD COMPUTING: A NEW APPROACH TO REDUCE ENERGY CONSUMPTION IN CLOUD DATA CENTER''**, submitted by Md. Asif Hossain Khan, ID No: 161-15-1011 and Md. Anhar Hossain Khan , ID No:161-15-1014 and Ranu Akther , ID No:161-15-1017 to the Department of Computer Science and Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of Bachelor of Science in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 26 November,2019.

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DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Md. Mahfujur Rahman, Lecturer, Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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ABSTRACT

In today's world cloud computing is most useful for every person who want to keep their data in a safe place and also want to access them from anywhere around the world .But the problem is data center needs huge amount of energy to run the server, for that reason huge amount of CO2 get produced by the Data centers. If we let this thing happen continuously then our world will face great disasters for climate changing. So, in this paper we proposed, how we could make green energy for reducing the amount of CO2 from the environment and the amount of energy consumption in the cloud data server. For reducing the amount of CO2, we proposed hybrid power plant that will significantly reduce the production of CO2. And for reducing the energy consumption in the data centers we use an Algorithm which will compress the original file and reduce the size of it .This reduction in file size will help us to process them in shorter period of time as a result, energy consumption will be reduced automatically because energy consumption is equivalent to the time period we use the device. Other methods like Virtual machine migration is also used in our proposed method. And for load balancing we used various Algorithm to compare them which one is best for reducing the energy consumption in the data centers. So, all of this method will help us to reduce the production of CO2 and also the energy consumption in the data centers.

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List of abbreviation

VM	Virtual Machine

CHAPTER 1

INTRODUCTION

1.1 Introduction

This is the era of modern science and technology. Cloud data center are one of the great inventions of modern science and technology for storing data and keep them in a secure place and also access them anytime from anywhere. In today's world use of data centers are increasing day by day and in future it will increase more. The main problem regarding data centers is the energy consumption. Because data center needs lots of energy as it has to be turned on all day long. For the source of energy most of the data center around the world are using coal, fossil fuel or oil power plant for maintaining their needs of energy. But the problem is, this methods of producing energy also produce harmful elements to our environment such as CO2 which is causing serious problem to our environment. Because in today's world climate change is a common problem and for that, every country have to face serious natural disaster every year and one of the biggest reasons of this problem is, increasing huge amount of CO2 in our environment. we need to take necessary steps so that we could reduce the amount of CO2 production in our environment as soon as possible. If we do not do that, then it will pause a big question mark on the existence of the human being. In a data center energy needed for various reason such as powering up the computers, cooling the machineries, operating the systems etc. It is not possible to measure exact amount of energy that is needed for a data center because it depends on different factors such as load capacity, size of data center, processing of data etc. Now a days, it has become very important to reduce the amount of energy consumed by the data centers using various methods and also how to make more and more green energy so that our environment does not get affected by the harmful elements.

1.2 Motivation

For greening the energy, the use of renewable energy sources is increasing day by day such as solar panel, hydro power plant, wind turbines etc. And for reducing the amount of energy consumption, different techniques and algorithms are getting introduced which are very helpful to solve this problem. So, in this paper we will discuss, how we could use the renewable energy sources to produces more green energy and also some techniques that will help us to reduce energy consumption in the data centers.

1.3 Objective

- To reduce the energy consumption consumed by the cloud data server.
- To reduce the timing of data transition.
- To reduce the carbon footprint from the environment.
- To reduce the amount of heat generated by the cloud server.

1.4 Expected Outcome

- The energy consumption by the cloud data server can be minimized.
- Excess emission of carbon footprint can be reduced from the environment by renewable sources.
- A Environment friendly cloud data server can be implemented.

1.5 Thesis Orientation

In the overall thesis, Chapter 2 Literature Review, Chapter 3 Proposed Systems, Chapter 4 Results, Chapter 5 Discussion, Chapter 6 Conclusions.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In today's world reducing energy consumption in data center is a big challenge & doing that in a ecofriendly way is another big challenge. Because data centers consume huge amount of energy. Only one server which has 42 racks consume 500 to 1200 watts/hour according to their load requirement [14].Another study shows that the data centers in U.S consume more than 90 billion Kw/hours of electricity per year which require almost 34 giant coal-powered plants which can produce 500 megawatts the source of producing this amount of electricity and the ways of producing it, are causing serious disaster to our environment [15].Because the basic idea of producing the electricity is burning the fossil fuel or using the coal power plant .This methods of electricity production produce amount of co2, As a result of which we are facing the global

warming .A review monthly google search generate 2,60,000 kg co2 and it requires 39,00,000 kwh energy which can easily show us how fast co2 are increasing through data centers around the world [1].If we let this things happening in the same way, one day this world will be no longer suitable for the living being.it can also make a big question mark on the existing of the human kinds .That is why we need to take necessary steps for doing the energy sources ecofriendly as soon as possible.

2.2 Renewable Sources

There are various methods have been proposed to produce the energy by using the renewable energy sources such as solar power plant, hydro power plant and wind power plant. Here is a pie chart which will show the amount of energy produced in 2017 using various methods in percentage and also the amount of energy which had produced from renewable energy sources.

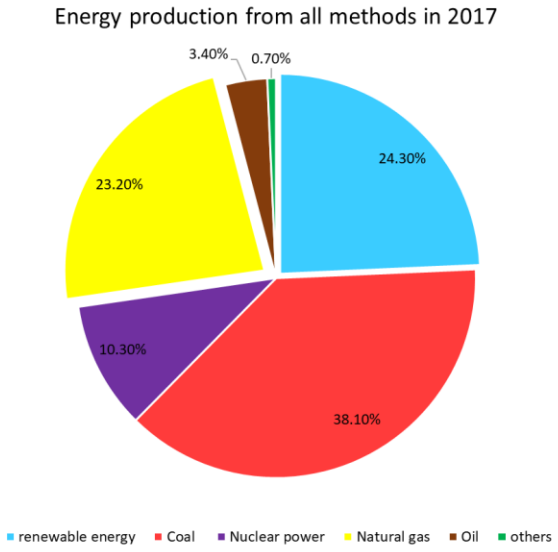


Figure 2.2.1: Energy produce in 2017 using various methods[8]

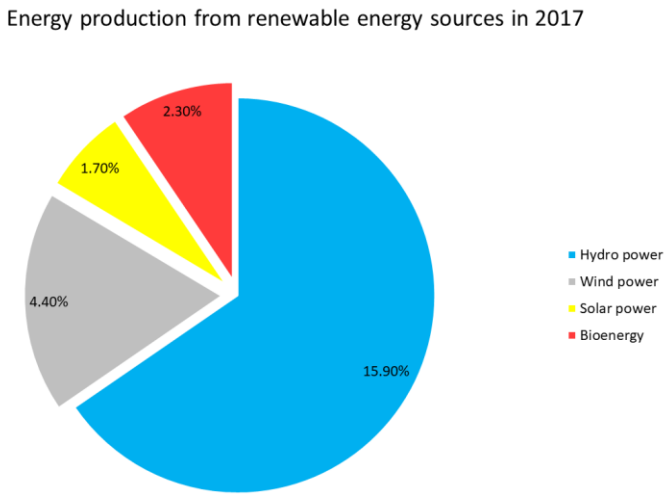


Figure 2.2.2: Energy produce in 2017 using only renewable energy sources. [8]

2.2.1 Solar Power

In this era of modern science and technology innovation of solar panel is a blessing of all time because here we use the sun power to generate energy which is totally eco-friendly. From the innovation of solar panel till now it is getting updated .The latest solar panels which we have in the market is 22.8% efficient where as previously maximum efficiency of as panel was 15% to 17%[16].According to a recent study a 250watts solar panel can produce 1 kwh (1000w) of energy per day if we keep the panel at least 4 hours in the full sun[17].In 2018 latest solar panel have been invented which was a capacity of watts .It can produce more energy than other solar panel available in the market .The average energy produced by a 400 watts solar panel per year is 564 kwh[16].But the energy produce by the panel depends on the condition of the weather.so we have to choose the place which has more sun coverage around the world such as New-Zealand ,Ecuador ,Argentina , Australia ,Bolivia etc. .In the less sunny area we can also use solar panel but production energy will varies from time to time ,so we always have to have a backup energy source while we are using solar panel. Here is a statistics of Global capacity of solar power production from past few years.

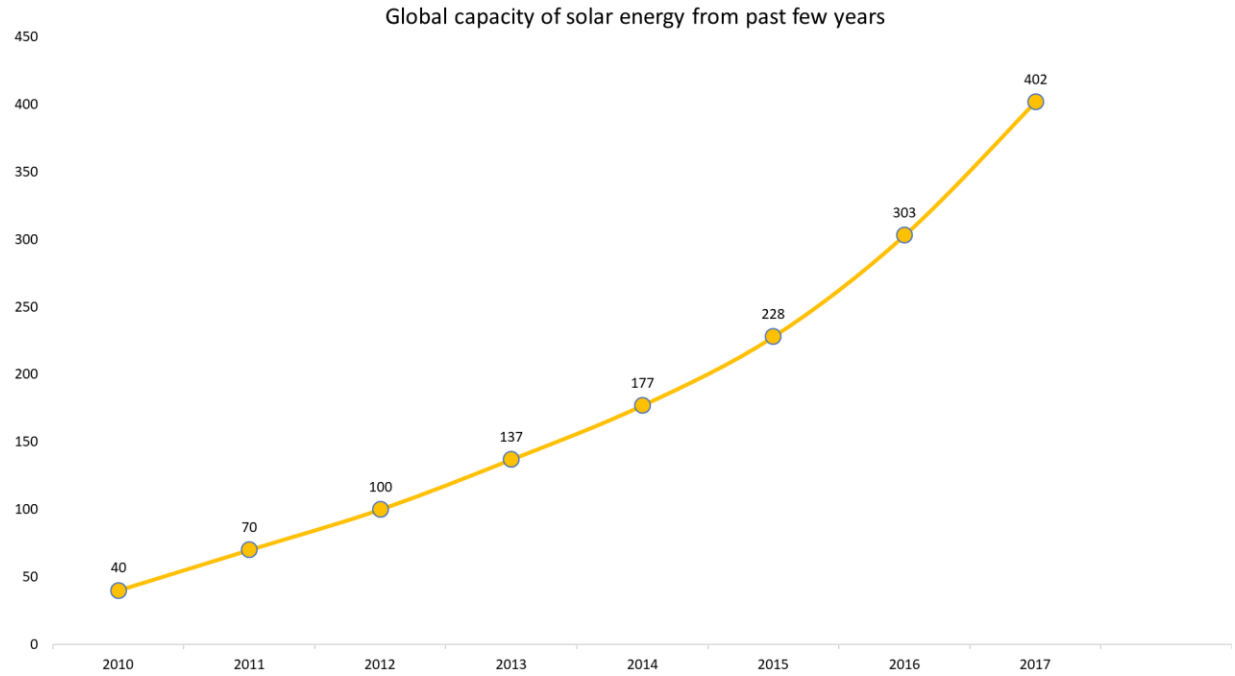


Figure 2.2.1.1: Global capacity of solar energy from 2010 to 2017.[9]

2.2.2 Hydro Power

Another great renewable sources is hydro power .In this power plant basically we use the kinetic energy of water to produce electricity or energy .In today's world hydro power is the largest renewable energy source .During fast few decades electricity production from hydro power had increased strongly .According to the hydro power report 2018, 4185 twh energy was produced from hydropower in 2017.In 2018 another record has been made by producing 4200 twh energy .China has largest capacity production from this hydro power plant which is 8540 megawatts .Other countries such as Brazil ,Pakistan ,Turkey ,Tajikistan ,Angola are also producing enough energy 3866 mw ,2487 mw ,1085 mw ,605mw ,668mw respectively from hydro powerplant yearly .Brazil has now got the position as 2nd producer of hydro energy after china and also had overtaken the US .Here we can see some statistics about the production of hydro energy from the year 2014.

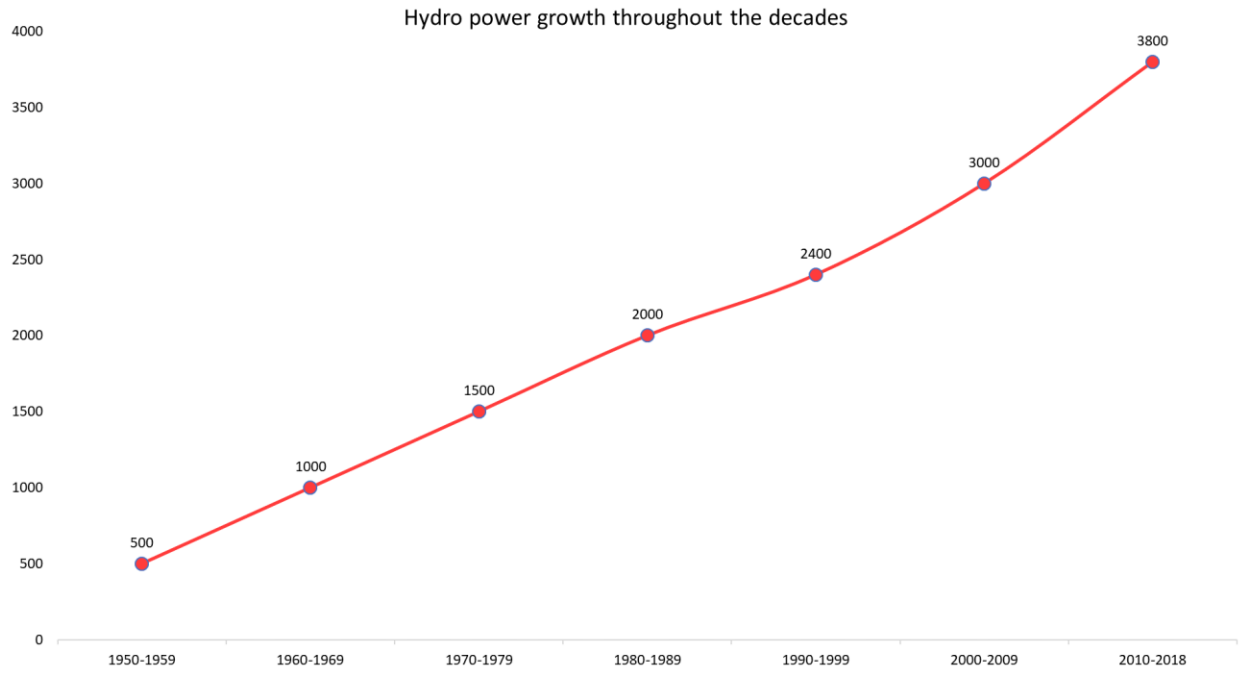


Figure 2.2.2.2: Graphical representation of Hydro power growth throughout the decades.

Hydro power generation plants are ecofriendly and there are basically three types of it:

- 1.The flow of the River; in which we use the flow of river to produce electricity.
- 2.reservoir; in which we store the water in a tank and produced electricity by releasing the stored water.
- 3.pumped storage; in which we stored back the water again once it used.

So from these above power generating methods we can use pumped storage powerplant for our data server .But the problem is from pumped storage system we do not produce electricity all the time .we only produce energy from it when we need to balance the load of our grid .The reason behind that is, this pumped storage method use two storage tank ; one at the top from where water get released to produce energy through a pipe and the second reservoir reserve the water .When the water from first reservoir got finished then we pumped back the water from second reservoir to the first one .But the challenge is to get continuous supply of electricity from this pumped hydro power plant .So, for that reason we have made a model of this power plant through which we can get continuous flow of energy.

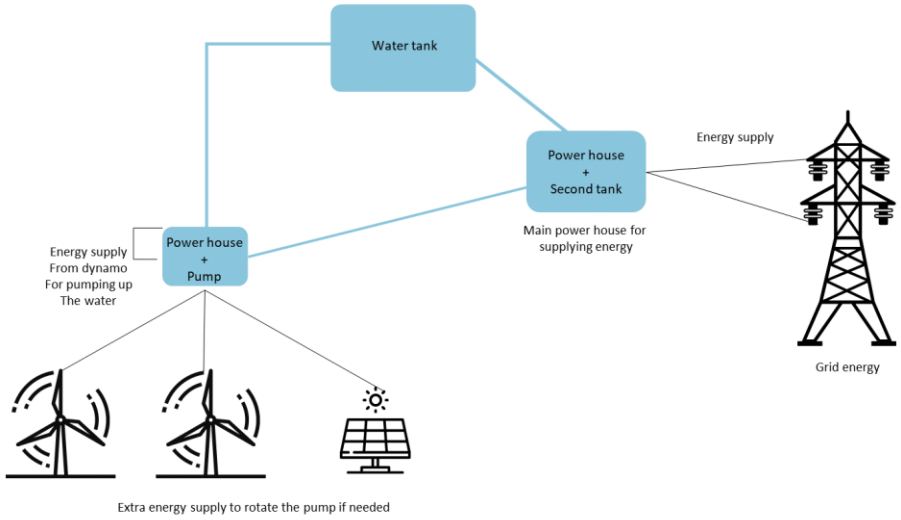


Figure 2.2.2.3: Hydro power plant model for continues power supply

2.2.3 Wind Power

In today's world wind power plant also getting much popularity .It is the fastest growing energy source around the world because this energy source is expended over 25% to 35% globally [2].Every year wind power capacity is increasing worldwide .It's capacity reaches 597 GW in 2018[11]. From a report of 2018, the number of turbine that had been installed from generating energy from wind could cover near to 6% of the global electricity demands .so ,it actually producing a large amount of energy in a eco -friendly way.

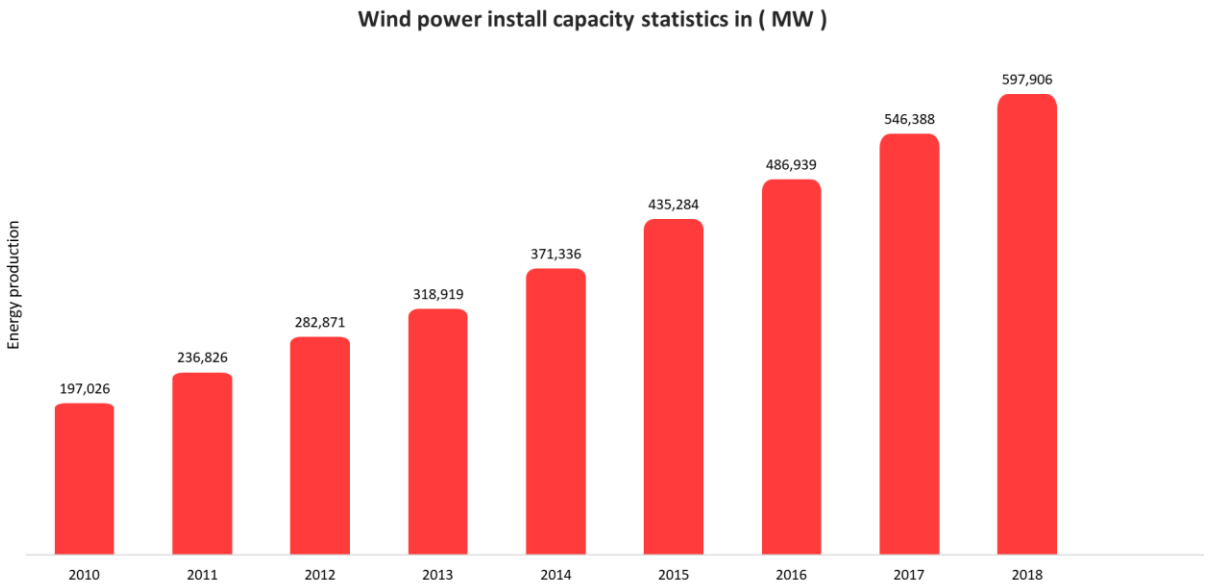


Figure 2.2.3.1: Graphical representation of wind power installation capacity from past few years.[10]

From the above statistics we can easily understand that wind power can give us large amount of energy without producing any carbon-di-oxide to our environment.

2.3 Nano Data Centers

Every year for the increase growth of data and to store them in a safe and secured way data centers have been increasing day by day .This largest amount data need largest amount of servers to contain them .As a result of which the size of data centers are also increasing .But there are some negative of a largest data center .In larger data center more cooling equipment is needed for chilling the equipment s and for covering the larger area it take more energy for the cooling machines for reaching the desired temperature .It also makes complex connection between servers using the wires .But if the size of the data center is not big and if it is a nano data center then it will have some great advantages ,such as it will not get too much hot inside the room because of little amount of server which will significantly reduce the energy consumption in a data centers .The basic idea behind the nano data is to create a distributed tiny server which is located at the edges of the network . Nano Data can also reduce the energy consumption through traffic localization [4].So , nano data is also a great idea for reducing the energy consumption in the data center ;because it has been said that it can save at least 20 % to 30 % of the energy rather then the data center we have now .

2.4 Wireless Connection

In data centers connection between server to server is made using wires .As a result of which where we see a server this is also exist a connection of huge amount of wires .This wire connection leads to a complexity to set up of the server room as well as increase the energy consumption because of the resistances in the wire .This connections of wire also hamper the cooling systems by disturbing the flow of chilled air .This problem can be solved by using or establishing wireless communication in the server .For that we can use 60 GHZ wireless server to server links to build communication between the servers [3].In data centers connection using wires increase its complexity for maintaining it .It also take more space for the wires too .In general copper optical fiber wire is used to established the connection in a server room of a data centers .The resistance in wires hampers the passing of electricity .But if we could stablished a wireless links to communicate between the servers then it could help us to reduce a significant portion of energy consumption in data centers also the other complexity that has been created because of huge amount of wires .

2.5 Cooling

From many years different types of cooling methods have been used in data centers for chilling their machineries. But this method consumes huge amount of energy. In a data center the amount of electricity consumption only for cooling purpose is up to 40% of its total ideal energy consumption [5].Every year the number of data centers is increasing .That is why more energy is needed to run the data centers and to chill them down .Because balancing the temperature inside a data center is an important issue . A data centers temperature should not exceed 82 degree F and that is the minimum level of it [19].But a good range of maintaining the temperature is between 68 to 71 degree F .So it is very important to keep the temperature in a suitable range .It is difficult to maintain this temperature with just small amount of equipment because in a data the number of server cloud be huge. That's why more power is needed to chill them. There are many methods such as Air-conditioner, water-cooling, Indirect air evaporative cooling System [12].These methods need more energy to do their job, as a result of which more energy consumption is happening in the data centers.

CHAPTER 3

PROPOSED SYSTEM

3.1 Introduction

As we are doing our research to produce green energy and to reduce energy consumption in the cloud data servers, we are proposing a full model of cloud data server with green energy production. In this model we have proposed a hybrid power plant which will produce green energy and significantly reduce CO2 production from our environment. Here the users will send compressed version of their files and the data centers will optimally handle them with the help of VM (virtual migration). In this process we have used different types of algorithms for VM and Huffman coding algorithm for data compression. This technique will reduce the time of our data processing and handle them optimally. For that reason, a significant amount of energy will be saved.

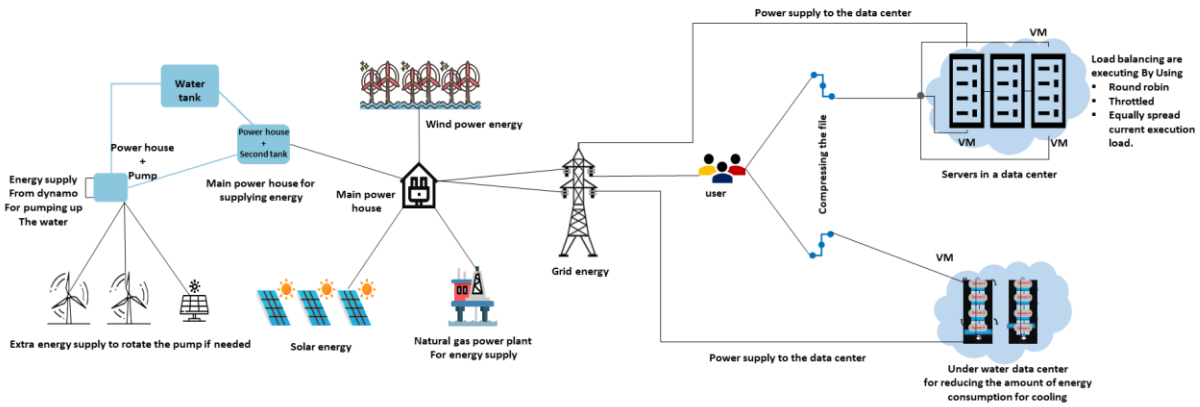


Figure : Energy and carbon efficient cloud data center model.

3.2 Proposed hybrid power plant

In data center supply of electricity must be continuous to make the server turn on all the time, for that reason a large amount of electricity is needed for a data center. Electricity does not needed only for turning on the servers , it also needed for cooling the data center and also for operating it.

So , a large number of electricity production is needed for maintain the power supply .but in today's world this much of energy is producing from coal power plant and by burning fossil fuel for that reason a large number of co2 get produces every minute in our environment. As a result of which we are facing so much problems and related to our environment .so , we used to make this production of energy are friendly and green as much as possible not only for the environment but also for the mankind that is why we proposed a hydride powerplant so that we cloud produce as much energy as possible in a ecofriendly way.

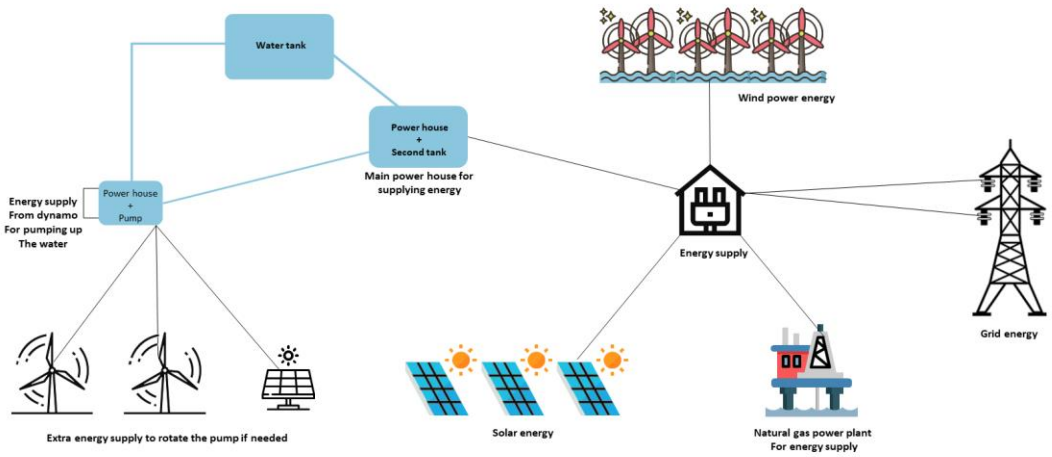


Figure 3.2.1: Proposed Hybrid Power Plant model for continuous green energy supply

From the above hydride power plant if we cloud produce 30% of energy from produced hydro power plant and 15% energy from wind power plant and 10% energy from solar power plant then we cloud get at least 55% of energy from totally a renewable and eco-friendly energy source. As a result of which the production of carbon di oxide will be (0%) .But it cloud be very from time to time that's why we need a regular energy source such as coal or fossil fuel for giving the backing when it is needed .But if it is possible to make a different power plant for a large data using hydro ,solar and wind then it cloud be possible to make the data center run using 100% renewable energy .For that a large number of investment is needed for one time but in future it will show us the benefits of using it by reducing the amount of CO2 from our environment. Below is a chart, which will clearly show us the emission of CO2 from the current methods of electricity production and from our proposed hybrid power plant [13].

Materials	CO2 production in per KWH energy
Coal	950 gm
Gas	350 gm
Nuclear	6 gm
Oil	778 gm
Total	**2084 gm**

Table 3.2.2: Current Methods

Materials	CO2 production in per KWH energy	
Solar	60 to 150 gm	150 gm (maximum)
Wind	3 to 22 gm	22 gm (maximum)
Hydro	4 gm	4 gm
Gas	350 gm	350 gm
Total		526 gm

Table 3.2.3: Proposed Methods

Here the above comparison clearly shows that the total amount of CO2 emitted from the proposed model is significantly lower than the current method. This power plant will help us to keep the balance of CO2 in our environment and also help us to control the emission of greenhouse gases.

3.3 Compressing Data

For a user it is very necessary step when a person is using the service of a data center. Consumer mainly put their data into the server so that they could get access of those data from anywhere and anytime. But for keeping their data into the server they need to upload their files into the server. File sizes varies from person to person. When any person streaming data to the server the average power consumption per GB data consume 5.12 kwh of energy[6]. So, from this statistic it is clear that large file size consumes more energy than the smaller one. That is why for uploading or downloading any files if it is possible to compress the file then it must be a needed thing to do. Suppose a 1 GB file could be make as 900 mb file then at least some amount of energy could be saved through data transforming system as it will reduce the time of processing the data .But it should be done in a way so that the original data does not lost its content .Here for this compression

method any good data compressing algorithm such as Huffman coding which is known as loss less data compression technique could be used .Another approach is the data which has not been used from long times and not so important as it was not checked by the user for long time such as different types of groups ,mails, files ,news, others unnecessary things could be compressed into the server so that the storage could be saved and also the servers after compressing the data could be turned off. Because the idea behind this method is ,there are so many server with so many digital waste that is not necessary, it should be handle with intelligence so that energy consumption could be saved .If this technique could be applied in a proper way it could be possible to save huge amount of energy from the data centers .Then the other things such as speed of the internet ,the connection of the network should be strong so that it could take lesser time to upload and download any data from the user and server respectively ,then it will also help to reduce the consumption of energy by ensuring the activation time of the server and the network providers. Here is a list of some files size before and after compression using Huffman coding algorithm from research article [7].

File name	File size in bytes before compression	File size in bytes after compression
Book1	111261	72936
Book2	768771	440041
Book3	610856	369216
Book4	102400	73394
Book5	377109	246793
Book6	246814	195180

Table 3.3.1

Here, 1000000 bytes of data which is streaming to the server needs 0.005 KWH energy on an average [6].

File name	File size in bytes Before compression	Energy consumed according to the file size
Book1	111261	0.00056 KWH
Book2	768771	0.0038 KWH
Book3	610856	0.00305 KWH
Book4	102400	0.00051 KWH
Book5	377109	0.0019 KWH
Book6	246814	0.0012 KWH

Table 3.3.2

the above table 3.3.2 shows the amount of energy needed to streaming the respective data according to their actual byte sizes before compression of data.

File name	File size in bytes after compression	Energy consumed according to the file size
Book1	72936	0.00037 KWH
Book2	440041	0.0022 KWH
Book3	369216	0.0018 KWH
Book4	73394	0.00037 KWH
Book5	246793	0.00123 KWH
Book6	195180	0.00098 KWH

Table 3.3.3

the above table 3 shows the amount of energy needed to streaming the respective data according to their byte sizes after compression of data.

From the above table 3.3.2 and table 3.3.3 we can see that in table 3.3.2 the total amount of data before compressing is 2217111 byte and the energy consumed by the server for this data is 0.01102 KWH. From table 3 the total amount of data after compressing is 1397560 byte and the energy consumed by the server for this data is 0.00695 KWH. Here it is clearly shows that after compressing the data less energy will consume by the server as the file size get compressed.

3.4 Using virtual migration:

Virtual migration is a popular method for reducing energy consumption in data centers. In data center virtualization helps to running multiple operating system parallelly on a single system. Actually, VM helps one system to do multiple jobs optimally .VM allocation and migration help to reduce energy consumption in data centers [1]. There are many algorithms have been proposed to perform virtual migration optimally such as Round Robin, Throttled, equally spread current execution load. For calculating how efficient the use of VM in cloud data server, we will use a simulator called Cloud Analyst. From the simulation result we will find the processing time of the data server. From that processing time we will easily find the energy needed for processing the data. Here we will use above 3 Algorithm for finding the most energy efficient algorithm for doing this job. Here we calculate the processing energy of data center by using their corresponding average processing time. So, the rule for that calculation of energy is:

$$E = p\ t$$

Here, p = power required to process the data per hour

t = time to process the data in hour

Here we need a parameter (p) for calculating the energy. As data center actual energy required is not possible to measure exactly because the energy consumption varies from time to time for the size of the data, load of the data center, equipment used in the data center etc. That's why we will consider 1000 KW energy is required to process the data per hour. So, we will consider p= 1000 kwh for the calculation of the energy.

3.5 Proposed Cooling Model

For solving this Cooling problem, we want to propose a model of underwater data server which cloud significantly reduce the problem of this energy consumption.

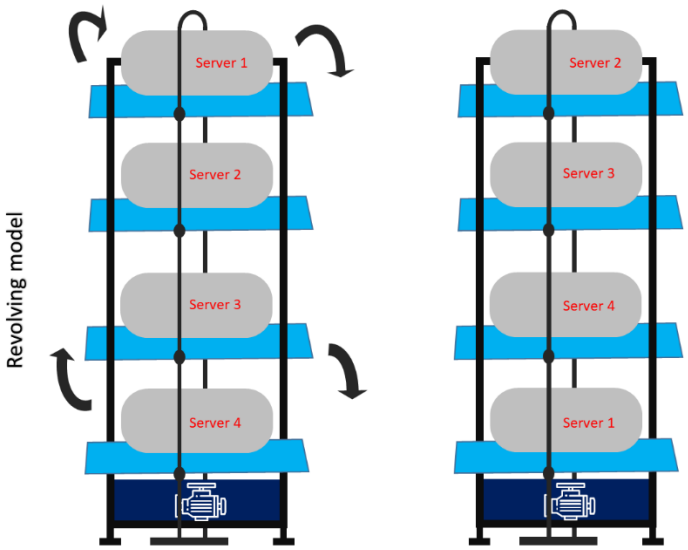


Figure 3.5.1: Proposed Under Water Server model

The idea behind this model is, under the sea water the temperature is 2 degree Celsius (28.4 degree F) at high tirade according to [20] and which we go more deeper inside the ocean it got more cooler then upper level. But in data center we need to maintain a balanced temperature which is between 68 to 71 degree. So that's why this model cloud help to keep the balance temperature . The main advantage of this model is this model could revolve from top to bottom which could take the server to their necessary portion of the water for maintaining their designed temperature water is a great source of heat remover. It could take heat so fast for chilling anything. so, that is why we propose this model for data server for their cooling system. Because if this method could use in data center it could reduce huge energy consumption which is unimaginable.

CHAPTER 4

RESULTS

4.1 Introduction

From the simulation result we will calculate the energy needed for the data server for processing the data. After that we will include all the information in table for showing the comparison among different algorithm and also represent that into a graphical form for better understanding of this data.

4.2 Simulation result using Round robin algorithm before compression of data:

Results of the Simulation Completed at: 24/11/2019 08:08:48

Overall Response Time Summary

	Avg (ms)	Min (ms)	Max (ms)
Overall response time:	15512.76	597.30	49376.63
Data Center processing time:	938.51	20.40	1563.50

Here, the energy required before compression using with VM is**,** E = p t

Here, average processing time of data center = 938.51 ms = 0.000261 h

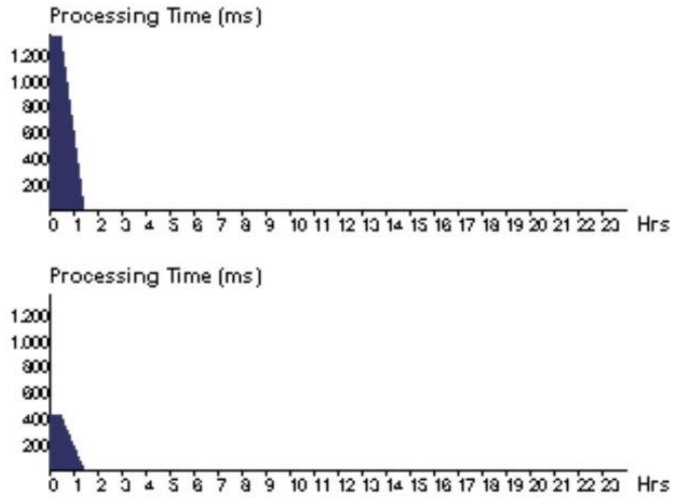
E = 1000*0.000261 = 0.261 KW

Data Center Request Servicing Times

Data Center	Avg (ms)	Min (ms)	Max (ms)
DC1	1358.31	123.92	1563.50
DC2	435.48	20.40	1000.96

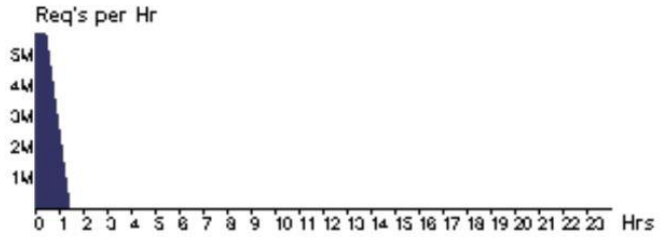
Data Center Hourly Average Processing Times

DC1
DC2

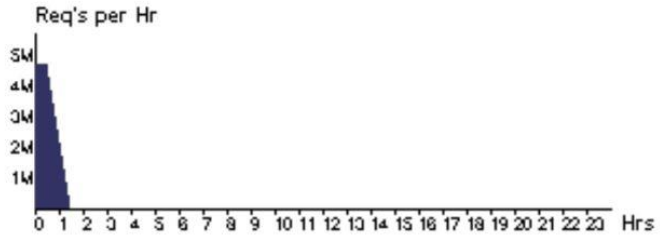


Data Center Hourly Loading

DC1



DC2



4.3 Simulation result using Round robin algorithm after compression of data:

Results of the Simulation Completed at: 24/11/2019 08:19:57

Overall Response Time Summary

	Avg (ms)	Min (ms)	Max (ms)
Overall response time:	10931.67	172.90	32473.39
Data Center processing time:	912.02	21.09	1563.49

Here, the energy required before compression using with VM is**,** E = p t

Here, average processing time of data center = 912.02 ms = 0.000253 h

E = 1000*0.000253 = 0.235 KW

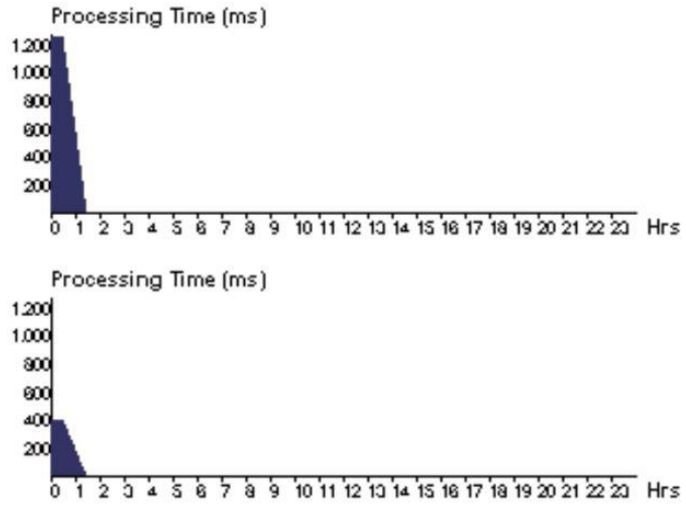
Data Center Request Servicing Times

Data Center	Avg (ms)	Min (ms)	Max (ms)
DC1	1264.87	123.82	1563.49
DC2	407.42	21.09	1500.52

Data Center Hourly Average Processing Times

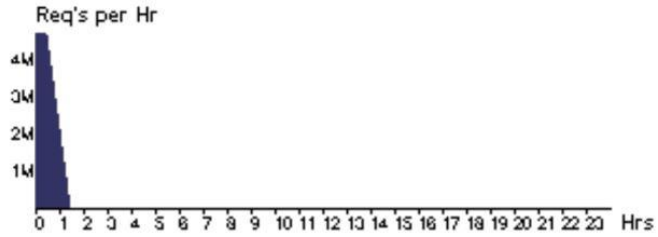
DC1

DC2

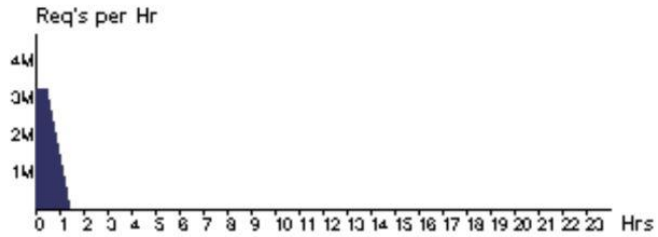


Data Center Hourly Loading

DC1



DC2



4.4 Simulation result using Throttled algorithm before compression of data:

Results of the Simulation Completed at: 24/11/2019 08:23:16

Overall Response Time Summary

	Avg (ms)	Min (ms)	Max (ms)
Overall response time:	15239.72	271.14	49376.63
Data Center processing time:	837.57	20.23	1563.49

Here, the energy required before compression using with VM is**,** E = p t

Here, average processing time of data center = 837.57 ms = 0.000238 h

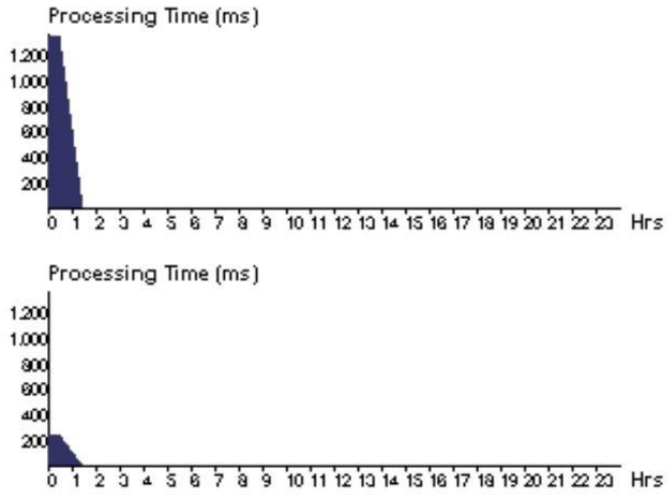
E = 1000*0.000238 = 0.238 KW

Data Center Request Servicing Times

Data Center	Avg (ms)	Min (ms)	Max (ms)
DC1	1370.05	126.96	1563.49
DC2	249.64	20.23	729.35

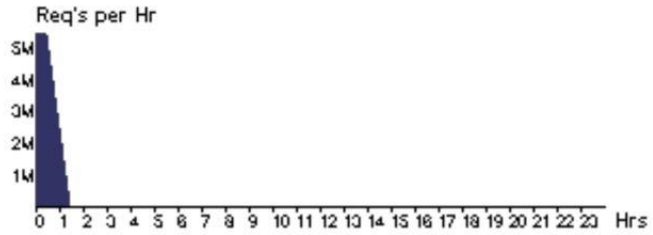
Data Center Hourly Average Processing Times

DC1
DC2

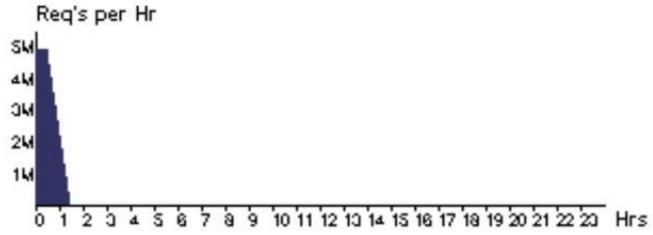


Data Center Hourly Loading

DC1



DC2



4.5 Simulation result using throttled algorithm after compression of data:

Results of the Simulation Completed at: 24/11/2019 08:26:12

Overall Response Time Summary

	Avg (ms)	Min (ms)	Max (ms)
Overall response time:	11215.76	291.20	32473.39
Data Center processing time:	853.22	20.63	1735.54

Here, the energy required before compression using with VM is**,** E = p t

Here, average processing time of data center = 853.22 ms = 0.000237 h

E = 1000*0.000237 = 0.237 KW

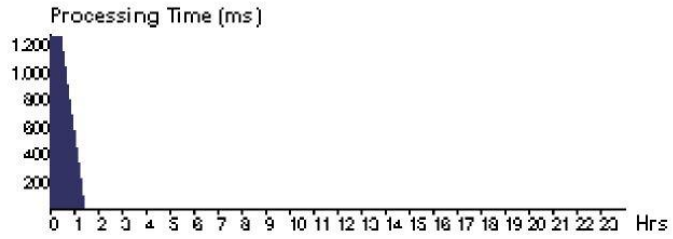
Data Center Request Servicing Times

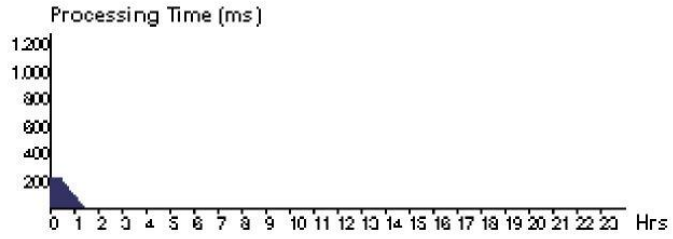
Data Center	Avg (ms)	Min (ms)	Max (ms)
DC1	1272.91	123.82	1735.54
DC2	225.55	20.63	673.13

Data Center Hourly Average Processing Times

DC1

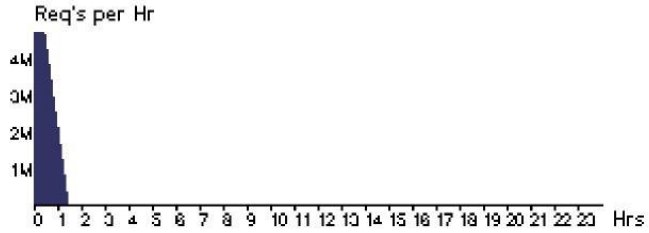
DC2



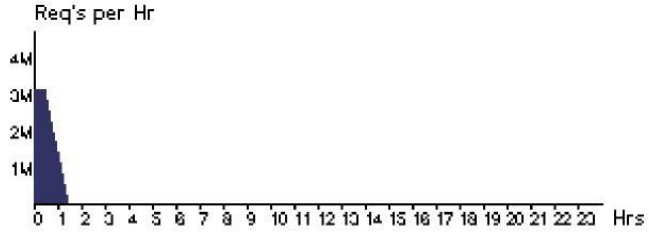


Data center hourly loading

DC1



DC2



4.6 Simulation result using equally spread current execution load algorithm before compression of data:

Results of the Simulation Completed at: 24/11/2019 08:30:10

Overall Response Time Summary

	Avg (ms)	Min (ms)	Max (ms)
Overall response time:	15284.55	597.30	48715.76
Data Center processing time:	936.56	20.84	1563.50

Here, the energy required before compression using with VM is**,** E = p t

Here, average processing time of data center = 936.56 ms = 0.000260 h

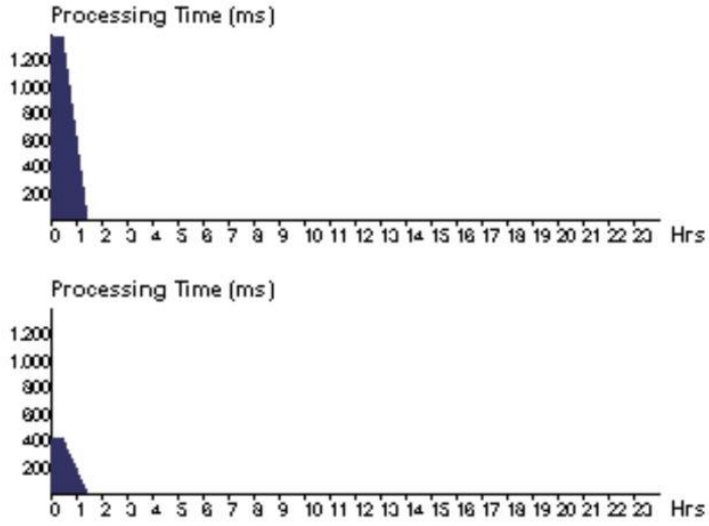
E = 1000*0.000260 = 0.260 KW

Data Center Request Servicing Times

Data Center	Avg (ms)	Min (ms)	Max (ms)
DC1	1381.48	123.92	1563.50
DC2	421.89	20.84	1000.62

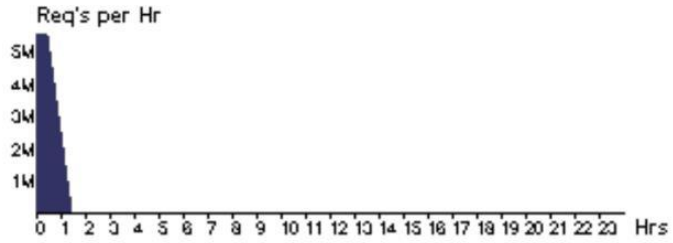
Data Center Hourly Average Processing Times

DC1
DC2

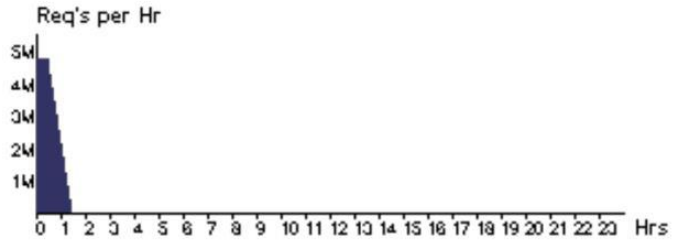


Data Center Hourly Loading

DC1



DC2



4.7 Simulation result using equally spread current execution load algorithm after compression of data:

Results of the Simulation Completed at: 24/11/2019 08:33:09

Overall Response Time Summary

	Avg (ms)	Min (ms)	Max (ms)
Overall response time:	10955.91	354.91	32473.39
Data Center processing time:	902.60	20.63	1563.50

Here, the energy required before compression using with VM is**,** E = p t

Here, average processing time of data center = 902.60 ms = 0.000251 h

E = 1000*0.000251 = 0.251 KW

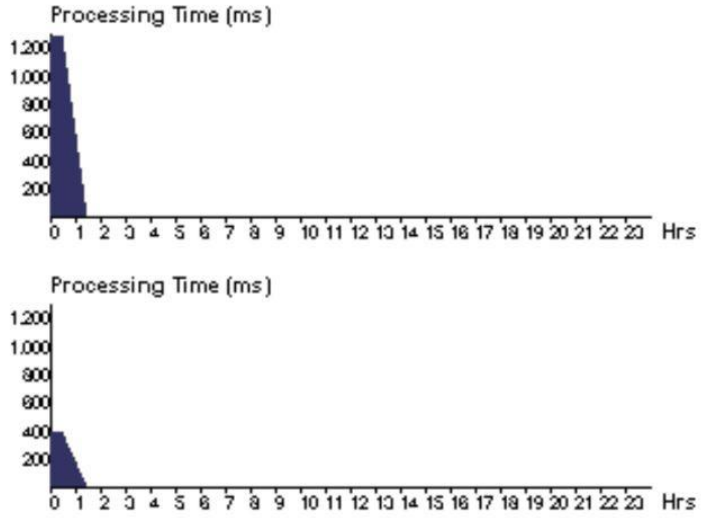
Data Center Request Servicing Times

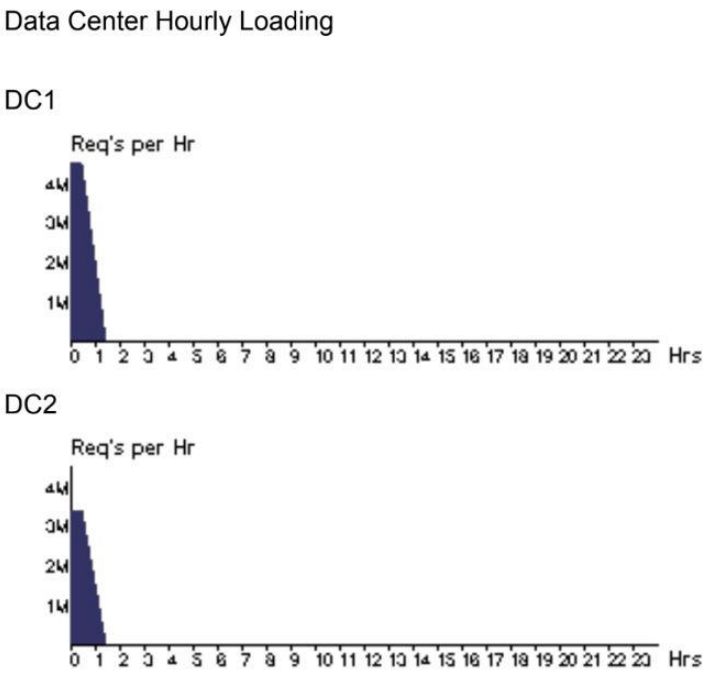
Data Center	Avg (ms)	Min (ms)	Max (ms)
DC1	1291.41	126.79	1563.50
DC2	391.05	20.63	1221.93

Data Center Hourly Average Processing Times

DC1

DC2





Algorithm	Before compression needed energy	After compression needed energy
Round Robin	0.261 kw	0.235 kw
Throttled	0.238 kw	0.237 kw
Equally spread	0.260 kw	0.251 kw

Table :4.8

Table:4.8 shows the comparison among the three algorithm and energy needed to process the data in the data centers

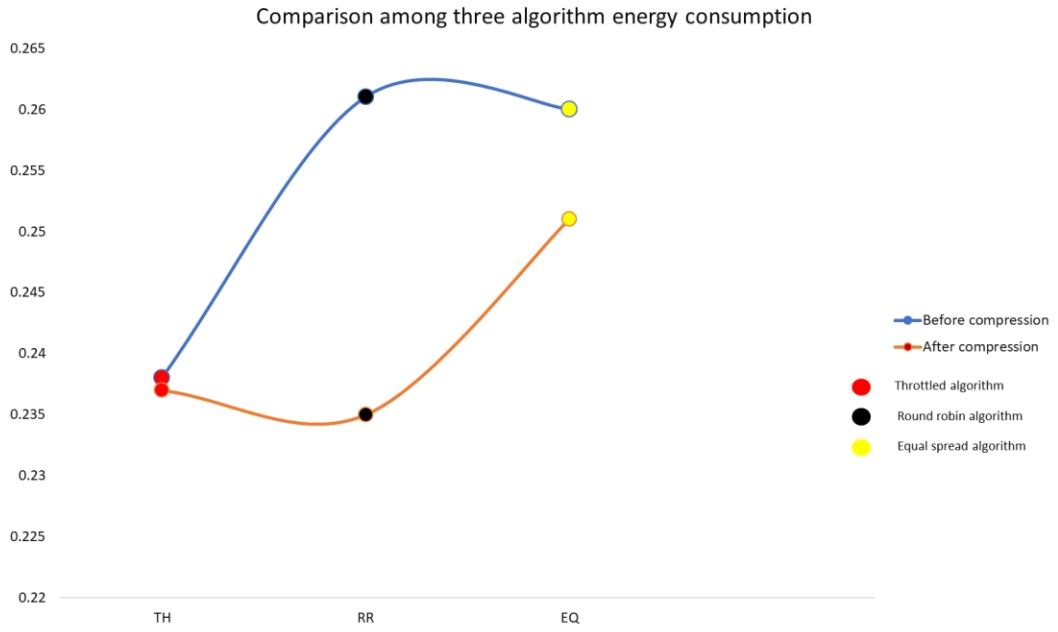


Figure4.8.1: Graphical Result of 3 algorithms energy consumption before and after compressing data

CHAPTER 5

DISCUSSION

Through our proposed hybrid power plant, we saw that, it significantly reduces the production of CO2, Almost 75% from the other power plants. It will also help us to make our environment carbon neutral. In data centers we are using compressed data with help of virtual migration using different types of algorithms for load balancing. We have used round robin, throttled and Equally spread current execution load algorithms to find out which algorithm gives us most efficiency. For data compression technique we have used Huffman coding algorithm as it is a loss less data compression technique. By compressing the file and by using the virtual machine migration technique we had calculate the processing time needed for the server for various data sizes. From that processing time we had calculate the amount of energy needed for the processing of that data. We used a simulator called cloud analyst for calculating the processing time of data centers. From the output of our answer we saw that our proposed method shows a reduction in energy consumption by the data centers.

CHAPTER 6

CONCLUSION

6.1 Future work

In future we will upgrade the algorithm so that the energy consumption could be handled more efficiently.

We will use upgraded devices so that from the device side energy consumption could be reduced.

We will find more efficient algorithm which will improve the simulation result of our data.

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Graph Source

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