RESEARCH ARTICLE

A Comparative Study of Performance About the Integrated Power Quality and Optimized Framework for Smart Grid

Naveen Kumar[1*], Gopal Singh[1], Manju[2]

[1]Department of Computer Science & Applications, M D University, Rohtak, Haryana, INDIA-124001
[2]Department of Computer Science & Engineering, Chaudhary Devi Lal University, Sirsa-125055, Haryana, India

Corresponding Author: Naveen Kumar, er.naveendahiya@gmail.com
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Abstract
As global warming becomes more serious in the 21st century, efforts are being made around the world to reduce greenhouse gas emissions. The greenhouse gas reduction objective is set in 2009 to be a 30% emission forecast and set to low carbon emissions. There are several grids which are using coal for generating electricity. As a result, the environment has got more pollutants and the world needs reducing such type of pollution for a green world. Then the concept of integration of renewable energy sources is coming to force. Their integration of such sources is providing the opportunity of availability of power with less pollution of the environment. A smart grid was developed and applied to the field as a system that can manage the energy in a smart environment. In this paper, a comparative study is performed about the performance of Integrated Technology in a smart environment.

Keywords: Smart Grid; IoT; Power Quality; Performance Analysis; Optimization

Introduction

With the progress and usage of smart devices along with the development and habit of technologies such as electric vehicles, which are being marketed recently, the overall load of the power grid amplified quickly, and at the identical time slot, the peak load derived nearby to the transmission capacity. Due to this problematic area cost of electricity increases strongly and is incipient due to the appearance of the electric power system, in which the generation cost increases as the user's demand increases as well as the risk of blackout. The smart grid, which is an emerging solution for the above issues, is a smart power grid that amalgamation of IT technology and the existing grid system, in which suppliers and consumers exchange information such as electricity price in real-time and electricity demand. By using this technology, consumers can optimize the electricity uses cost by using their smart devices [44] within the available times when electricity prices are cheaper and slots. The Utility can monitor and control of wastage of electricity and unscheduled shutdowns. This study emphasizes the prerequisite information during the integration of energy sources and to power using an optimized schedule [17] to satisfy the power demand of each n every appliance installed by users. It will also monitor the power outage and usage of consumers. The smart grid enables two-way communication or full-duplex mode which can deal with is complete. A typical example is the charging system of an electric vehicle. real-time scheduling methods and techniques. Apart from this point this study also focuses on the power usage schedule in real-time to minimize the cost and prevent the transmission capacity from being exceeded when an unscheduled additional power demand suddenly occurs. We would like to propose a smart grid [3,4,16,21,22] system process that can minimize the inconvenience of consumers.

Integrated Framework

In order to reduce the limitations of the power quality and schedule for the smart grid mentioned in [10], The smart grid serves as a communication system between N no. of consumers and a single grid responsible for power supply and generation. It consists of a multitude of information aggregation units, and a consistent supervision system that manages the usage schedule by integrating the demand-supply information of each consumer. painting.
The smart grid optimization framework proposed in [10] study is categorized into interruptible devices and non-interruptible devices, and it is set to perform optimal scheduling [36] considering the operation characteristics of each load. First, an interruptible device, the start time can be set, and the process can be stopped during the process and restarted at a different time. For other a non-interruptible load can set the start-up time period, but once the device is started, it cannot be stopped until the process

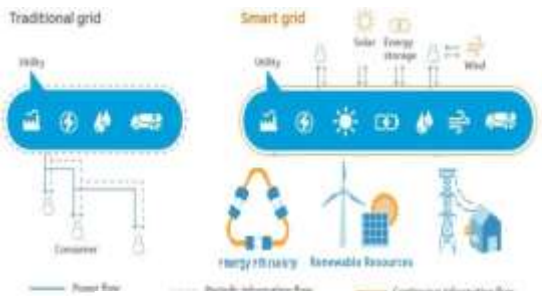


Figure 1: Smart Grid Vs Existing Grid

Table 1: Load Specification Matrix

$E_{1,1}^{NL} = \begin{matrix} 2H \\ 14:00 \\ 0:00 \\ 3\ kwh \end{matrix}$	$E_{1,2}^{NL} = \begin{matrix} 4H \\ 14:00 \\ 0:00 \\ 4kwh \end{matrix}$	$E_{1,t}^{t} = \begin{matrix} 6H \\ 14:00 \\ 0:00 \\ 9kwh \end{matrix}$
$E_{2,1}^{NL} = \begin{matrix} 2H \\ 17:00 \\ 5:00 \\ 4\ kwh \end{matrix}$	$E_{2,2}^{NL} = \begin{matrix} 6H \\ 17:00 \\ 5:00 \\ 6\ kwh \end{matrix}$	$E_{2,t}^{t} = \begin{matrix} 6H \\ 17:00 \\ 5:00 \\ 9kwh \end{matrix}$
$E_{3,1}^{NL} = \begin{matrix} 4H \\ 24:00 \\ 10:00 \\ 5\ kwh \end{matrix}$	$E_{3,1}^{NL} = \begin{matrix} 6H \\ 24:00 \\ 10:00 \\ 7\ kwh \end{matrix}$	$E_{3,t}^{NL} = \begin{matrix} 9H \\ 24:00 \\ 10:00 \\ 9\ kwh \end{matrix}$

CSS calculates the power usage scheduling vector that can minimize the negotiator's power usage cost by bearing in mind the power demand [30] information $E_{1,1}^{NL}$ and $E_{n,1}^{t}$. The grid transmission capacity is derived using a genetic algorithm, and the method is:

$$[Y_{JK}^{NL}(Y_{JK}^{L})] \equiv [Y_{JK1}^{L}(Y_{JK1}^{L}) \dots \dots \dots \dots Y_{JKh}^{L}(Y_{jkh}^{L})] \text{--------}1$$

Here, symbolizes the $L_i h$ power consumption essential for agent i at h time. Concluded this, the total power consumption l_h that the grid must supply in h hour, the sum L of the power consumption that needs to be supplied at all times of the day,

$$l_h = \sum_{i=0}^{N} L_i h \text{--}2$$

$$L = \sum_{h}^{H} l_h \text{--}3$$

The PAR value can be calculated as

$$PAR = \frac{max_h\, l_h}{\frac{L}{H}} \text{---}4$$

Case 1: When the transmission capacity exceeds the allowable capacity when a sudden demand request is accepted. Since the power demand in h-hour becomes higher than the transmission capacity, the power supply and demand may become unstable or blackout may occur.

Case 2: When the transmission capacity does not exceed the allowable capacity even when the sudden demand request is accepted. Even if the sudden demand is supplied as it is, the possibility of a power outage is low, but the power consumption in the corresponding time period is high, and the SMP for the sudden demand is very high.

Implementation and Comparative Analysis

The analysis is done by using the MATLAB/SIMULINK 2017b. The Comparative performance analysis is as follows:

Power Usage Scheduling Scenarios

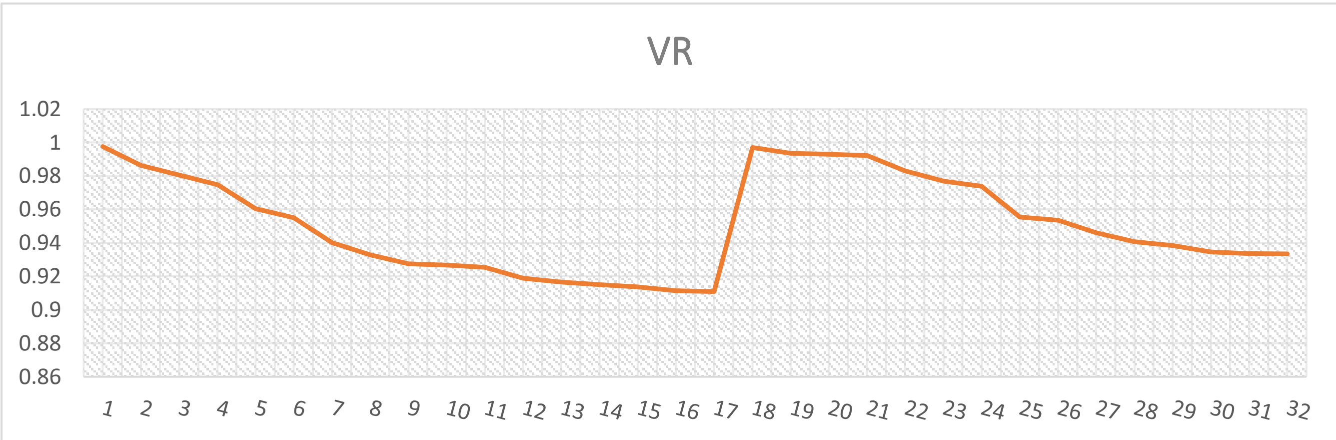
As an experimental condition for analysing the performance of the framework for smart grid presented in this study, it is assumed that a day is divided into 24 time slots at one-hour intervals, and 10 consumers who have Three-types of non-interruptible devices and two-types of interruptible are assumed. The power demand information e_i and importance $im_{i,j}$ of each user were randomly derived within the range of power consumption per hour and operating time of realistic home appliances and used in the relevant experiment. The capacitor, Reactor Bank and decision function used in this experiment, and after assuming several sudden demands that occur as the day progresses, the operation delay discomfort function $dis_{i,j}$. [In order to find obtainable weight, how the weight of the factor dissatisfaction i.e., h] changes the experimental result, the effect of the proposed framework on the performance of the framework was inspected by changing the dissatisfaction weight at 0.25 intervals.
As a result of the scheduling, the PAR value decreased from 1.88 to 1.4567, which reduced the risk of power outage and improved the performance of the power system.

Results and Discussion

Figure shows the variation in consumption outlines beforehand and afterward applying the proposed scheduling framework which is published [10]. The initial random scheduling under the corresponding experimental conditions shows the cost optimization transformation of proposed framework integrated with scheduling through Genetic Algorithm.
As can be seen from the figures, it can be long-established that the scheduling, daily power consumption is distributed much more evenly compared to the initial random schedule, and power usage during peak hours is also reduced.

Table 2 Load Categories and Parameters

Time Slot	Load 1			Load 2			Load 3			Total IN
	L_1	LD_2	D_1	L_2	LD_2	D_1	L_3	LD_3	D_1	
0-1	0	0	7	-	-	-	-	-	-	7
1-2	4	6	0	-	-	-	-	-	-	10
2-3	4	6	7	-	-	-	-	-	-	17
3-4	4	6	0	-	-	-	-	-	-	10
4-5	4	6	0	-	-	-	-	-	-	10
5-6	5	6	7	0	0	0	-	-	-	18
6-7	5	0	0	0	6	0	-	-	-	11
7-8	0	0	7	0	6	0	-	-	-	13
8-9	0	0	0	0	6	8	-	-	-	14
9-10	0	0	8	0	6	8	0	0	8	30
10-11	0	0	0	0	6	8	0	0	0	14
11-12	0	0	0	4	0	0	0	0	8	12
12-13	0	0	0	4	0	0	0	0	8	12
13-14	0	0	8	0	0	8	4	0	0	20
14-15	-	-	-	0	0	8	4	0	0	12
15-16	-	-	-	4	0	0	4	0	8	16
16-17	-	-	-	4	0	8	0	0	0	12
17-18	-	-	-	4	0	0	0	0	8	12
18-19	-	-	-	4	0	0	0	0	8	12
19-20	-	-	-	-	-	-	4	6	8	18
20-21	-	-	-	-	-	-	4	6	0	10
21-22	-	-	-	-	-	-	4	6	0	10
22-23	-	-	-	-	-	-	0	6	8	14
23-24	-	-	-	-	-	-	0	0	0	0
Total	26	30	44	24	30	48	24	24	64	314



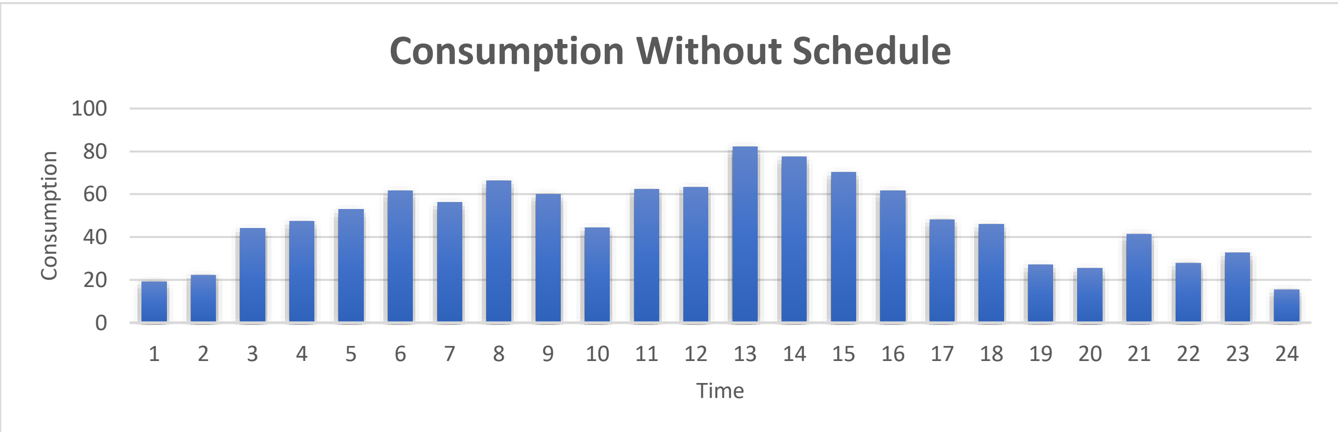


Figure 2:Consumption without Scheduling

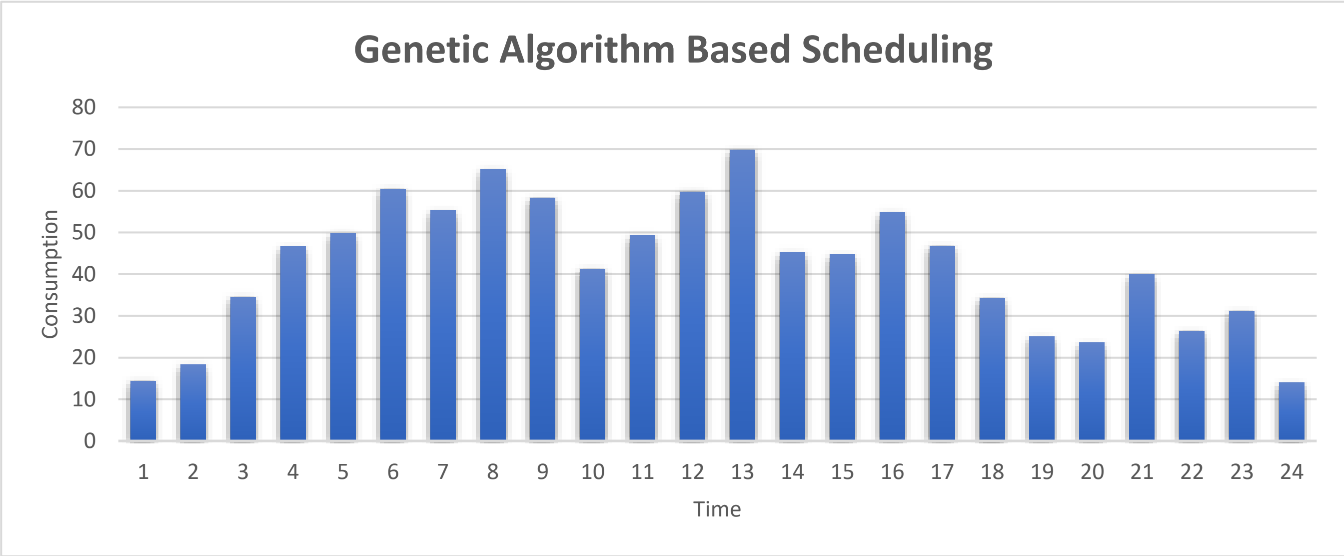


Figure 4: Consumption with Scheduling

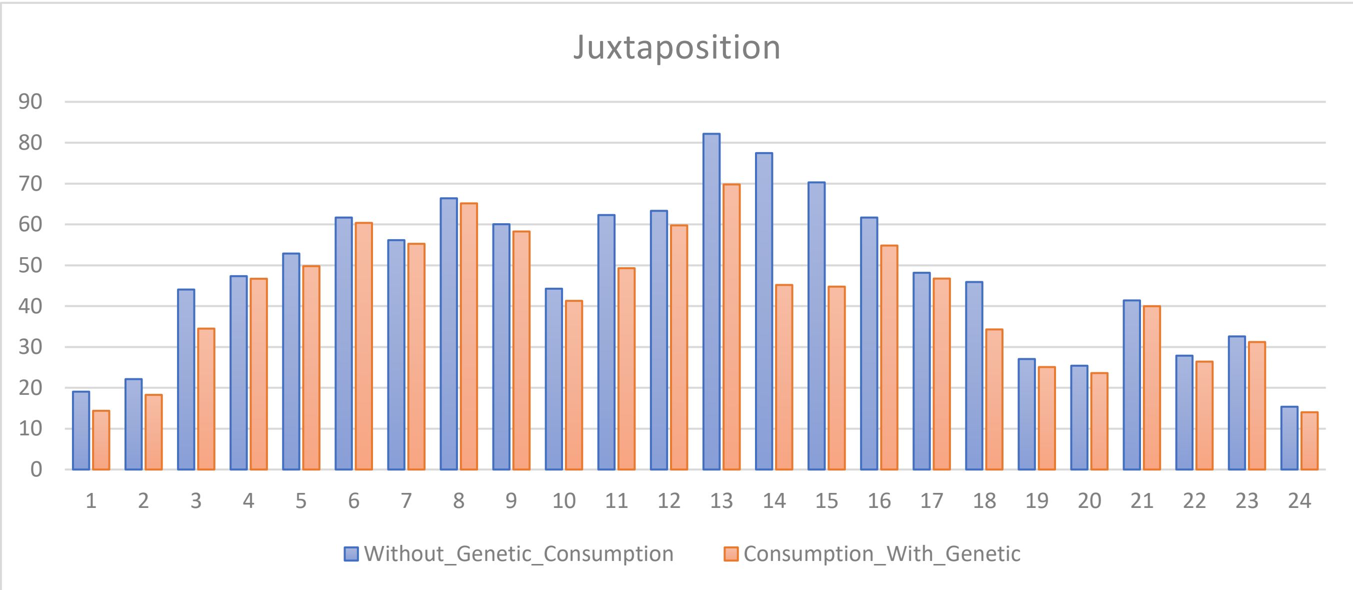


Figure 5: Comparative Analysis

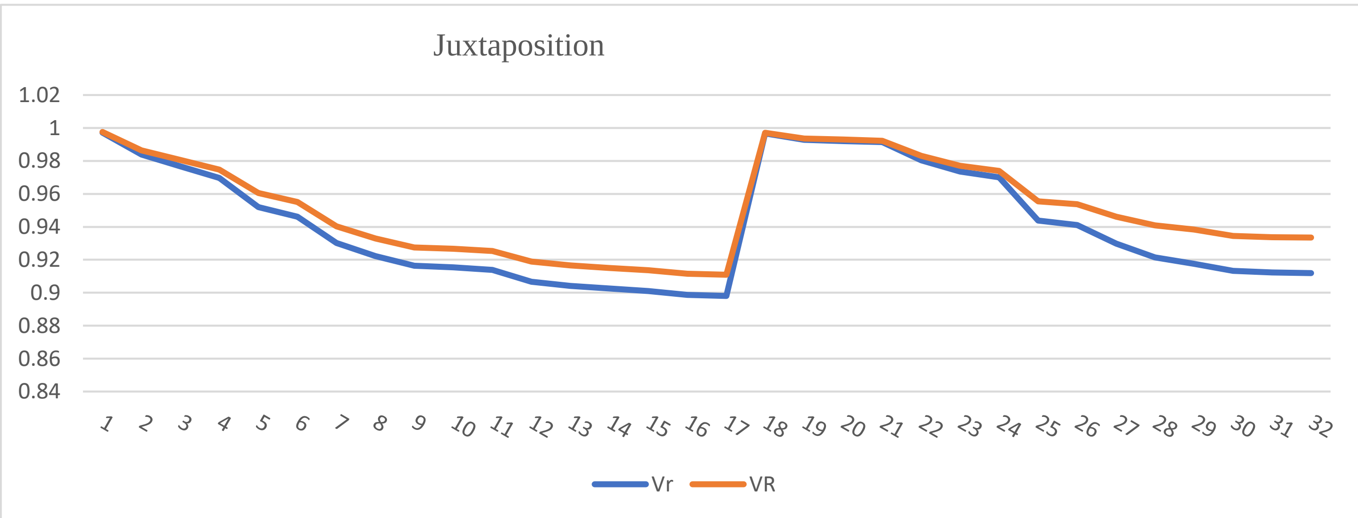


Figure 6: Comparative Analysis of Voltage Profile

Table 3: Cost and PAR of Consumed Power

Sr. No	Cost	Before Unexpected Demand	Accept All Demand
1.	Load_1	16.86	16.86
2.	Load_2	22.69	22.69
3.	Load_3	19.87	24.74
4.	PAR	1.8832	2.4646
5.	Total Cost	59.42	64.29

Table 4: Experiment Condition and Status

Sr. No	Particular	Status
1.	Number of Users	10
2.	Time Interval(h)	1
3.	Number of Interruptible appliances	3
4.	Number of Non-Interruptible appliance	2
5.	Power unit consumption cost function $Ch(l_h)$	$\frac{i_h^2}{1000}$
6.	Discomfort function $dis_{i,j}(h)$	$d_w \cdot i_{mi,j} \cdot 10h^2$ $dw \in [0,1]$ $im_{i,j} \in [0,1]$
7.	Value of Discomfort factor weight dw	0.25: 0.25 : 1
8.	Number of Sudden Demand occurrence	8

The Smart Direct Load Control method proposed by [9], which is to be compared in this paper, occurs in the consistent period analogous pattern with this paper when the power demand surpasses the transmission capacity. It is a method to reduce the risk of a power outage beyond the power supply boundary by suspending the operation schedule of the device with the lowest importance among the power demand array. However, as long as the power supply limit is not exceeded, there is no organic schedule change for the sudden power demand, and recompense for the delay in the process schedule is not taken into account, so the user's discomfort is not resolved. Algorithms to be compared with the method of this study are methods that process power demand in real-time without prior scheduling, which is presented in this paper. Therefore, when comparing the performance of the entire smart grid system, the Comparative analysis is difficult. To this end, it is assumed that the same power demand as the schedule derived from the optimization framework integrated with scheduling and implemented in the [10] and at the same time, the situation in which the sudden demand in each time zone assumed in the experiment occurs together so that the performance under the same situation can be compared. did.

Conclusion

In this study, by applying a real-time data and load using the characteristics of Genetic Algorithm in a smart grid that enables two-way communication in real-time, it is possible to derive an optimized power usage and schedule the load for satisfying the power demand of each consumer and reduce the risk of the wide-area power outage and power usage cost. We have proposed an integrated framework with power quality, optimization as well as scheduling, and a real-time sudden demand processing method that additionally considers the user's inconvenience due to the change in the electricity usage schedule, which was not considered in previous studies in the situation of additional sudden power demand. As a future research plan, research that can further improve the users' satisfaction, and how to find the best operation suspension compensation amount that can minimize the supplementary power consumption cost for the unexpected power demand.

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