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SMART GRIDS ANALYSIS AND DESIGN OF DEMAND SIDE MANAGEMENT

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Abstract-In the power supply system, load demand is a critical issue. To minimize blackouts and it's technical, economic, and societal implications, a balance between the demand (consumption) and supply (production) should be constantly maintained. Earlier days, to meet the demand with insufficient grid capacity were handled on the supply side (energy generators and suppliers) by enhancing the generation with capacity expansions. However, continuing expansion today encounters increasing economic and environmental constraints. With the liberalization of electricity markets, the focus has shifted towards how to deal with peak load issues from the demand side. Energy providers and policymakers recognize the potential for demand side reduction in peak load demand and are exploring various peak load reduction measures toinfluence customer flexibility. However these activities are still in the decision stage and being tested at both at demand (customers) and supply (utilities, generators).Yet no common tactics to describe demand side actions are available. Nowadays, terms like load management, demand sidemanagement (DSM), demand response management are used which are confusing to the consumers. From the supply side, analyzing, comparing the best demand side management tacticsis more difficult. Demand side management strategies will help utilities plan meticulously about setting up of new power plants or capacity additions with the existing ones.

***IndexTerms* – Demand, Energy, Grids, Power.**

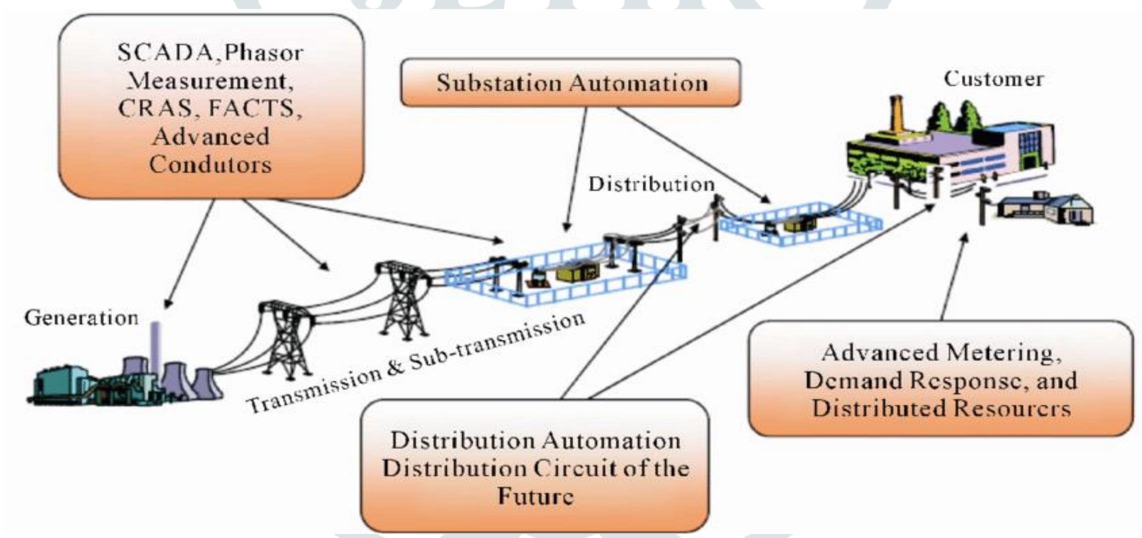
INTRODUCTION

This paper foregrounds the outline of Demand Side Management (DSM) techniques in Smart Grids from a perspective of Karnataka. Implementation of Demand Side management techniques to solve the problem of projecting maximum demand in poor nations with underdeveloped power systems and no smart meters to record significant volumes of historical data is a challenging task.The research problems are highlighted to formulate the research objectives and Methodology.The fundamental concepts of Smart Grids and Demand Side Management are addressed tounderstand the essence of the research work. A country's growth is gauged with reference to its power consumption and energy use, both of which are fast expanding. Energy consumption management improves energy generation and delivery. Energy management is traditionally approached from the top down. Large power plants are employed to feed the grid, and a demand-supply balance is attempted. This traditionalstrategy causes power interruptions and increases peak-hour electricity demand. Power generation, transmission, distribution, and control are all covered by a traditional power grid. Thegeneration units are located far from the customers, and power is delivered to them through a single-direction power line. The creation of smart grid is a result of the ever-increasing demand for power and the limitations of traditional power grids. The smart grid is a remarkable update to the power grid of the twentieth century, which employs two-way electrical and information flows to build a complex, energy delivery network that is computerized and distributed [1]. A smart grid includes, among other things, a smart power generation system, a smart distribution network,interactive terminals, smart meters, smart scheduling, and novel energy storage technologies. [2]. To allow bidirectional data transfer of energy between generators (conventional generation of energy and dispersed green energy resources) [1] and users (private enterprises, industrial, and domestic users) in the smart grid, an authentic and efficient infrastructure for communication is required, with the goal of administering smart equipments at users' homes to reduce energy consumption. One of the most essential smart grid technologies is DSM. DSM refers to the management practices used by electric utilities to achieve optimal resource allocation and increase terminal user efficiency [2]. In the smart grid, DSM is a control device that balances the power demand and supply process between consumers and utilities. This counterbalance isperformed by integrating energy management with dependable communication, with the goal of establishing a real-time, effective relationship between customers and energy suppliers. DSM involves customers by altering their consumption in relation to electricity pricing. In order to reduce electricity generation costs, [3] DSM is one of the most critical features of future smart grids. The DSM has a significant impact on per-unit costs as well as individual user costs. Inorder to provide real-time communication between the utility and the end customers, the DSM model architecture includes power flow and bidirectional communication. The objective forunderstanding the daily operation of the electrical system's loads, which is normally not available on structures using conventional meters, is a key barrier in using the DSM system. One of the obvious strategies to combat supply and demand activities is DSM. When generation capacity is not enough to meet basic demand, the

peak load is handled and power consumption is reduced. The ability of the electricity grid can be enhanced by reducing the losses and efficiently managing the assets and that losses depend on load curve. Since the loss of line is proportional to square of the current, it is easily clear that when demand is less, the electricity grid performs considerably better. [3] Load reduction, as well as minimizing peak demand for grid stability, is the most apparent techniques for enhancing grid performance. Straightening the demand load curve is another way to improve grid stability and performance. In India, power consumption, generation capacity, and transmission and distribution networks have all increased dramatically. With the advancement of technology, new monitoring and control systems are being developed with the goal of integrating smart grid principles at both the distribution and transmission levels. India's national electric grid had a capacity of 383.37 GW as of May 31, 2021. A record-breaking 200.57 GW of peak
electricity demand was reached by India on July 7, 2021. Even though statistics show that demand is less than supply, resources are unevenly distributed or concentratedin one area. As a result, electricity transmission from producing stations to loads necessitates a robust transmission network. The Indian government launched a project "Power for All" to address the lack of appropriate power supply, with the purpose of supplying constant, uninterrupted power to all homes, businesses, and industries. India's smart grid vision is to createa safe, sustainable, and technologically enabled ecosystem. In the preceding decade, the state of Karnataka has served as a model for India's service sector-driven growth. Karnataka has surpassed Gujarat as India's leading state in terms of renewable energy capacity, demonstrating obvious leadership and support for the much-needed electricity sector overhaul. One of the twelve pilot projects
for smart grids sanctioned by the Ministry of Power is being undertaken in the Small Region of Karnataka's Mysore district. Smart grids are under development stage in India and requires a strong infrastructure development for effective Implementation of Smart grids and Demand Side management plays an effective role to build a power architecture that is Smart. cording to Wikipedia, "A smart grid is an electrical system that includes a variety of operational and energy measures, such as smart meters, smart appliances, renewable energy resources, and energy efficiency measures". [4] The smart grid is a sophisticated energy management system that interacts with programmable grid elements like smart meters, programmable loads, switchable storage devices, and a wide range of

Figure 1.1: Smart Grid Elements [4]

controlled power resources like solar and wind. The smart grid is long-term, dependable, and cost-effective, and it is set to maximize the



benefits to smart microgrid members while also interacting reliably with any major grids it's connected to. Figure 1.1 depicts the smart grid's components.

Review of Literature

This describes the exhaustive review of different demand side management strategies likepeak clipping, load shifting module approaches. The various existing load forecasting and price prediction models for demand side management of domestic, commercial and industrial loads are analysed. The existing works on DSM of domestic consumers, the algorithms and methodologies adopted are discussed. The existing works on integration of renewable energy sources for demandside management in smart grids are discussed for different consumers and applications. Existing works of electric load prediction for Demand Side management in Smart grids The existing works for electric load prediction for DSM in smart grids are discussed in this segment, which includes forecasting models for load prediction of residential users, commercial and industrial users. Models for forecasting electrical power load are crucial to a utility's planning and operation. Electric utilities use electric load prediction to help them make important decisions including purchase of power and production, switching of load, and expansion of the infrastructure. Load forecasting has become even more crucial as the energy industries have deregulated. Electric Load prediction is critical for utilities since there is a fluctuation in demand and supply, climatic conditions and power prices can increase by a factor of 10 or more during demand periods. Forecasts for various time periods are critical for various functions inside a utility firm. Forecasts based on Short-term varies between an hour to a week, forecasts based on medium-term are vary from a week to a year, and forecasts based on long-term are for more than a year. Electric power prediction is one of the major tools used in demand side management.
Short Term Load forecasting: The electric load is a crucial part of Demand Response systems, and utility companies' efficiency is dependent on how well the electric load can be handled. Temperature, property heating/cooling, residency schedule, hot water usage, and lighting conditions are all elements thatinfluence customer load. As a result, electric power prediction is one of the major tools used in demand side management.

Simona Vascilica [9] proposes a data model for DSM for smart trade. The main objective is to design and develop an informatics prototype for energy forecasting, analysis, and decision models that will allow interested market participants to estimate energy demand and generation in a suitable manner for an efficient trading in the wholesale market.

Syeda Aimal [10] suggested a structured Convolutional Neural Network and Efficient K- nearest neighbor for load and electricity pricing prediction. The suggested model comprises of feature engineering and classification. Prediction of load is done using ECNN and EKNN after the features are extracted.

S.Devi [11] proposed an approach based on artificial neural network for load prediction in demand side management. A neural network based on back propagation with one concealed layerfor load forecasting based on short term to persuade users to voluntarily reduce their electricity consumption while maintaining service quality and customer satisfaction is proposed. **Nikos Andriopoulos [12]** proposed a novel methodology that takes advantage of the benefits of state- of-the-art deep learning algorithms, particularly Convolution Neural Nets (CNN). The suggested methodology's major characteristic is that it takes advantage of each time series dataset's statistical qualities in order to optimize the neural network's hyper parameters and transform the dataset into a format that permits optimal use of the CNN algorithm's for load forecasting.

Mingxin Wang [13] presented an approach for forecasting household load using a multitask deep convolutional neural network. Based on deep convolutional auto encoders, one branch is responsible for household profile encoding and utilizes a multiscale dilated convolutional model as its baseline. In addition, a unique feature fusion technique is included intothe forecasting branch, and the household profile is encoded using an efficient encoding strategy created.

Ashfaq Ahmad [14] suggested a day-ahead load-prediction model for smart grids based on hybrid artificial neural network with the goal of enhancing forecast accuracy without incurringincreased execution time costs. The model suggested by this article lowers execution time and improves forecast accuracy through the use of a supervised architecture and MARA for training,a multi-model forecasting ANN with a supervised architecture is developed.

Seunghyoung [15] provides demand-side load prediction based on short term using deep neural networks. DNN prediction models are trained using individual customer electricity use data and regional weather parameters. Processing of data, training the DNN, and DNN prediction are all included in the proposed framework, as well as a daily load profile projection for the following day based on climate, date, and prior energy utilization. DNNs produce more precise and robust predictions than other prediction frameworks; for instance, MAPE and RRMSE are reduced up to17% and 22 %, correspondingly, in comparison with other forecasting models.

Huanhe Dong [16] presents load prediction based on short term for special days which include national holidays, bridging days using bagged regression trees model combined with eight variables. Comparative investigations reveal that the BRT outperforms the ANN network in terms of forecasting precision and speed.

Chen Li [17] introduced a fuzzy theory-based machine learning solution for short-term load forecasting on weekdays and weekends. A fuzzy time series (FTS) is utilised for data mining, with a back propagation (BP) neural network as the primary predictor. To take advantage of the trade-offs between forecasting stability and accuracy, the parameters of BP are changed using multi-objective optimization. In addition, to handle forecasting uncertainty, an interval forecasting architecture with numerous statistical tests is built. Dynamic, nonstationary, and nonlinear characteristics of daily peak load make accurate forecasting difficult. A deep bidirectional long short-term memory based sequence-to-sequence regression approach (Bi-LSTM S2S) was designed, built, and tested for forecasting peak demand a day before with preliminary success by the work of **N.Mughees [18]**. The MATLAB softwareis used to test and develop a model for forecasting peak electricity demand a day in advance. Models including shallow Bi-LSTM S2S, shallow LSTM S2S, deep LSTM S2S, Levenberg- Marquardt back propagation artificial neural networks (LMBP-ANN), and medium Gaussian support vector regression (MG-SVR) are also designed and evaluated for performance comparison. Performance metrics include Mean Absolute Percentage Error (MAPE) and Root Mean Squared Error (RMSE). During public holidays as well as non-holiday days, the suggested deep Bi-LSTM S2S day-ahead ―peak‖ prediction model outperformed all other models in terms of performance measures. **Maheen Zahid [19]** utilised Deep Learning (DL) and data mining approaches to forecast electricity usage and pricing in his research. For feature selection and extraction, XG-Boost (XGB), Decision Tree (DT), Recursive Feature Elimination (RFE), and Random Forest (RF) are utilised. Classifiers include the Enhanced Convolutional Neural Network (ECNN) and Enhanced Support Vector Regression (ESVR). Grid Search (GS) is a technique for calibrating classifier specifications to improve their performance. ECNN reduces the risk of over fitting by using many layers. The suggested models' performance is assessed using MSE, RMSE, MAE, and MAPE and the achieved 2% better accuracy than CNN.

The work of **Mingzhe Zou [20]** presented a stacked bidirectional long short-term memory (SB- LSTM) recurrent neural network-based

MingzheZou [20]	Stacked bidirectional long short-term memory (SB-LSTM) recurrent neural network	MAE, MAPE	Prediction accuracy for specific days is low
Zahra shaifi[21]	Neural Network and Particle Swarm Optimisation	MAE,MSE,MAPE	More parameters to be considered for forecasting

approach for electric power forecasting, which is acutting-edge deep learning method for analyzing time-series data. The described SB-LSTMrecurrent neural network approach uses a "memory mechanism," which is represented as a recurring link to itself. As a result, the SB-LSTM approach effectively learns about the temporal features that are relevant to the entire input data series. The given findings and analyses how accurate the SB-LSTM approach is at producing forecasts for Load forecasting for the day and week ahead utilizing meteorological data. Due to their capacity to adjust to the hidden characteristic of the consuming load, neural-network-based approaches resulted in fewer prediction mistakes. Since the performance of a neural network is heavily influenced by its parameters.

Zahra shaifi [21] proposes an electrical load prediction based on short term using neural networks and the particle swarm optimization (PSO) algorithm. In order to anticipate electrical load using the PSO method, several parameters of the neural network, such as learning rate and number of concealed layers, are determined. The neural network is then used to forecast the outcome using these adjusted parameters. This method uses a three-layer feed forward neural network trained using the back propagation methodology, as well as an updated global best PSO algorithm.

Wen-jing Niu [22] based on selection of features and optimization of parameters, a promising machine learning model for load prediction based on short-term was proposed. The original loadsare split into a series of comparatively simple fragments using the ensemble empirical mode decomposition; the support vector machine (SVM) is chosen as the basic predictor for eachsubcomponent, with the real-valued cooperation search algorithm (CSA) used to determine the optimum hyper parameters for the model and the binary-valued CSA as a tool for selection of features. Traditional forecasting methods may fail to capture the dynamic change of load curves due to the volatility and randomness of power demand, which the suggested model can capture. The existing works Summary for Short Term Load forecasting Existing works on Electricity Price forecasting and pricing schemes for DSM inSmart grids. Every power plant can only produce a certain amount of energy. Energy demand, on the other hand, is uncontrollable. It fluctuates from time to time, causing the utility to become unstable. The DR programmes address the load balancing issue. Price-based tariffs, such as Critical Peak Pricing (CPP), Real Time Peak Pricing (RTP), and Time of Use (ToU) tariffs, are established under the DR programme. To reduce the amount of electricity used during peak hours, DR programmes provide incentives to users who reschedule their loads from demand hours to non- peak hours. Among the various pricing schemes, the ToU tariff is the most often used. The ToU tariff divides non-peak, shoulder-peak, and demand hours into three groups.

Adia Khalid [23] developed a scheme to determine the costs for demand hours and shoulder- peak hours, using a Game Theory (GT)-based Time-of-Use (ToU) pricing model. The suggested model has the same cost per-unit for all users, but consumers that move their load from demand hours to non-peak hours are compensated. Residential loads are shifted from demand hours to non-peak hours using the Salp Swam Algorithm (SSA) and Rainfall Algorithm (RFA), lowering the peak average ratio (PAR) and lowering the consumer's electricity cost. Recent advances in the disciplines of artificial intelligence (AI) and machine learning approaches,such as electricity price forecasting, have emerged in a major growth in their popularity in the literature. The work of **Grzegorz Marcjasz [24]** presented deep neural networks in electricity price forecasting before a day. In this work the choice of the structure of DNN model used for electricity price prediction with single vs multiple outputs is highlighted. The first model, models price vectors for each hour of the day and represents the daily auction structure. Another reflects the daily auction structure and models price vectors for each day.

The work of **Chun-Yao Lee [25]** presents electricity price prediction of similar days using regression and ANN on a short term basis. The similar days were selected using four models namely Euclidean norm, Manhattan distance, cosine coefficient, and Pearson correlation coefficient. The results of simulation show that neural network with Pearson correlation coefficient model had better prediction precision than the regression model.

Jesus Lago [26] proposed a new paradigm for modelling using deep learning for predicting day ahead energy costs. Deep learning models like deep neural network, hybrid LSTM-DNN, hybrid GRU-DNN and CNN models are suggested for improved accuracy of prediction. The results of simulation show that three of the suggested four models performed better than the modelsconsidered earlier. Deep neural networks give the best prediction accuracy. Electricity prices have a number of characteristics that make forecasting challenging, including high arbitrariness, high recurrence, nonlinearity, mean reversion, and non-stationary.

Zhang Yang [27] proposed a mixed strategy that merges the wavelet transform, the kernel extreme learning machine (KELM) based on self-adapting particle swarm optimization, and an autoregressive moving average (ARMA) to increase forecasting precision utilizing the distinct characteristics of each model. WT's were used for decomposition of the original price series, the ARMA model forecasts the linear component of the power price, while the KELM model, in conjunction with SAPSO, anticipates the nonlinear part. To change the penance factor and kernel specifications of the KELM, the SAPSO algorithm was used as a training process. The suggested method is used to predict energy costs of electricity markets. The proposed model had a fast learning speed and better prediction accuracy compared to other hybrid models.

Abidur Rahman [28] proposed a new scheme based on ToU pricing for demand side management of domestic energy users belonging to the low income group. In the proposed method electricity cost and size of the block are improved through genetic algorithm while yet providing monetary benefits to both residential and utility customers. Therefore, the proposed algorithm prevents the low-income consumers from incurring any financial burdens.

To estimate short-term power prices in smart grids, a unique hybrid forecasting model based on RTP that considers linear and non-linear characteristics within input data is presented in the work of **Xing Luo [29].** Customers' behaviours are influenced by accurate real-time price (RTP) forecasts, such as rescheduling of domestic loads so as to reduce their energy bills. A hybrid RTP forecasting model that combines the least-square (LS) fitting model, grey prediction (GP) model, and artificial neural network (ANN) is proposed.

SMART METER DATA ANALYSIS

Demand side Management (DSM) is a notable component of the Smart Grid. Advanced MeteringInfrastructure (AMI) is crucial for the effective implementation of DSM. Conventional electricity meters can record a home's or business's power consumption where as smart meters can monitor energy consumption in intervals of 15-minutes or at least hour by hour and send the statistics to the utilities. Smart meters, first and foremost, set up communication in both directions with the utility and a home or business. A local survey on the exploration of smart meter statistics acquired from a tiny area of Mysore district in the state of Karnataka is discussed in this chapterin order to bring about advance investigations on Demand side management techniques that are possible to be implemented to lower power utilization during demand period as well as flattening the load curve.

Advanced Metering Infrastructure

During the initial stages of technology for the home, traditional energy meters were employed to provide electricity. In order to detect how much electricity is consumed in individual homes, businesses, and factories these meters are vital. With standard meters, users receive a monthly report on their consumption, which is insufficient because they are ignorant of the equipment's daily power use and to address the

concerns with traditional electricity meters, smart meters have been modernized and constructed. Energy consumption alerts can be provided to consumers on an hour by hour or daily basis in order to accomplish the principal goal of lowering energy consumption.
Smart meters, bidirectional communication networks, equipment of the control centre and other applications that permit the collection and dissemination of power utilization data in near-real- time are all termed as AMI (Advanced Metering Infrastructure). AMI enables a bidirectional link with consumers and acts as a backbone of the smart grid. Smart meters, communication networks, meter data collecting, and management systems are the major components of AMI. The smart meters help customers get a better comprehension of theirpatterns of electricity usage, as well as the utilities for tracking of the system and bill generationof the consumers. A smart or advanced meter is an automated device that monitors parameters such as consumption of energy, levels of the voltages and current, power factor. With a range of load control functions built into the metering infrastructure, smart meters permit demand side management. DSM can give customers new methods to control their usage of electricity, as an example capability to plan their utilization or modify it on based on the demand to save money. The smart meter data also enables utility to understand the behavioral patterns of hourly, daily, weekly and monthly power consumption of all consumers so as to estimate the load curve. The Peak hours, off peak hours day wise and seasonal demand can also be estimated and predicted which in turn helps utilities plan the quantity of energy to be put on sale or procure to meet the demand. It aids in the development of demand response programmes, which incentivize consumers to plan and schedule their loads from demand hours to hours of less demand, reducing peak electricity and flattening the load curve. Smart meter data analytics help utilities implement new features like Deeper customer engagement by sending notifications of high consumption or power outage status, circuit quality analytics, power system stability etc. It also helps in optimal selection of customers who can effectively participate in DR programs.

Role of Smart Meters in Mysore pilot Project

The data from smart electricity meters is measured in a more straightforward manner. V.V. Mohalla, Vontikoppal, Jayalakshmipuram, Gokulam, Paduvarahalli, CFTRI, Metagalli, Hebbal, Brindavan Extension, and Hootagalli were among the 24,532 customers who received smart meters as part of the trial project, which covered 14 feeders in the Vontikoppal and Hootagalli Sub-Divisions. Figure 1.2 shows the project area covered by CESCOM.

Figure 1.2 CESC Pilot Project Areas

Figure 1.2 depicts a smart remote sensing meter that can be managed online using technologies for smart grids, including reading of the meter online, reconnecting and disconnecting of the meter, regulating the load, outage detection and management, TOU tariff, real time load monitoring, prepaid or credit metering mode, net metering feature for roof top solar energy integration and other functions. Consumers can use their mobile phones to access remote metering technology, and the CESC can use it from the control room. The smart meter has a radio frequency chip; the information may be viewed online. The consumer's power supply can be interrupted for non-payment of bills online.

The meter automatically makes a transition to the higher power billing and the consumer receivesthis notification when the consumer consumes more energy than prescribed by CESC. By giving incentives to consumers and billing them accordingly, the smart meter may integrate renewable energy. A consumer-CESC staff interface, power outage monitoring, and peer-to-peer communication are among the other features.
Instead of a complete blackout i.e a total load-shedding of the feeder line is avoided in a Smart Grid area by curtailing

Figure 1.3 Smart remote sensing meter

the load of individual consumer installations. Smart Grid also allows for real-time energy consumption visualization, allowing consumers to take control of their energy usage through a portal for consumers. It aids CESC in the detection of defects at an early stage and the rectification of those faults in shortest amount of time.

An Efficient Peak Load Management Model

One of the demand-side management solutions aimed at balancing energy usage throughout the day is peak power management. Peak load, which refers to consumers' peak demand during specified hourly hours and its management, is discussed in this chapter. Shifting electric loads from demand hours to hours of less demand relieves the stress on utilities to satisfy demand and supply while also lowering the cost to consumers for shifting their loads from demand hours to hours of less demand. The Peak Load Management Model provides a better framework for reducing loads and shifting loads from demand hours to non-peak hours. In this chapter, a cascaded artificial neural network is used to build a demand side management technique for managing peak electricity in residential houses. The simulation results and performance review emphasize the results and discussion of the peak load control model. The proposed work is compared to existing methodologies that have been improved in terms of hardware constraints.

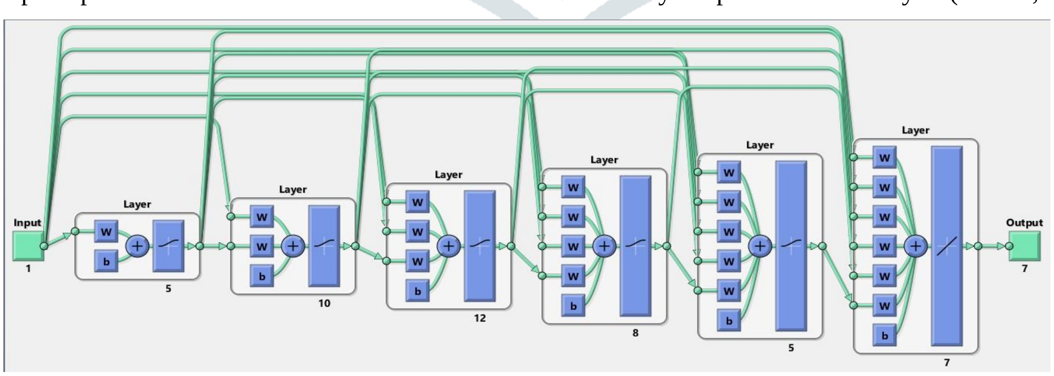
Research Problem

The objective of energy demand management is to bring the supply and demand of energy closer together to a near-optimal value, lowering the need for additional infrastructure investment on thepart of utilities while also supporting end users in receiving incentives for reducing peak power use. Due to the increasing power demand the energy suppliers have tried all possible ways to manage peak loads. The core plan of the utilities was to match the utilization to production. In an electrical grid, peak demand refers to the highest amount of electrical power demand over a designated period of time. The fluctuations in peak demand can occur on a daily basis, monthly basis, seasonal basis, and yearly basis. Customers' energy use may surpass a utility's energy supply during peak periods, resulting in significant electricity interruptions such as outages, system instability, and blackouts. When demand exceeds supply, the PLM allows a large number of customers to take advantage of power limits. Utilities have the ability to reduce component load, improve grid efficiency, and improve grid resilience. Various demand side management techniques like clipping of the peak, shifting of load, valley filling are proposed in literature to manage the peak power demand using optimization algorithms, differential tariff based load scheduling, incentive based load scheduling algorithms. From the existing approaches of peak power management the following research gaps are identified Appliances scheduling is carried based on variable tariff for demand hours and off peak hours. In developing countries with underdeveloped power systems, and without smart meters to record historical data efficiently, no research is being conducted on managing peak power demand. No controller is designed that automatically manages the loads during peak hours without causing much discomfort to the user. Hence there is a need to develop a novel automated peak power management model for limiting the power consumption during peak hours with effective participation of consumers. Research Methodology Optimal energy consumption scheduling reduces the Peak-to-Average Ratio (PAR) and peak loaddemand while lowering energy consumption costs. A novel peak load management (PLM) controller for energy consumption scheduling of household appliances to achieve the lowest energy consumption and reduce the peak demand is designed and simulated. An apartmentcomprising of 11 houses with different area and appliances are considered for modelling the load management model. In the suggested work, the highest load of the entire apartment is managedby scheduling the appliances of individual houses based on priority of loads. A cascaded multilayer neural network as shown in Fig.6.1 is used to generate control signals for various appliances of all the houses in the apartment to clip the peak power. Three control strategies have been proposed for peak load management. The first strategy is designed to implement peak clipping DSM wherein the non priority loads based on the consumer preferences are switched off to reduce the peak demand.

The second strategy uses time based scheduling where in the switching on and off of load is done in way to reschedule the load from demand hours to non peak hours so as to lower the peak demand. The third control strategy uses solar power source to manage the peak demand based on its availability

Conclusion and Future Scope

The Demand side management model is designed and used for peak power management in futuresmart grids of developing countries with underdeveloped grid infrastructure. The electricity load forecasting and price prediction model provides a better accuracy of prediction that helps residential and commercial consumers plan their power consumption within the peak power limits. The load management model provides a structure for peak power demand reduction of residential consumers that helps in achieving grid stabilization through process of peak clipping, load shifting and green energy integration to mitigate the peak demand. Multilayer cascaded feed forward neural network is used to design the both the demand side management models. The simulation results (prediction accuracy) are analysed and tabulated for electricity load and price prediction model of LT2 and LT3 consumers. Similarly the performance analysis (MAPE, MSE) for the electricity



load and price prediction model is evaluated. The simulation results (PAR, bill cost) are analysed and tabulated for load management model of residential consumers. Similarly the performance analysis (MAPE, MSE) for the load management model is evaluated using Matlab. The research work's important contribution and key discoveries are highlighted and explained asfollows.

From a Karnataka perspective, the research study is set with three design objectives to build a hybrid Demand Side Management model for smart grids. The first design goal is to use a multilayer cascaded feed forward neural network to estimate power load and pricing. The second goal is to create a load management model for peak load reduction in smart grids utilizing an ML cascaded feed forward network for demand side control. The final design goal is to create a load management paradigm that uses renewable energy. The simulation outcomes, such as forecast accuracy are analysed as well as performance evaluation indicators such as MAPE and MSE are evaluated for the load and price prediction model designed using multilayer feed forward neural network.The peak load control model's performance evaluation parameters like peak to average (PAR), bill cost,user comfort are highlighted in the simulation results and performance review.

To begin, a multilayer cascaded feed forward neural network is used to create an electrical load and price prediction model. The load forecast model was created for Karnataka Electricity Board's household (LT2) and commercial (LT3) customers. The daily power consumption of 100 residential households and 100 commercial stores is predicted using a short-term load prediction model. Following the load prediction model, the electricity price prediction model predicts the consumer bill using the KEB's flat rate tariff structure.The simulation results reveal that accuracy of prediction was enhanced by 50% for the multilayer cascaded feed forward based load forecasting model than the multilayer shallow ANNmodel. The performance evaluation parameters like prediction accuracy, MAE, MSE are analysed.The multilayer cascaded FFNN showed a prediction accuracy of 99.85% withMAPE of <1% and MSE of 0.7297.The MLCFNN structure was compared with shallow multilayer FFNN with improvements in the accuracy of prediction and training parameters.

Next, the peak load management module is designed using MLCFNN for load management of a residential building comprising of 11 houses and 7 groups of loads is constructed.The peak load management model achieved reduction in peak power using the two DSM strategies like peak clipping and load shifting.The peak clipping model utilised the load curve without controller to achieve the peak demand reduction and 1.25 kW of reduction in the peak demand was achieved during the peak hours for a day using the controller.The load shifting model achieved the peak demand reduction by shifting the load from demand hours to hours of lesser demand and a reduction of 2.9kW was achieved.

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