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ARTICLE

ENERGY MANAGEMENT OF MICRO GRID USING SUPPORT VECTOR MACHINE (SVM) MODEL

Rambabu M [1*], Nagesh Kumar GV [2], Siva Nagaraju S [3]
[1]GMRIT-Rajam, INDIA
[2]GITAM-university-vizag, INDIA
[3]JNTUK-Kakinada, INDIA

ABSTRACT

Micro grids (MG) are currently getting great consideration and measured the future trend for power distribution, consumption and storage; intended to meaningfully improve the self-sustainability of future electric dissemination of grids. In this paper the effective predictive energy organization model for micro-grid is implemented on the basis of generation model, energy storage scheme and load demand. Generation model comprises of a solar photovoltaic (PV) and wind turbine (WT), whereas hybrid power supply scheme comprises of battery and fuel cells (FCs). The goal is to ensure the load demand totally while sustaining the scheme constraints. The proposed optimized model is based on the SVM calculation. The SVM prediction model is prophesied the output on the basis of that produced the training dataset from the projected scheme restraints. The SVM can prophesied the control signal to converter for monitoring the power flow, then projected controllers can achieve the power signal and preserves the linear power transmission in a numerous load demand. Lastly, the application is performed by the MATLAB/Simulink platform and the presentation of the projected model is investigated on the basis of the two cases namely linear, non-linear load burdens and stable, non-stable produced power. The optimal power signal assessment investigation is achieved with dissimilar outmoded methods such as ANN, fuzzy over the reference signal.

KEY WORDS
SVM, REMS, Micro grid, Power transfer, PV, WT, Energy management, battery, fuel cells.

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***Corresponding Author**
Email: m.rambabu2001@gmail.com
Tel.: +919985456004
Fax: +91-08941251591

INTRODUCTION

This period is predictable to observer unparalleled growth and encounters in power generation, delivery, and usage. Ecologically responsive (renewable and clean alternatives) power generation skills will show a significant part in future power supply because of augmented worldwide public consciousness of the requirement for ecological defense and wish for less requirement on fossil fuels for energy manufacture [1]. These machineries comprise power generation from renewable energy (RE) resources, PV, micro hydro (MH), namely wind, biomass, ocean wave, geothermal, and tides, and clean alternative energy (AE) specifically FCs, power generation skills and micro turbines (MTs) [2]. The assistances of RE penetration comprise a reduction in outside energy dependence, reduction in transmission and alteration losses and further progress the scheme reliability, etc. [3][4]. To upsurge the energy dependability, wind and solar energy are utilized as dual energy sources. Though, seasonal climatic circumstances and geographic circumstances disturb the wind-solar energy output [5]. Consequently, a third energy scheme is desirable to progress the energy supply reliability. Therefore, the PEM FC preferably fulfils the necessity for any twitch up power. After the wind and the solar scheme energy are inadequate output then the FCs backups the delivery scheme [6]. An overall power scheme utilizes battery energy storage to evade a power outage or power surges produced by usual ecological influences.

The latest tendency of RE expansion is an amalgamation of disseminated power sources and energy storage subsystems to custom a small micro-grid that can decrease loss of energy from power broadcast lines over long distances [7]. A renewable-based micro grid can be implicit as a specific case of a more overall idea known as a 'smart grid' that is an interdisciplinary name for a group of technological results for electric power scheme management [8]. The modern idea of micro grid is extremely talented as a result to the issue because of shortage of fossil fuel in future in conservative power generation. Micro grid is a platform to assimilate DERs into circulation network. The DERs may comprise DGs and distributed storage (DS) [9]. The MGs function in grid-connected or island mode, and may involve distribution networks with inhabited or commercial end-consumers, in rural or urban parts [10][11]. Process of micro grid is on the basis of prosperous integration of DERs that is associated with numerous factors such as power quality problems. The power quality problems should be sagely distributed with to attain sensible values of voltage and frequency in grid associated and islanded mode of micro grid in firm state and also at the time of dynamic state i.e. conversion from grid associated mode to islanded mode and vice versa [12] [13].

The energy accomplished from the RES is fresh and generates no pollution, but on another aspect it is stochastic and subsequently problematic to control. Because of this disadvantage, a high diffusion of the RES can create reliability, stability, and power quality issues in the chief electrical grid. Thus, an optimum way of assimilating the energy proficient from the RES must be intended [14, 15]. In this aspect, the hybrid scheme, fashioned by intersecting small, modular generation and storage devices has demonstrated to be the best means of gathering the energy demand with high dependability, flexibility and cost efficiency [16], [17]. Energy organization of hybrid energy schemes is vital for safeguarding optimal energy application and energy sustainability to the supreme extent. Additionally, the upsurge in infiltration of RE in power schemes, chiefly at the distribution level, presents novel encounters for frequency and voltage regulation as they can alteration the generation/demand balance of the network almost promptly as associated with conventional alternators whose dynamics are governed using their inertia constant [18][19]. Dynamic

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communications amongst the load claim then the RE source can prime to critical issues of stability and power quality. Consequently, handling the flow of energy throughout the hybrid scheme is indispensable to upsurge the operating life of the membrane and to safeguard the unceasing energy flow. The cumulative number of RE sources and disseminated generators necessitates novel approaches for their operations for maintaining the energy balance amongst the renewable sources and utility grid or micro-grid [20].

At this time, I have envisioned to suggest an artificial intelligence (AI) method for energy management of combined RE scheme resources with MG. The projected combined RE system is on the basis of PV scheme, WT, Batteries and UC system correspondingly. The projected control method will be holding the power flows amongst the collective RE sources and the grid. It will be encountering the existing RE power and to preserve the grid power claim from the grid operator. The electrical power desirable by the grid operator is provided as a reference to the input of micro grid. The projected approach must be dispersed the total power reference among the scheme portions properly. In the projected method, the objective performance will be well-defined by the scheme information subject to equivalence and dissimilarity restraints. The constraints will be the obtainability of the PV power, wind power, power demand and the SoC (states of charge) of storage rudiments. Batteries will be used as an energy source, to alleviate and allow the renewable power scheme units to keep running at a firm and steady output power.

RECENT RESEARCH WORK: A TRANSITORY REVIEW

Amounts of research work are heretofore occurred in literature that on the basis of the energy management of RE scheme with micro grid. Some of the works are studied here.
an Energy Management System (EMS) for hybrid systems (HS) collected by a amalgamation of renewable resources with the provision of dissimilar storage devices (battery and hydrogen system) that permit its operation without the requirement of grid connection (i.e. a stand-alone system) was proposed by Juan P.Torreglosa et al. [21].The prominence of the projected EMS lies in considering economic problems that disturb to the decision of that device of the HS must function in each moment. Linear programming was utilized to encounter the objective of decreasing the net present value of the operation cost of the HS for its whole lifespan. The complete operation costs on the basis of mainly on the reposition charges of its mechanisms.

A Genetic Algorithm (GA) is used to apply a tri-objective design of a grid independent PV/Wind/Split-diesel/Battery hybrid energy scheme for a characteristic residential building with the objective of decreasing the Life Cycle Cost (LCC), CO2 emissions and dump energy was described by A.S.O.Ogunjuyigbe et al.[22]. To attain some of these objectives, small split Diesel generators are utilized in place of single big Diesel generator and are agreeable on the basis of convinced group of principles on the basis of existing RE resources and SOC of the battery. The algorithm was used to study overhead five situations for a characteristic load profile of a inhabited house with the help of typical wind and solar radiation information.

The implementation of a meta-heuristic algorithm specifically Cuckoo Search (CS) in the arena of a hybrid energy organization design issue was elucidated by Sarangthem Sanajaoba et al.[23]. Solar and wind power on the basis of hybrid energy scheme with energy storage unit gives a dependable and cost effective energy alternative above the conservative diesel generator on the basis of scheme usually utilized by remote users. The efficiency of Cuckoo Search algorithm in resolving hybrid energy scheme design issue was inspected and its function was associated with other well-known optimization algorithms such as GA and Particle Swarm Optimization (PSO) algorithm. At this time, the consequence of wind turbine generator (WTG) force outage rate (FOR) on the optimal scheme dependability and economics.

A Energy Management System (EMS) for a micro grid on the basis of four energy bases: a WT, PV solar panels, a battery, and a hydrogen system, that was collected of a FC and an electrolyser was described by Pablo Garcia et al.[24]. That control approach enhances the complete cost of the hybrid scheme via lifetime assessments designed hourly for each energy storage device. That control approach links the anticipated lifetime of the energy sources to their generation costs, i.e., if the lifetime was low, the generation cost upsurges and, subsequently, that energy source will surprise to be utilized less.

An Improved Harmony Algorithm (IHA) for optimal allocations and sizing of capacitors in numerous distribution schemes was proposed by E.S.Ali et al.[25]. Initially, Power Loss Index (PLI) was familiarized to attain the uppermost candidate buses for fixing capacitors. At that time, the IHA was engaged to resolve the most optimum locations of capacitors and their sizing from the designated buses using PLI. The objective performance was premeditated to decrease the entire cost and losses and accordingly, to upsurge the net saving per year. The algorithm was verified on three dissimilar radial distribution schemes.
A hybrid many optimizing liaisons (MOL) and the teaching learning based optimization (TLBO) based optimization of integrated hybrid renewable energy sources (IHRES) for techno-economic-socio investigation was demonstrated by Ranjeeta Khare et al.[26]. Optimal sizing of IHRES was performed based on solar irradiation, wind speed, demand load, reliability index, loss of load probability (LOLP) then the CO2 emission over diesel generator. Annual cost of the system (ACS) was assessed via the existing hybrid algorithm. Sovereignty of the recommended hybrid technique for optimal sizing of hybrid scheme was demonstrated by associating the solutions with other optimization systems such as TLBO, ITLBO, PSO, MOL and SGA.

A Flower Pollination Algorithm (FPA) for optimum distributions and sizing of capacitors in numerous dissemination schemes was proposed by A.Y.Abdelaziz et al.[27]. Initially the most applicant buses for connecting capacitors were recommended by Loss Sensitivity Factors (LSF). Formerly the FPA was engaged to assume the sites of capacitors and their sizing from the chosen buses. The algorithm was associated with others to focus the assistances of the algorithm in decreasing total cost and exploiting the net saving.

The evaluation of the current investigation work displays that, energy organization of hybrid RE storage devices for MG. For the energy administration, dissimilar renewable devices are encompassed typically PV and wind power generators, together with a diesel power generator. In the energy management scheme, the purpose of the size of PV, wind, and diesel power generators is tremendously challenging. The organisation of the energy sources is talented by the energy supervisory scheme. It is accountable for monitoring the energy sources of the RE scheme and their power converters. This is mostly because of a great amount of factors complicated in the problem, the instability developing from the renewable resources and the demand load, and the multifaceted interaction between issues. Conservatively, there are numerous methods are utilized to energy management strategies such as fuzzy, neuro-fuzzy and optimization algorithms. By utilizing fuzzy logic controller (FLC) for a WT /PV/hydrogen/battery REMS on the basis of the energy management, that provides better solutions but it does not illustrate the exclusive nature of fuzzy schemes theory. On another aspect, PSO has been established to have decent worldwide search ability. Though, in PSO algorithm, the velocity equation comprises of stochastic variables so the worldwide best value is changing hesitantly. Consequently, a RE scheme control approaches are mostly intended to track the required power, to usage optimally the energy sources and to standardize the DC bus voltage of the REMS. Consequently, a combined RE scheme is obligatory for an auspicious result to overawed this encounter. In literature very scarce methods on the basis of works are accessible to solve this issue; these disadvantages and issues have encouraged doing this research analysis.

PROPOSED RENEWABLE ENERGY MANAGEMENT SYSTEM (REMS)

The representation figure of the REMS under deliberation is shown in [Fig. 1]. It is expected that MG comprises dissimilar kinds of distributed generators (DGs) such as WT, PV and energy storage system (ESS) like UC, battery and FC. The incorporation of these DGs and ESS is generally interfaced with the load and the chief grid by power electronic converters. The dissimilar topologies of power converter are essential to control power flow to be appropriate for the load power claim. The REMS organization is familiarized to direct the enhanced values of each source to power converter control circuit bearing in mind the outputs instructions from the Support Vector Machine (SVM).

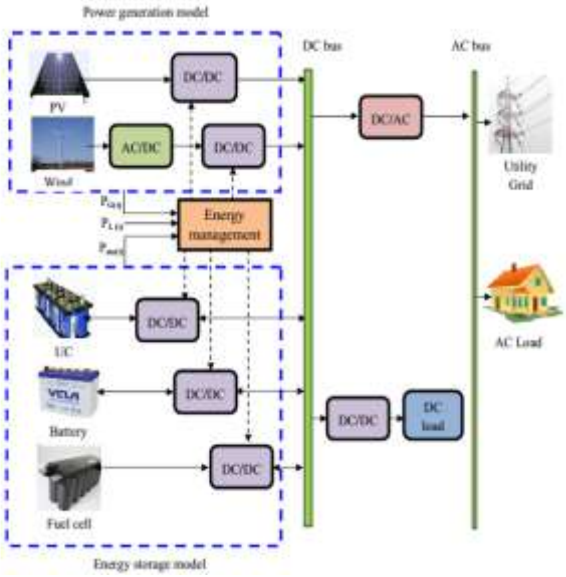

Fig. 1: Proposed schematic diagram of the REMS

The SVM algorithm for organization and regression is the last preparation in the name of the support vectors that abbreviates the large training information to a meaningfully lesser subspace of SVs. The training dataset are generated on the basis of the projected organization parameters then the function is investigated also associated with other out-dated approaches specifically ANN and fuzzy.

POWER GENERATION MODEL

Photovoltaic array

The PV cell is demonstrated as a corresponding circuit that comprises of an ultimate current source I_{cs} in parallel with a diode and resistance R_p all in sequences with resistor R_s. The diode models the semiconductor material, and R_s models the resistance amongst the contactor and semiconductor material [28]. The overriding equations (1), (2), (3) and (4) are,

$$V_d = V_{cell} + I_{pv} R_s \quad (1)$$

$$I_{pv} = I_{cs} - I_s\left[e^{\frac{(qV_d)}{AKT_{pv}}} - 1\right] - \frac{V_d}{R_p} \quad (2)$$

$$I_s = I_{s,r}\left(\frac{T_{pv}}{T_r}\right)^3 e^{\frac{qE_{bg}}{AK}\left(\frac{1}{T_r} - \frac{1}{T_{pv}}\right)} \quad (3)$$

$$I_{cs} = \left[I_{s,r} + K_I\left(T_{pv} - T_r\right)\right]\frac{S_{pv}}{1000} \quad (4)$$

Where, V_d and V_{cell} are the diode voltage and PV cell voltage, correspondingly; I_{pv} is the PV cell output current, and I_s is the cell saturation current; q, A and K are an ideal factor, an electron charge, and the Boltzmann's constant, correspondingly; $I_{s,r}$ is the cell's reverse saturation current at reference temperature T_r; E_{bg} is the band-gap energy of the semi conductor; K_I is the cell's short circuit current temperature coefficient, S_{pv} represents that the irradiance of the PV. The cell model is ascended to a PV arrangement by bearing in mind η_{pv} cells in sequences, thus the assortment power is specified as equation (5),

$$P_{pv} = \eta_{pv} V_{cell} I_{pv} \quad (5)$$

For brevity, we only abridge the PV model equations (1) to (5). Note that a maximum power point tracking (MPPT) algorithm is typically engaged to progress PV efficacy. Then additional renewable energy source wind turbine model is enlightened below.

Wind turbine power model

The WTs detention portion of the kinetic energy of winds and translate it into electrical energy. This abstraction of energy produces a wind energy scarcity amongst the wind leaving the turbine and the wind arriving in front of the turbine. Henceforth, a discount of power output is fashioned at down WTs [29]. The WT power P_w is demonstrated with the help of a non-linear expression that fundamentally on the basis of the wind speed and the wind turbine features is designated as equation (6),

$$P_w = \frac{1}{2}\rho A C_p(\lambda_1) v^3 \quad (6)$$

Where, ρ is the air density $(kg.m^{-3})$, A is the surface of the turbine blades (m^2) and C_p is the power coefficient, which is given by equation (7),

$$C_p(\lambda_1) = 0.5176\left(\frac{116}{\lambda_1} - 0.4\beta - 5\right)e^{\frac{-21}{\lambda_1}} + 0.0068\lambda_1 \quad (7)$$

Where, $$\frac{1}{\lambda_1} = \frac{1}{\lambda_1 + 0.08\beta} - \frac{0.035}{\beta^3 + 1} \quad (8)$$

And, λ_1 is represented as the tip-speed ratio, that revenues that the ratio amongst the tangential speed of the tip of a blade and the real speed of the wind v. Then the tip speed ratio is designated as equation (9),

$$\lambda_1 = \frac{\Omega R}{v} \quad (9)$$

Where, R is the helix radius (m), Ω is the angular mechanic speed $(rad.s^{-1})$. The anticipated energy storage scheme can switch the power flow of the micro grid on the basis of the parameters of the scheme. The output of the scheme can be measured on the basis of the SVM that is trained on the basis of the input parameters of the generator and storage scheme. The storage model is utilized some storage schemes specifically battery, UC, FCs. The energy storage scheme model is designated below.

Energy storage system model

On the basis of the load demand curve, the batteries in a conventional stand-alone solar scheme are substituted archetypally. An enormous battery scheme is recommended to cater for the peak power and also to extend the battery lifespan. The dilapidation in battery lifespan is because of the unpredictable battery charging using the solar energy source, by way of the output of the source is deeply reliant on weather circumstance. The output of the solar energy source alters rendering to the intensity of the light, subsequently an inconsistent battery charging and settling cycle [30]. Heavy current satisfying because of the heavy load necessities will also distress battery life. The stress factor on the battery similarly asymmetrical discharging rate and widespread time at the low SOC could upsurge the rate of impairment to the battery. The distinguished damage contrivances are associated to battery electrolyte stratification and also irreparable sulphating that significantly abridges battery lifespan.

The DC/DC converter associated with the FC is a high-step up boost-type topology functioning in incessant conduction mode. The control approach utilized in the DC/DC converter understands a single current loop to control the output power inoculated into the micro grid [32]. The full-bridge inverter continuously performs as a current source whether the micro grid functions in impartial or grid linked mode, being a slave converter. The inverter is well-ordered by two loops i.e. a current loop and a voltage loop. The anticipated SVM depended on energy management system needs dataset for the training procedure that is enlightened below

Dataset Generation for classification training and testing

The REMS hinge on upon the RE sources of the REMS on the basis of the power need of the grid and the load with the help of the power production model and the energy storage schemes. At this time, we utilizing the SVM organization and testing model is attained the REMS. The projected SVM model can produce the training dataset and measured the output of the SVM. The training datasets are on the basis of the actual produced power of the natural generators such as PV array and wind turbine and the load claim at the specific duration [33]. Primarily the generator model power is designated as equation (10),

$$P_G(t) = P_{PV}(t) + P_W(t) \tag{10}$$

And the storage system model is demonstrated as equation (11),

$$P_{sto}(t) = P_{BAT}(t) + P_{UC}(t) + P_{FC}(t) \tag{11}$$

The training dataset decides the reference power necessary from the RE sources and the storage strategies. The fashioned power can be designated through the equation (12).

$$P_P(t) = P_G(t) + P_{sto}(t) \tag{12}$$

In which, $P_G(t)$ signifies the entire power produced from the PV and wind energy from time interval; $P_P(t)$ represents the entire power of the accessible sources in the REMS from time t interval and $P_{sto}(t)$ indicates the total power from the storage devices from time t interval; $P_{PV}(t)$ characterizes the power produced from the PV scheme from time t interval; $P_{WT}(t)$ characterises the power produced from the WT from time t interval; $P_{BAT}(t)$ suggests the power needed from the battery from time t interval; $P_{UC}(t)$ narrates to the power mandatory from the UC from time t interval and $P_{FC}(t)$ resembles to the power needed from the FC from time t interval [34]. On the basis of the above equations, the training dataset of the SVM has been industrialized that is displayed in the equation (13).

$$\begin{bmatrix} P_G(0), P_L(1) \\ P_G(1), P_L(2) \\ \vdots \\ P_G(t-1), P_L(t) \end{bmatrix} = \begin{bmatrix} P_{ref}(0) \\ P_{ref}(1) \\ \vdots \\ P_{ref}(t) \end{bmatrix} \tag{13}$$

At this time, the SVM inputs are may be the preceding prompt power generation from the produced RE sources $P_G(t-1)$ and the load demand $P_L(t)$ and the output panel is reference influence of the REMS $P_{ref}(t)$. By engaging the relative parameters, the new ANFIS method has been able to produce the rules and tuned proficiently. The produced dataset is used for training the SVM and it accomplishes the energy of the REMS at the challenging time. The SVM on the basis of energy management is enlightened below

Support Vector Machine

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To apply the load profile documentation, a SVM model that appropriately classifies the actual load profile from the SVR load profile models is skilled and authenticated. This again, comprises the 3 stages as declared above: information pre-processing, model assortment, and cross-validation and grid search. SVM is an extensively utilized machine learning algorithm for organization and reversion investigation. It is on the basis of the organizational risk minimization belief rather than the experiential risk minimization principle that can decrease the experiential jeopardy and self-assurance interval instantaneously so as to confirm the generalization presentation of learning [35]. The chief benefit of the SVM algorithm for organization and deterioration is the final origination in the name of the support vectors, which shortens the large training information to a meaningfully lesser subspace of SVs. Furthermore, the preparation does not necessitate any computationally intensive accurate operations.SVM alters the learning issue to an optimization issue of arched quadratic programming that can acquire the worldwide optimal result theoretically and the arrangement is demonstrated in [Fig. 2].

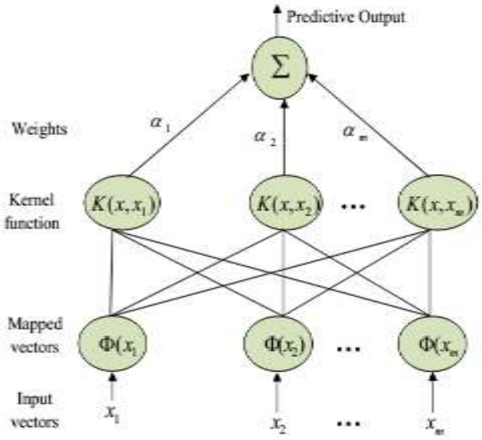


Fig.2: Structure of SVM training model

Specified a training sample set $T=\{(x_i,y_i),i=1,2,...,n\}$, where, x_i is the i^{th} input sample, $x_i\in R^n$, y_i is the consistent output, $y_i\in\{1,-1\}$ and n is the number of samples. The primitive optimization issue is expressed in equation (14),

$$\min_{w,b}\frac{1}{2}\|w\|^2 \tag{14}$$

Subject to,

$$y_i(w.x_i+b)-1\geq 0, i=1,2,...,n$$

For making the result of the primitive issue more modest and feasible, it is malformed to a dual issue. The Lagrange performance is familiarized and demonstrated in equation (15),

$$L(w,b,\alpha)=\frac{1}{2}\|w\|^2-\sum_{i=1}^{n}\alpha_i\{y_i[(w.x_i)+b]-1\} \tag{15}$$

Where, is the Lagrange multiplier; By manipulative the partial derivative for ; constructing them equal to 0, the subsequent dual issue can be attained as equation (16),

$$\max_{\alpha}\sum_{j=1}^{n}\alpha_j-\frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n}y_iy_j\alpha_i\alpha_j(x_i.x_j) \tag{16}$$

Subject to,

$$\sum_{i=1}^{n}y_i\alpha_i=0,\alpha_i\geq 0, i=1,2,...,n$$

Following that issue (15) is solved; the optimal gratifies the equation (17),

$$w^*=\sum_{i=1}^{n}\alpha_i^*y_ix_i \tag{17}$$

And the decision performance is articulated as equation (18),

$$f(x)=\operatorname{sgn}\left[\sum_{i=1}^{n}\alpha_i^*y_i(x_i.x)+b^*\right] \tag{18}$$

For realizing the SVM in nonlinear condition, samples should be represented from the original nonlinear space to the high dimensional linear space. This nonlinear mapping can be comprehended with the help of the kernel performance is provided as equation (19),

$$K(x_i,x_j)=\phi(x_i).\phi(x_j) \tag{19}$$

The nonlinear alteration comprehended by the kernel performance cans significantly diminution the computational difficulty. At that time, the issue can transmute to equation (20),

$$\max_{\alpha} \sum_{j=1}^{n} \alpha_j - \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} y_i y_j \alpha_i \alpha_j K(x_i . x_j) \tag{20}$$

Matter to,

$$\sum_{i=1}^{n} y_i \alpha_i = 0, 0 \leq \alpha_i \leq C, i = 1,2,\ldots, n$$

In which, C is the consequence co-efficient; C is utilized to regulator the chastisement degree for erroneously categorized samples. By resolving the quadratic programming issue (20), the subsequent decision performance can be acquired as equation (21),

$$f(x) = \mathrm{sgn}\left[\sum_{i=1}^{n} \alpha_i^* y_i K(x_i . x) + b^* \right] \tag{21}$$

The mapping ϕ is frequently nonlinear and unknown. As an alternative of computing ϕ, the kernel function K is utilized to calculate the inner product of two vectors x_i and in the feature space $\phi(x_i)$and $\phi(x_j)$, that is provided in equation (19). The sophistication of using the kernel performance is that one can compact with feature spaces of random dimensionality without having to calculate the map $\phi(x)$ obviously [36]. Any performance sustaining Mercer's condition can be utilized as the kernel performance. The succeeding are three frequently utilized kernel functions as equations (22), (23) and (24),

Linear: $K(x_i, x_j) = x_i . x_j$ (22)

Polynomial: $K(x_i, x_j) = (1 + x_i . x_j)^{\rho}, \rho > 0$ (23)

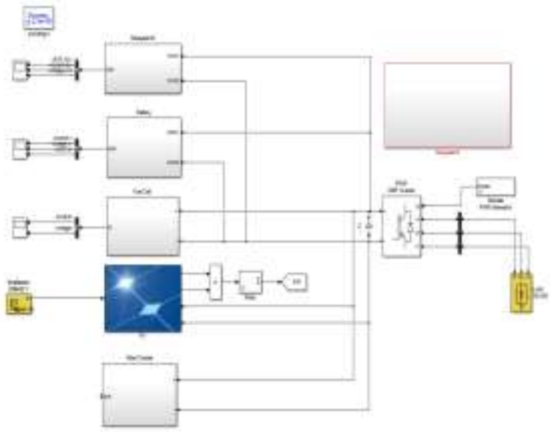
Radial basic function (RBF): $K(x_i, x_j) = \exp\left(-\gamma \left\| x_i - x_j \right\|^2 \right)$ (24)

At this point, ρ and γ are adaptable kernel parameters. The kernel parameter should be prudently selected as it subliminally describes the structure of the great dimensional feature space $\phi(x)$ and therefore panels the complication of the final result. Additionally, the function of the model is seriously reliant on the regulation parameter C, the width of the tube ε and the parameter of the selected kernel performance. From the application point of view, training is corresponding to disentangling a linearly embarrassed quadratic programming (QP) with the number of variables twice that of the input information dimension.

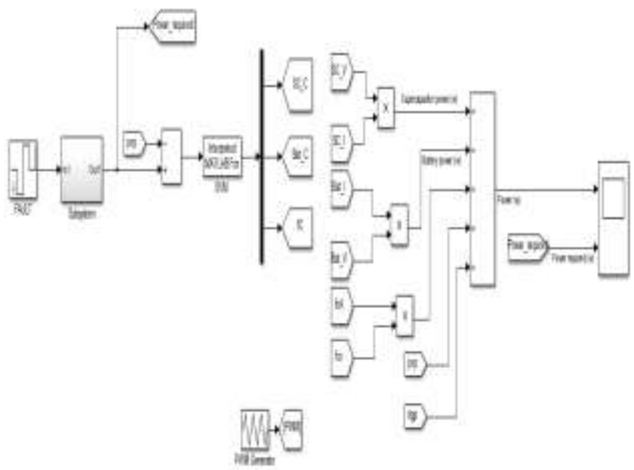
The anticipated technique exploits these recompenses of the SVM to attain a computationally effectual assessment algorithm. This stage involves information acquisition, information alteration and format adaptation for the SVM arrangement model applied to accomplish the information facts from each of the load profiles. These information points are then rehabilitated into the feature variables of the input vector. Then it pacts with the assortment of the optimal kernel has to be applied in the classification model of the load profile. Numerous kernels are assessed and the one with optimized parameter that provides the uppermost accurateness with lowest number of SVs is selected. Lastly, the cross validation is performed and the groups of information are utilized as the testing information while the others are utilized for training determination. This permits the classification accurateness to better reproduce the model's capability in categorizing novel information. The performance investigation of the projected technique is appraised and elucidated in segment 4.

RESULTS AND DISCUSSION

In this segment designated the result and discussion of the projected technique with the SVM organization algorithm. In that the projected scheme is applied with Intel(R) core(TM) i5 processor, 4GB RAM and MATLAB/Simulink 7.10.0 (R2015a) platform. The projected scheme is applied and the simulation diagram is demonstrated in [Fig. 3]. At this time, the projected technique restrained the actual parameters and preserves the stable power slow for the grid connected scheme. The controlling parameters are measured hinge on the SVM classifier. In this segment, the measured parameters are appraised to the function of the anticipated scheme and associate with other approaches and to assess the efficiency of the scheme. In this investigation, the procedures have two cases on the basis of the load and output power of the scheme. Primarily, the non-linear power and linear load parameters are assessed and evaluated secondly, the linear power and non-linear load. The parameters are assessed and to preserve the power flow on the basis of the SVM training dataset.



(a)



(b)

Fig. 3: The Simulink structure of (a) the projected model (b) SVM prediction model

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Table.1: The simulation parameters

No	Parameters	values
1.	PV rated power	3.78kW
2.	PV open circuit voltage	64.2V
3.	PV short circuit current	5.96A
4.	WT rated power	1kW
5.	FC rated power	1.26kW
6.	FC nominal stack efficiency	55%
7.	Battery nominal voltage	26.4V
8.	Battery rated capacity	6.6Ah
9.	UC rated voltage	16V
10.	UC rated capacitance	500F

Performance investigation of the projected method

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Case1: Linear load demand with non-linear power generation

The projected scheme application parameters are tabularised in [Table. 1]. In this parameters are utilized in an application progression. The actual parameters are appraised and assess the reference parameters of the training dataset and then it will train with the help of SVM. The assessed parameters are exemplified in subsequent. Primarily the case 1 like non-linear power and linear load condition is accessible and appraised.

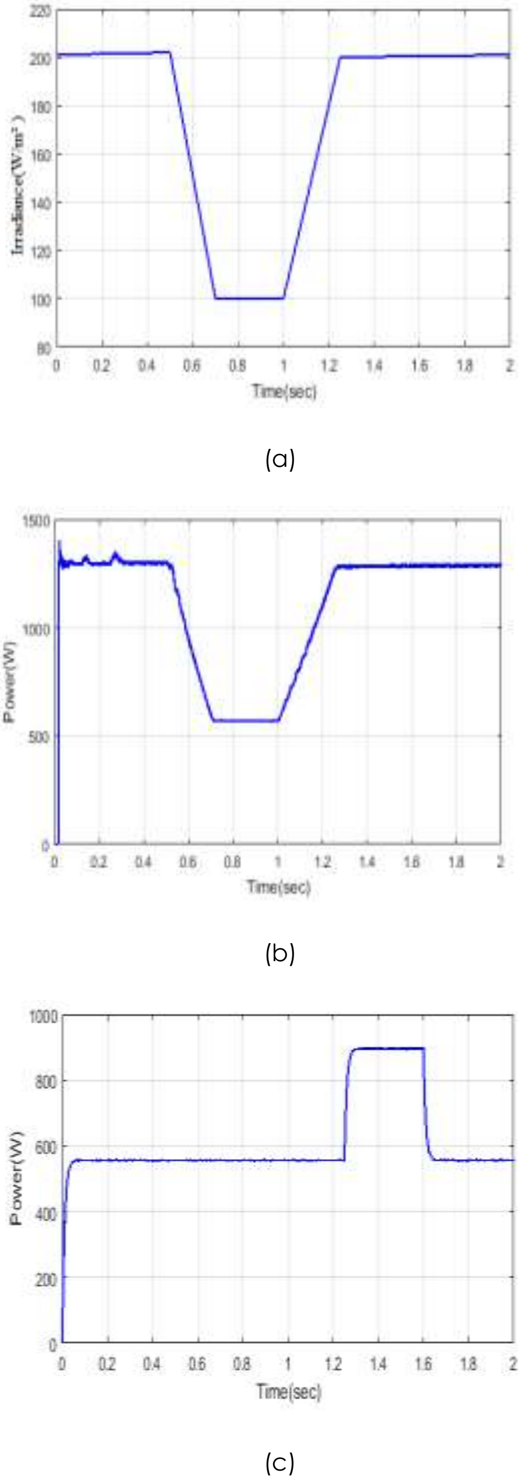

Fig.4: Power fashioned from the generation model (a) Irradiation, (b) PV power, (c) Wind power in case 1.

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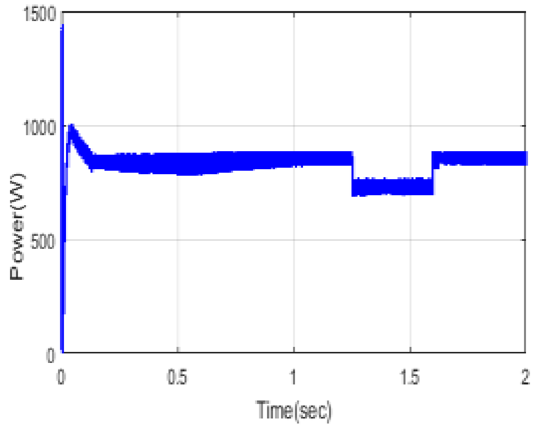
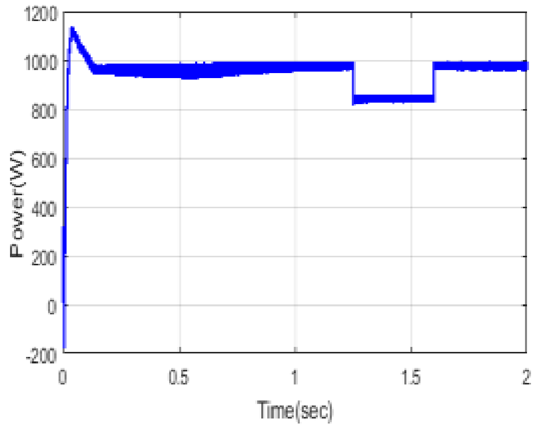
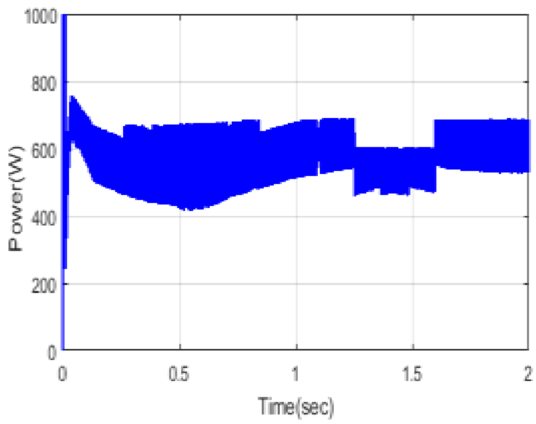


(a)



(b)



(c)

Fig.5: Power fashioned from the storage model (a) Battery, (b) UC, (c) FC in case 1.

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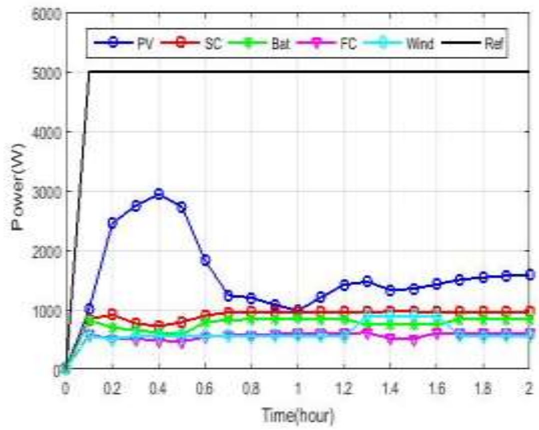

Fig. 6: Power produced from the existing sources SC, Battery, FC, PV and WT in case 1.

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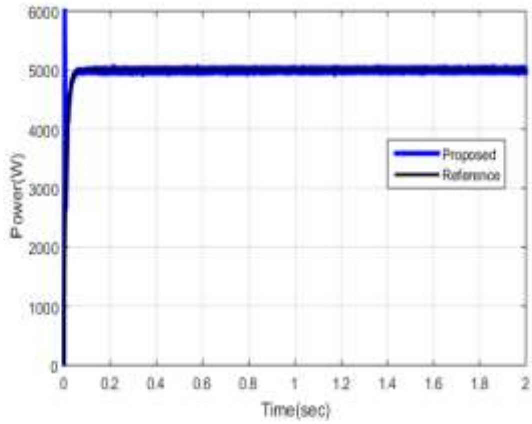

Fig. 7: Projected technique load power contrast in case 1.

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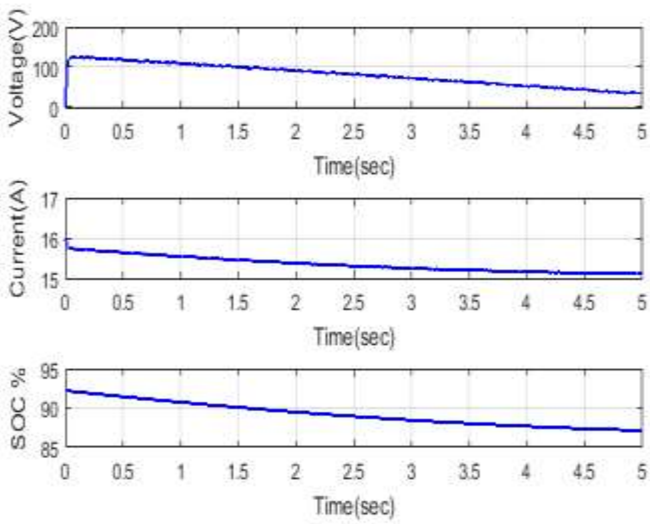

Fig. 8: Battery states of charge in case 1.

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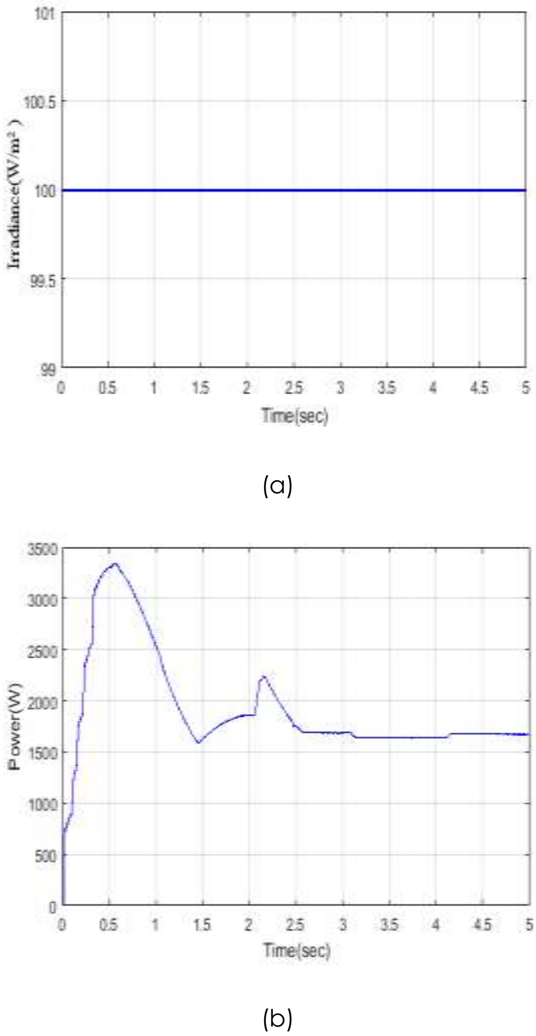
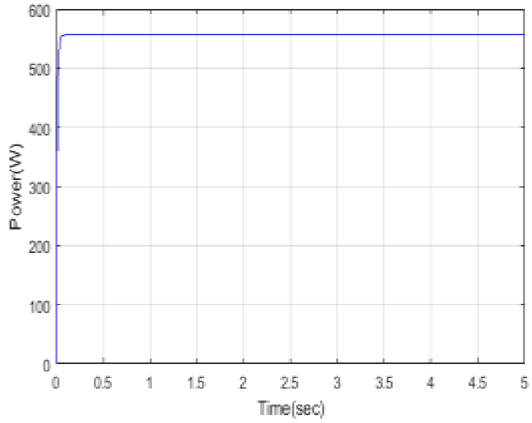
In case 1 is the generated power is unbalanced condition and the output load is linear circumstance. The power generation of a generation scheme model is assessed and demonstrated in [Fig. 4]. In a figure declared that the variation of the irradiations, PV power and WT model is designated. Then the storage scheme model power is restrained and plotted in [Fig. 5]. In that the battery, UC and FC power variation is demonstrated. If the power of the battery is deposited the energy and control the flow of the micro grid.

The power assessed from the manufactured and stored scheme model is exemplified in [Fig. 6]. In this figure, demonstrated the generated model and storage model power and declared and associated with the reference power of the projected scheme. The efficiency of the projected model with this case 1 on the basis of the linear load demand is demonstrated in [Fig. 7]. Then the storage scheme battery state of charge is designated in [Fig. 8]. SoC is generally utilized if conferring the current state of a battery in usage when conferring the lifetime of the battery after recurring usage. Frequently, SoC cannot be restrained directly but it can be assessed from direct measurement variables. Lastly the second case is restrained and also assessed the parameters of the influence of the structure.

Case2: Non- linear load demand with linear power generation

In the case2 encompasses of the linear power output and non-linear load circumstance of the projected scheme that revenue that the output of the PV and WT power is stable condition. In this condition, the power of the irradiance, PV and WT are restrained and exemplified in [Fig. 9]. The irradiance of the solar is unwavering and it preserves normal values. The power of the PV and WT is originally high value and it preserves the stable values. The solar irradiance is 100, PV power upholds 1700 watts and the WT upholds the 550 watts for generation model. Then the storage scheme model is restrained and appraised in case 2 so the output load demand is fluctuating and it cannot be unhinged.





(c)

Fig. 9: Power fashioned from the generation model (a) Irradiation, (b) PV power, (c) Wind power in case 2.

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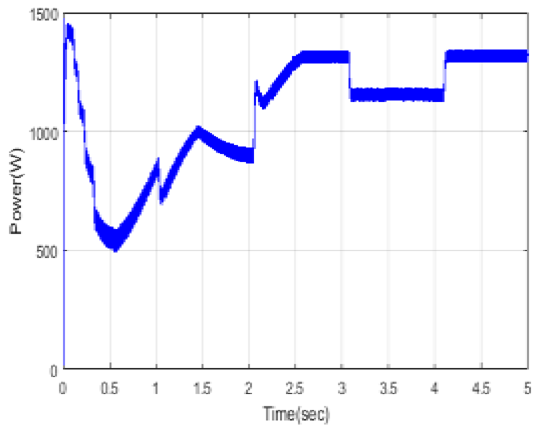
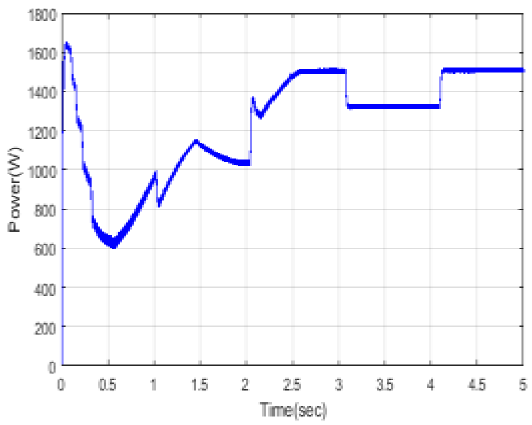
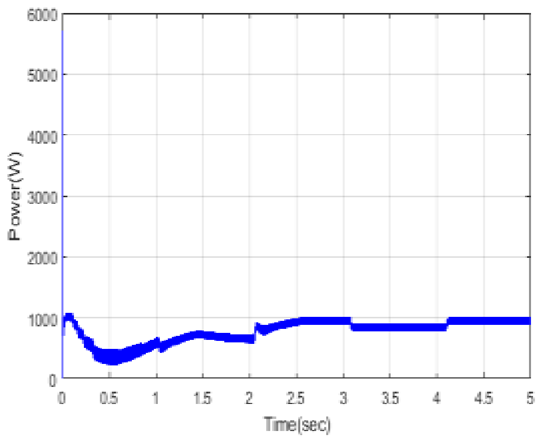
The restrained power of the battery, UC and FCs are assessed in [Fig. 10]. The power of the battery is differs from 500 watts and the UC is differs from 600 to 1500 watts and then the power of the FC is hesitated less than 1000 watts. Lastly, the assessed power of the renewable sources and the energy storage schemes are associated with the reference power signal that is designated in [Fig. 11].



(a)



(b)



(c)

Fig.10: Power produced from the storage model in case 2 (a) Battery, (b) UC and (c) FCs.

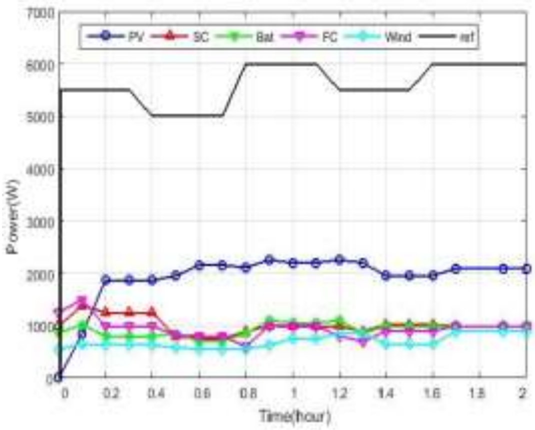


Fig.11: Power produced from the existing sources UC, Battery, FC, PV and WT

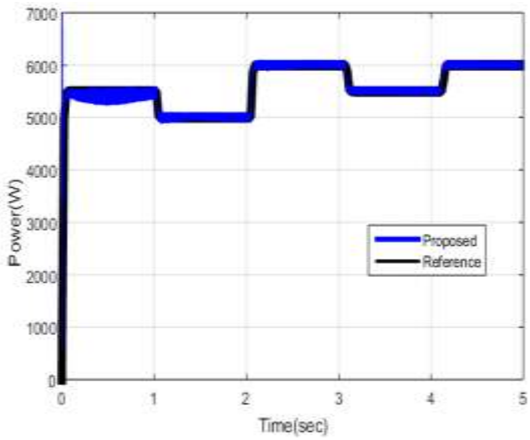


Fig.12: Projected technique load power assessment in case 2.

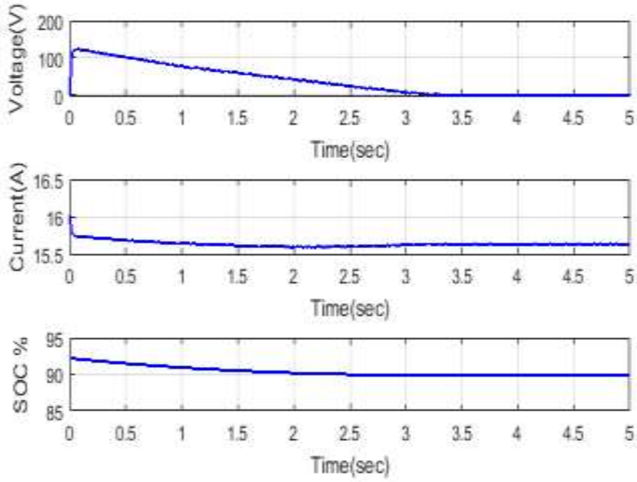


Fig.13: Battery states of charge in case 2.

In the present case 2 the awaited system efficacy with the load demand is associated in [Fig. 12]. Then, the monitoring power storage scheme states of charge is demonstrated in [Fig. 13] that displays the voltage, current and state of charge for battery is revealed. In this battery charge can progresses the power control of the MG on the basis of demand of the loads. The association with the load demand is assessed and appraised below.

Comparison with the reference signal

In this sub segment, the comparison investigation of the projected model with the dissimilar traditional models such as ANN and fuzzy, this associated with the reference power signal of the projected model. The projected model assessment investigation is designated in [Fig. 14], that the optimal power flows of the projected method consistent with the reference signal. At that time, the energy organization is associated with the traditional methods that demonstrated in [Fig. 15]. In this figure, encompasses the efficiency of the projected model can transformed the power conforming the load claim of the MG model. In this segment, designated about the function of the projected technique for the load demand and the projected predictive model are greater to other methods. In this technique, function is enhanced on the basis of the load demand also the battery life span of the storage scheme.

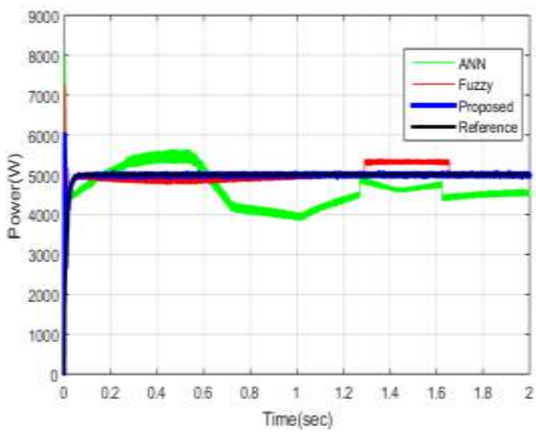


Fig.14: The comparison investigation of the generated power with dissimilar methods

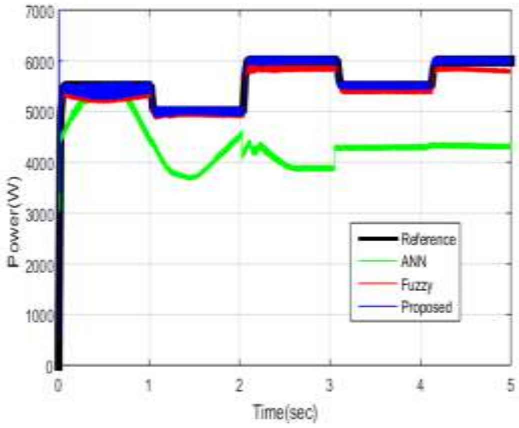


Fig.15: Energy management assessment with the help of dissimilar methods

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The power flow of the MG is joined with the converter utilized for power alteration of the MG. Henceforth; the contrast investigation is shown that the projected forecast model is better operative for the linear, non-linear load ultimatum. Then the projected model is determined in segment 5.

CONCLUSION

This article suggested an energy management model for micro-grid implementation on the basis of the SVM expectation model. The projected model is associated with the generation classical then the energy stowage model. The production model comprises of a solar PV and WT, the energy storage scheme comprises the UC, battery, and FCs. The SVM prognostic model is produce the dataset on the basis of the projected energy organization scheme restraints for training the extrapolation model. Then the projected scheme is enhanced the power necessities by considering a photovoltaic power accessibility, battery bank SOC and load power request. The function of the projected model is investigated on the basis of the two cases similarly linear and non-linear load stresses and power generation. Lastly, the load power request association investigation is achieved with diverse traditional methods such as ANN, fuzzy complete reference signal. Formerly the association solutions are recognized that the anticipated technique is improved than the other out-dated methods.

CONFLICT OF INTEREST

There is no conflict of interest regarding the publication of this paper.

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No financial contribution for my manuscript.

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