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Evolutionary Algorithms Based Optimization of PID Controller for Hybrid Renewable Energy System

Sampathkumar V. Patil
Department of Electrical Engineering
Visvesvaraya Technological University, Belgaum, Karnataka
sampathkumarvpatil@gmail.com

Dr. S. B Shivakumar
Department of Electrical Engineering
Proudadevaraya Institute of Technology, Hosapete, Karnataka
shivashantala@gmail.com

***Abstract:** In these paper, Optimum design of PID Controller for Hybrid Wind/PV system is demonstrated considering the meteorological Data of solar radiation and wind speed from NASA surface and solar energy database of Hospet has been taken (latitude 15.54°N and longitude 74.48°E).Around 160 family or approx. 1 village community electricity consumption data has been taken thereby using the HOMER Software simulation has been carried out to find the Best Hybrid system in Hospet comparing the economic advantages like cost, payback period and other economic factors. It finds that Cost Reduction is around 70% compared to Conventional Energy source, but due to Non-linear Power generation and Load side variation, usage of Hybrid power system became very less. So, in order to avoid the above, we came up with Energy Management system (EMS), where the PID Parameters are used for controlling the EMS charging and discharging. Here the PID Controller is tuned through different Evolutionary Algorithm approaches like Genetic Algorithm(GA), Hyper-Spherical Search(HSS), Flower Pollination Algorithm(FPA) and Particle swarm Optimization(PSO).Hybrid System like Wind/PV is modelled in Simulink and algorithms is implemented in Matlab, finally, all the above algorithms are computed based on Objective Function Value, Rise time, Settling time and Overshoot and it is validated that HSS algorithm is best compared to all other algorithms*.

Keywords:** Renewable Energy Sources, Wind-Turbine, Photovoltaic, NASA Surface and Solar Energy Database, Google Earth Hybrid-RES, Load Sensitive EMS control, Evolutionary Algorithms, Genetic Algorithm, Hyper Spherical Algorithm, Flower Pollination Algorithm and Particle Swarm Optimization.

1. INTRODUCTION

Hybrid renewable energy systems (HRES) are becoming popular because of cost reduction and improvement in reliability. A hybrid energy system, or hybrid power, usually consists of two or more renewable energy sources used together to provide increased system efficiency as well as greater balance in energy supply. Every renewable energy system has one or other disadvantages like Solar panels are too costly and the production cost of power by using them is generally higher than the conventional process, it is not available in the night or cloudy days. Similarly, Wind turbines can't operate at high or low wind speeds and Biomass plants collapse at low temperatures. So in order to avoid the above here we combined two renewable system and provided the best solution for the above disadvantages, here the best Hybrid system is calculated based on the factors like cost, Payback period, Cost and it is simulated in Homer energy software, based on the simulation results the best Hybrid renewable systems is considered. In these paper Both Generation side and Load side is controlled through an EMS (Energy Management system), where the Optimization of PID parameter is done through which charging and discharging of Battery is controlled based on actual speed and reference speed load torque is generated which is directly proportional to armature current, due to this armature current, Load power is calculated and finally based on Load power and generated power, the PID parameters are tuned through which the charging and discharging of batteries or EMS is controlled, there by balancing the generated power and Load Power.

2. OBJECTIVES

Our proposed model, as Hybrid-RES encompasses WECS and Photovoltaic cells as power generators, while Nickel-Cadmium batteries are considered as power storage device. Considering control mechanism to assist reliable power generation and transmission (say, delivery) to the customers, we emphasize on enabling efficient charging and discharging control of the EMS system where realizing power-system dynamics both the generation pattern, as well as load side variations, are taken into consideration. Unlike major existing approaches where either PI or PID controllers are used to control generator side parameters such as WT speed control or pitch angle control, or even EMS charging-discharging control, we have enhanced PID parameters using EC approaches. Non-deniably, the classical approaches with static PID parameters (i.e., gain parameters) can't be optimal for control functions, particularly under dynamic load or generation conditions. Realizing such limitations of the existing approaches and taking it as motivation, in our research enhanced EC schemes such as AGA and BPSO algorithms are applied to perform on-line PID parameter tuning to assist swift EMS control and stabilization. Unlike classical Genetic Algorithm (GA), our proposed AGA algorithm applies adaptive GA parameter assignment such as the adaptive probability of crossover and mutation. It enables swift convergence that in practice alleviates the issue of local minima and convergence. Similarly, the use of BPSO enables swift best solution retrieval to cope up with the transient variations. However, the robustness of AGA keeps it leading to meet reliable optimization demands. Some of the key contributions of this research paper are:

1. Hybrid-RES based Power system by proving that Wind/PV is the best combination for generating power considering the disadvantages of conventional energy sources like greenhouse effect of burning fossil fuel and exhaustible nature.
2. Entire concentration is given on Optimization of Batteries where we have increased the number of batteries compared to Diesel generators and used batteries as backup source
3. Optimisation of Batteries is done by using Hybrid Evolutionary algorithm like Adaptive Genetic Algorithm and Particle swarm Optimization through tuning of PID Parameters
4. Consideration of both the non-linear power generation patterns as well as dynamic load variations to control EMS functions

3. HYBRID WIND/PV RENEWABLE SYSTEM

3.1 Project Site Location

The Project site location is chosen as Hosapete, which is located at Karnataka State of Bellary District. It has a Latitude of 15° 27' 0'' N and Longitude of 76° 39' 0'' E. Site location is captured using Google Earth. The calculation is done for the community of around 1200 to 1500 People, which will be approx. 160 to 170 kwh/Day.

Fig. 1. Hospete View from Google Earth

The average annual solar radiation in Hospet as per data base NASA Surface and solar energy database it is approximately 5.33 kwh/m2/day and annual average wind speed is 3.68 m/s.

3.2. Solar Radiation and Wind speed in Hosapete as per NASA Surface and solar energy Data Base

Solar Radiation: From the Fig.2, it clearly indicates that during of June-Aug the radiation is lower, which will be around 4.4 to 4.8, but the care is taken from backup sources like batteries and wind turbine. Annual average of solar Radiation is 5.33 KWh/m2/day

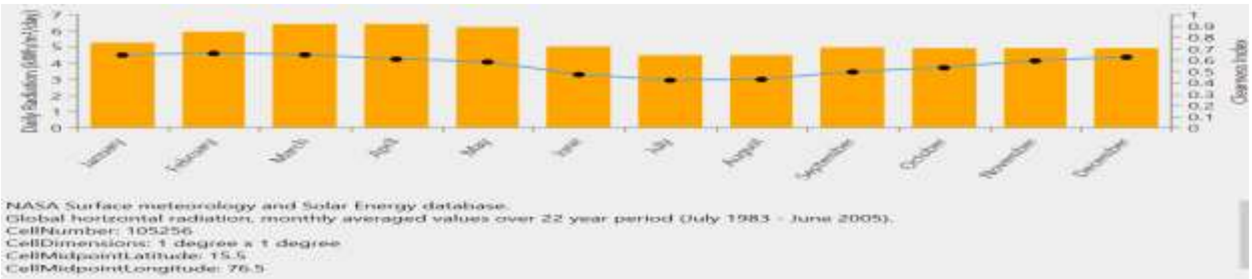


Fig. 2. NASA Surface Meteorology and Solar Energy Database of solar Radiation throughout the year

Table 1. Solar Radiation DataBase of Hosapete throughout the Year

Month	Solar Radiation	
	Daily Radiation (KWh/m2/day)	Clearness Index
January	5.250	0.642
February	5.930	0.657
March	6.420	0.645
April	6.400	0.606
May	6.230	0.581
June	5.020	0.470
July	4.470	0.420
August	4.510	0.427
September	4.990	0.493
October	4.910	0.530
November	4.930	0.591
December	4.910	0.623
AVERAGE	**5.33**	

3.3 Wind Speed: From the Fig, it clearly indicates that during of June-Aug the radiation is high, which will be more than 5 m/s, which will act as a backup source along with batteries. Annual average wind speed is 3.68 m/s.

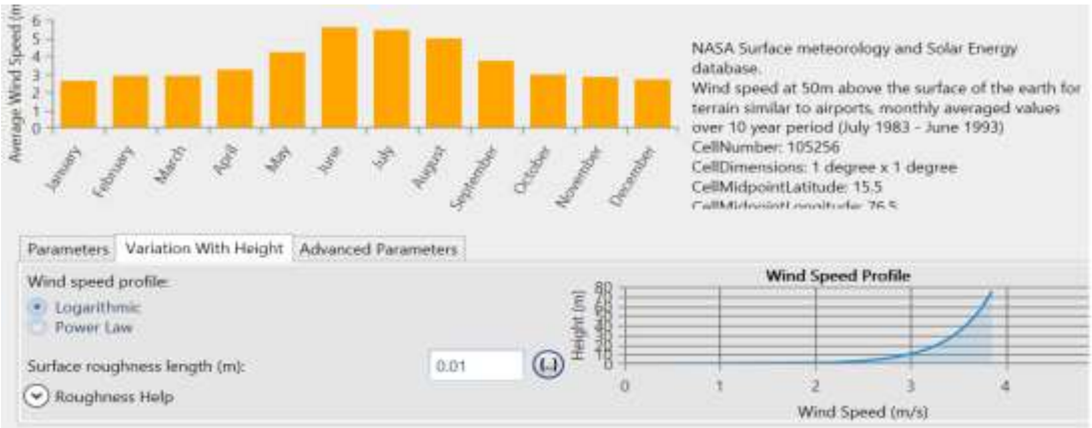


Fig. 3. NASA Surface Meteorology and Solar Energy Database of Wind Speed Throughout the Year

Table 2. Wind Speed DataBase of Hosapete throughout the Year

Month	Wind(m/s)
January	2.610
February	2.910
March	2.910
April	3.260
May	4.220
June	5.560
July	5.420
August	4.990
September	3.710
October	3.000
November	2.810
December	2.710
AVERAGE	**3.68**

3.4. Load Estimation

3.4.1. Electricity Demand for each Family

i. Two CFL bulb = 20(power rating of each bulb) ×2(no. of bulb) ×6(hours of operation) = 240Wh
ii. One Fan = 60(power rating of fan) ×1(no. of fan) ×8(hours of operation) = 480Wh
iii. One Television set and other appliances (e.g. Mobile Charger) = 40(average power rating) ×6(hours of operation) = 240Wh
iv. So, Total Demand for each family from above is 240+480+240=960 Wh/day

3.4.2 Electricity Demand for Temple or Mosque

Considering one temple and one mosque around one community of 1200 people and considering 4 cfl bulbs and one fan which would be around 900Wh/day

3.4.3. Electricity demand for School and Total Demand

i. Considering a school of 4 cfl, two fans and other accessories which would be approx. 1500 Wh/day
ii. The total Maximum demand for energy for a community of approx. 1200 people of 160 families would be (160*960)family+900(temple)+1500(school)=156 KWh/day
iii. During the dry season of March-June considering 4 pumps of each one h.p would be approx. 746(watts)*4(quantity)*6(hours of operation)=17.9 KWh
iv. So approx... For a community of 1000 to 1200 people electrical Load is calculated for 164 KWh/day.

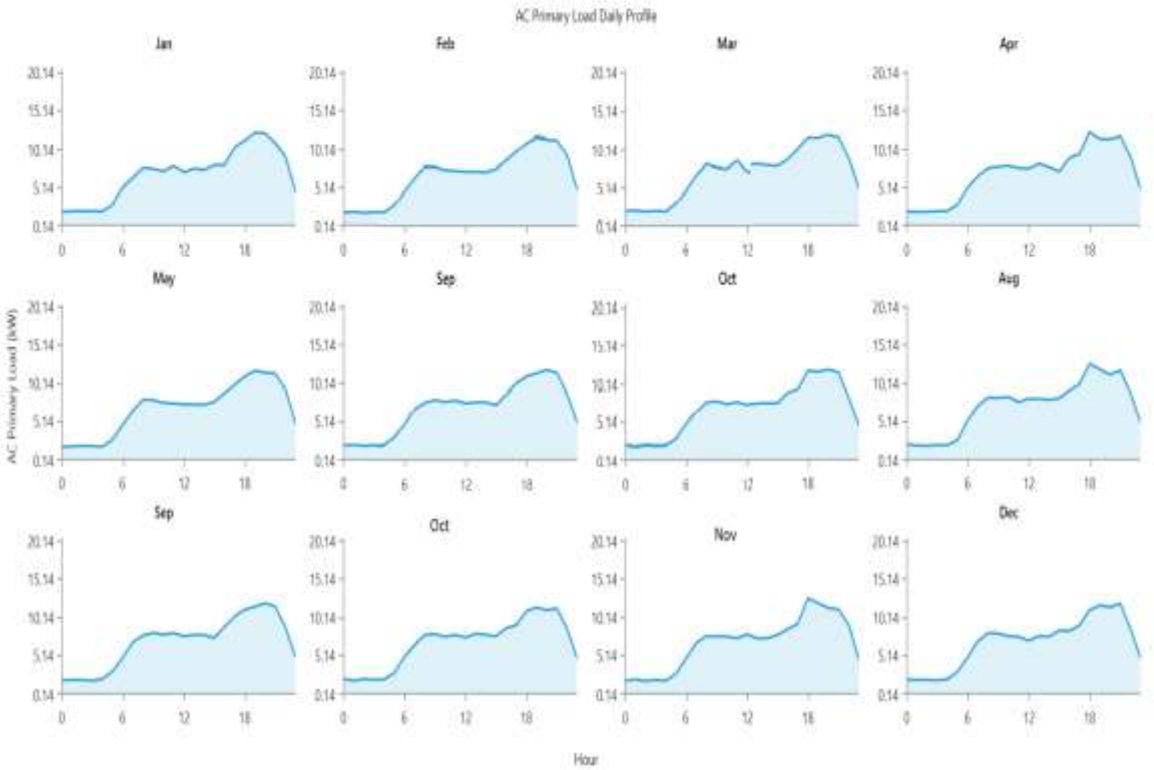


Fig. 4. AC Primary Load Daily Profile Throughout Year

3.5. INPUT COST OF equipment

Table 3. Lists the Unit Price of Equipment's used for Calculation

(Unit costs Data is collected from Local Market.)

Component	Size(KW)	Capital Cost	Replacement Cost	O & M Cost
Wind Turbine-Generic 3 KW	3	2,40,000.00	2,20,000.00	10,000.00
Generic Flat Plate PV	1	90,000.00	80,000.00	4,500.00
Diesel Generator Scheme	10	80,000.00	70,000.00	200.00/hr
Storage Device	1	7,000.00	6,000.00	200.00
Converter	4	25,000.00	20,000.00	1,200.00

3.6. Component Model of Hybrid System

Here the different components like wind Turbine, solar Panel, Batteries, Diesel generators, convertor are used for optimizing the Best Hybrid System and Model is shown below.

Fig. 5. Model of Hybrid Power System with Wind/PV/Generator

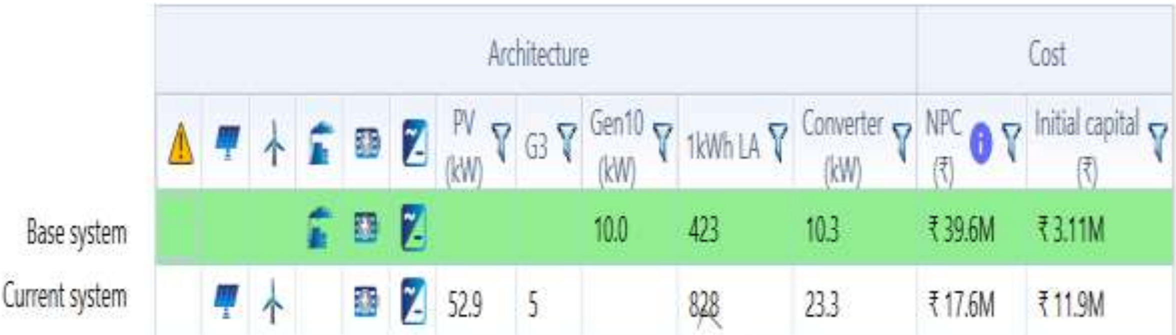
3.7. Cost Summary and Comparison with Conventional Energy Source

In these paper, we have simulated the Hybrid Power system with Wind, PV and Diesel generator, but the Optimization result shows that use of Wind/PV is the best compared to the Diesel Generators. Due to non-linear power generation, in many cases, Diesel generators are used as a backup source but which in turn we are again depending on the Conventional energy sources, so in order to avoid the above we are optimizing and increasing the size and efficiency of battery by using the suitable evolutionary algorithm. Here the Cost comparison is done using Total Net Present Cost (NPC), Cost of Energy (COE) and Operating Cost. The total net present cost (NPC) of a system is the present value of all the costs the system incurs over its lifetime, minus the present value of all the revenue it earns over its lifetime. Costs include capital costs, replacement costs, O&M costs, fuel costs, emissions penalties, and the costs of buying power from the grid. COST OF ENERGY (COE) is defined as the average cost per kWh of useful electrical energy produced by the system.

Table 4. The Cost Associated with each Component

Cost Summary (Net Present	**System**	**Generic Flat Plate PV**	**Generic 3 kW**	**Generic 1kWh Lead Acid**	**System Converter**
Capital	₹ 1,19,05,484.24	₹ 47,64,010.19	₹ 12,00,000.00	₹ 57,96,000.00	₹ 1,45,474.05
Replacement	₹ 18,05,259.68	₹ 0.00	₹ 3,50,688.09	₹ 14,05,194.92	₹ 49,376.67
O&M	₹ 43,51,185.72	₹ 30,79,341.03	₹ 6,46,375.83	₹ 5,35,199.19	₹ 90,269.67
Salvage	₹ -4,71,400.28	₹ 0.00	₹ -1,97,635.23	₹ -2,64,471.87	₹ -9,293.19
Total	**₹ 1,75,90,529.36**	**₹ 78,43,351.22**	**₹ 19,99,428.69**	**₹ 74,71,922.24**	**₹ 2,75,827.21**

3.8. Comparison with Conventional Energy Source- Generator



	Architecture					Cost	
	PV (kW)	G3	Gen10 (kW)	1kWh LA	Converter (kW)	NPC (₹)	Initial capital (₹)
Base system			10.0	423	10.3	₹39.6M	₹3.11M
Current system	52.9	5		828	23.3	₹17.6M	₹11.9M

Fig. 6. Comparison of Wind/PV with Generator

Table 5. Cost Summaries

Total NPC	1,75,90,529.36
COE	22.25/KWh
Annual Consumption	60,340 KWh/year
Present worth (₹)	₹ 2,19,60,770
Annual worth (₹/yr)	₹ 20,57,258
Return on investment (%)	27.0%
Internal rate of return (%)	27.4%
Simple payback (yr)	3.63year
Discounted payback (yr)	4.20year

3.9. Pay Back Period

i. Here, Total Net Present Cost (NPC): Rs.1,75,90,529.36
ii. Levelized Cost of Energy (COE) : 22.25/KWh
iii. Operating Cost :Rs.4,39,763.10
iv. Initial Capital cost of the system :Rs1,19,05,484.00
v. At 6% interest rate, system fixed capital cost = 7,14,329.00
vi. Total initial capital cost of the system = 1,26,19,813.00
vii. Return on Investment from Optimisation Result is 27% i.e..,1,19,05,484*.27=32,14,480.00(as annual consumption of Load is 60,340 KWh/year)
viii. So, Payback Period is Initial Capital Cost/Annual Income i.e.1,19,05,484/32,14,480=3.70 years.

Thus from the Above, it clearly indicates that Hybrid Source is the Best source compared to conventional energy source because the payback period is approx. 4 years and one time investment in entire 20 to 25 years life cycle. Economically Hybrid Renewable system of wind/PV is the best system compared to another system, but the Reliability, quality and sufficient amount of power during different seasons has to be taken care, which is explained in the next chapter

3.10. Analysis of Output of Wind, PV & Charging , Discharging of Batteries on Year Basis

From Fig.7 it clearly indicates that during the Month of June –Sep, due to whether condition the PV power output is low, but at the same time wind and battery discharge is high which can be compensated.Even if the shortage of power occurred during any month, using the excess amount of batteries the requirement of excess energy can be compensated.

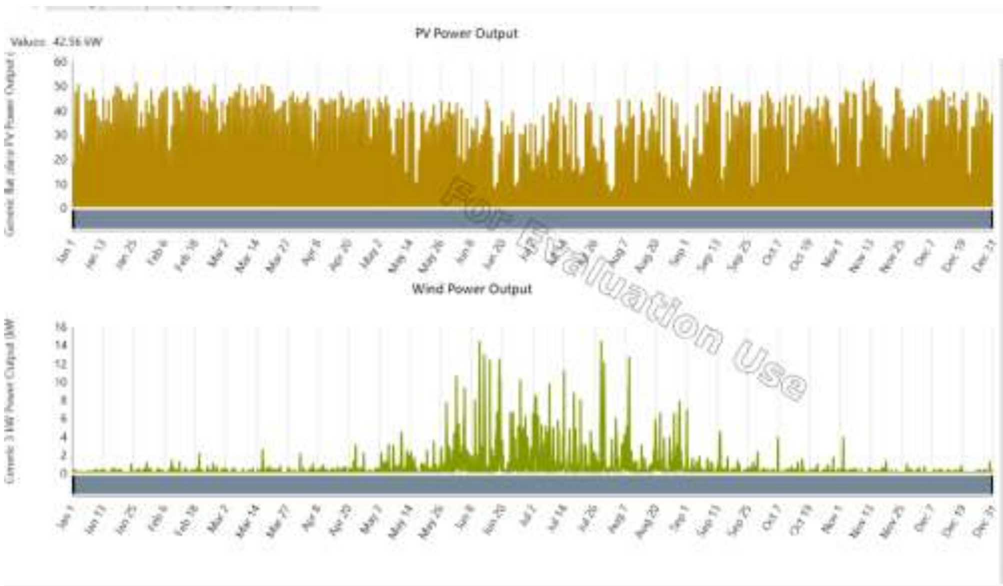


Fig. 7. PV Power Output and Wind Power Output in KW

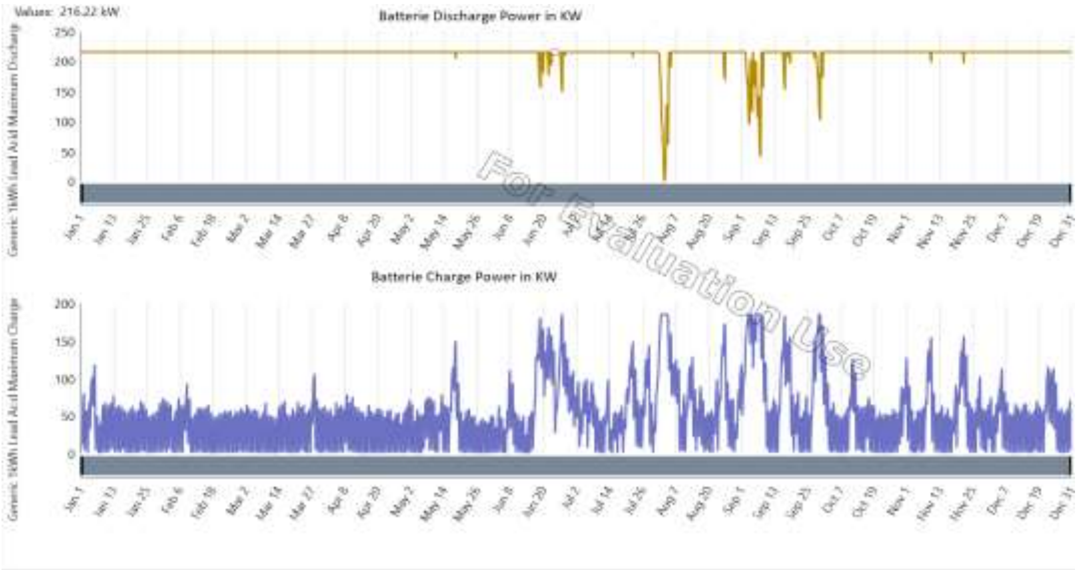


Fig. 8. **Battery Discharge and Charging Power**

3.11. Proportional-integral-derivative (PID) Controller

In present day industrial applications, PID controllers are the most commonly applied controllers, particularly for electrical or electronic system control. A simple schematic of the PID controller is given in Fig. 9. PID controller employs the continuous time and the transfer function to perform control functions [49]. In our proposed EMS control model PI controller with EC based parameter tuning is applied.

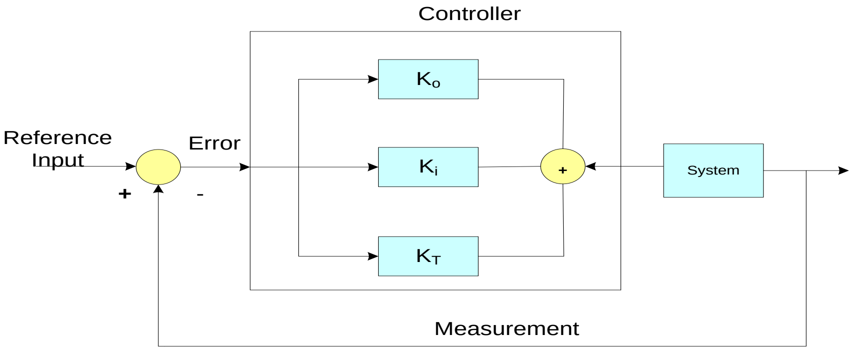


Fig. 9. **Schematic of PID Controller**

$$u(t) = K_p\left[e(t) + \frac{1}{T_i}\int_0^t e(t)dt + T_d\frac{e(t)}{dt}\right]$$

$$G_{Controller} = K_D + K_T s + \frac{K_i}{s}$$

This is the matter of fact that the robustness of PID controller enables it to be one of the prominent alternatives for EMS control; however, the static or fixed gain parameter of the classical PID confines its suitability, particularly under those conditions like exceedingly dynamic non-linear generation and load variation. To deal with these limitations, optimal PID parameter selection, and tuning can be of paramount significance. With this motivation, in this research work, we have applied different enhanced EC algorithms such as AGA and BPSO to perform PID parameter running in the real-time environment.

3.12. Objective Function (OF)

Generally, there are numerous indices applied to assess PID controller performance. Some of these indices are; Integral Square Error (ISE), Integral Absolute Error (IAE), ITAE, and Mean Square Error (MSE). In this paper, we have applied ITAE reduction as the objective function to perform PID parameter tuning, where AGA and/or BPSO tries to reduce ITAE iteratively to achieve optimal PID parameters so as to enable swift and efficient EMS control. The efficiency or capability of ITAE to avoid long duration transient makes ITAE suitable for our study. Mathematically, ITAE is given in equation (1), which is obtained as the difference between the load power and the generated power.

$$\text{ITAE} = \int_0^{\infty} \text{t}|\text{e(t)}|\,.\,\text{dt} \tag{1}$$

Noticeably, once achieving the minimum objective function e(t), the respective PID parameters are selected and based on which the charging and discharging control is performed using PID controller. In addition to the above mentioned, ITAE based PID parameter tuning, in our model as a supplementary enhancement, we have applied EC-PID scheme (i.e., enhanced EC based PID controller) for Wind-Turbine speed control. In this case equation (1) characterizes the objective function e(t) as the error between the reference speed and the actual speed.Now, applying above mentioned objective functions, we have performed PID (tuning) parameter optimization using AGA and BPSO algorithms. A brief of the EC schemes applied in this research work is given in the following sub-sections. In this paper, the emphasis is made on applying EC schemes mainly for EMS control optimization to avoid any outage probability and to facilitate quality power to the customers.

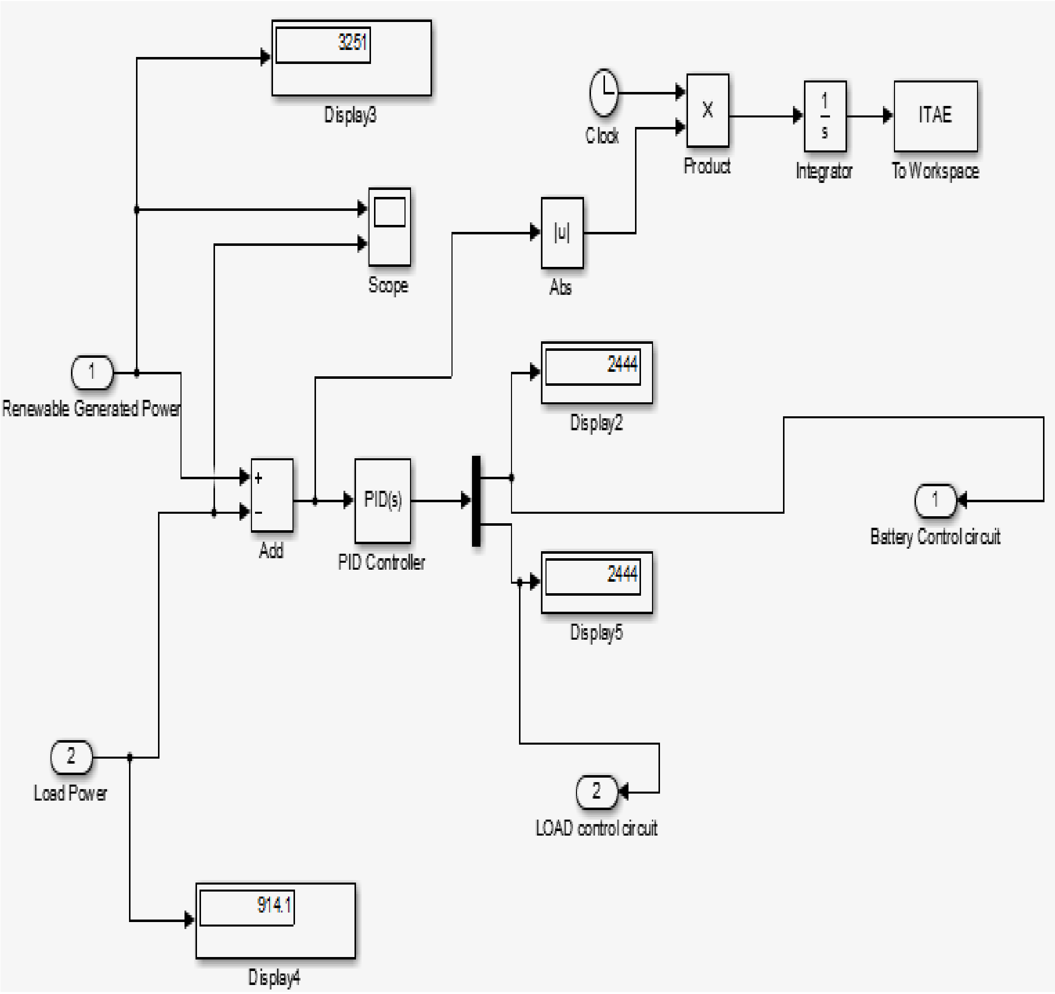


Fig. 10. Evolutionary Computing Assisted PID Controller for EMS

3.13. Evolutionary Computing Algorithms

Generally, EC algorithms are derived from the natural phenomenon such as GA is based on human evolution; PSO is based on swarm behaviour. Similarly, other EC algorithms such as Ant Colony Optimization (ACO), Bee Foraging Optimization (BFO), Flower Pollination Optimization (FPO) too employs respective natural behaviour to obtain certain optimal or sub-optimal solution. Especially, these algorithms become inevitable in case of NP-Hard problems. Considering present study, where the emphasis is made on obtaining the best PID tuning parameters to perform charging and discharging control of the EMS system so as to enable dynamic or load sensitive controllability. Amongst major solutions available (say, random PID parameters as population), EC algorithms can help in retrieving the best solution to achieve efficient and swift control of charging and discharging of the battery systems.

3.13.1. Adaptive Genetic Algorithm (AGA)

In GA, a population of strings, also called chromosomes encode an individual solution for optimizing the result, evolves toward certain more efficient solutions. Noticeably, solutions are signified in binary form as the strings of zeros and ones. In GA process the evolution is started from a population where the individuals are generated randomly and the generation continues till stopping criteria. Here, in all iteration the fitness value of each population is obtained based on which the individuals with higher fitness are selected to provide solution. Further, the selected populations are altered by performing reproduction and mutation to generate a new generation having better fitness and proximity to the optimal solution. The newly obtained population is then processed in the next iteration to achieve a better solution than the previous once and this process continues till the stopping criterion is obtained. It might continue iterating till the error ITAE error becomes minimal by maintaining generation and load demands equal.

3.13.2. BPSO (Binary Particle Swarm Optimization)

Typically, BPSO algorithm represents a type of stochastic heuristic optimization approach that performs removal of the features from the correlation investigation. It applies swarm intelligence technique to identify optimum PID tuning parameter or gain parameters by means of obtaining global minima. In this algorithm, the particles inform the inner velocity in PSO and dissimilar to the classical GA, BPSO avoids iterative crossover and mutation process that significantly reduces computational overheads and time. In addition, through GA chromosome distributes key information to one another, which is usually avoided in BPSO which executes information swap via finest area. Classical EC algorithms functions in the continuous domain but BPSO can be adapted into the discrete domain too.

3.13.3. Flower Pollination Algorithm (FPA)

In the year 2012, yang was found FPA, enthused through the flow pollination procedure of flowering plantations. The rules of FPA are given as follows.

- ✓ Rule1: Biotic and cross-pollination is able to be measured as a procedure of global pollination method, and pollen-carrying pollinators go in a manner that obeys Le'vy flights.
- ✓ Rule 2: A biotic and self-pollination are employed for local pollination.
- ✓ Rule 3: Pollinators for example insects is able to develop flower dependability that is equal to a reproduction probability, which is proportional to the comparison of two flowers engrossed.
- ✓ Rule 4: The communication or changing of local pollination and global pollination is able to be managed through a switch probabilityp $\in [0,1]$, by exploiting a slight bias toward local pollination.
- ✓

3.13.4. Hyper-Spherical Search(HSS)

Generally, optimization is a method of creating somewhat superior and is formed as follows:

✓

$$min\{f(x)|x \in X\} \quad (17)$$
$$subject\ to : g(x) \geq 0; \ \ h(x) = 0$$

- ✓ The least value of the OF, f(x), is established via the optimization process exposed to a few constrictions that are classified as parity and disparity constrictions, h(x) and g (x), respectively. The value of the OF depends on the set of verdict parameters, x, maneuvering in the feasible range of values $X_{i,min} \leq x_i \leq X_{i,max}$. The HSS algorithm is a metaheuristic approach employed in non-linear optimization issues. The usefulness of this algorithm above the customary optimization techniques was illustrated

4. RESULTS AND DISCUSSION

Considering the significance of a robust EMS control model for Hybrid-RES system, in this work, the emphasis was made on exploiting both load variations and non-uniform generation pattern to perform optimal charging and discharging control. We modelled Wind-Turbine Energy Conversion system (WECS) and Photovoltaic (PV) cells, where WECS was developed for the specification of 3kW generation power, 50 Hz frequency and 440 V supply. Noticeably, here we used PMSG wind turbine of 3kW power. Similarly, PV cell of 1 kV was used to derive PV power system, with traditional Perturb and Observe (PO) Maximum Power Point Tracking (MPPT) facility. In addition to the power generation units other key components, such as DC/DC Buck converter, DC-DC Bidirectional converter, and Nickel-Cadmium Battery Storage System (BSS), two circuit breakers (for charging and discharging control), PID controller (for EMS control as well as speed control of WECS), and AGA/BPSO/FPA/HSS algorithm. The overall models were developed using MATLAB 2015a/SIMULINK tool. As depicted we used DC/DC converter to connect PV cells with DC bus, while bidirectional converters were used in the wind-turbine interface to the DC bus. To examine the efficacy of the proposed EC based EMS control, we simulated proposed Hybrid-RES system in three distinct simulation cases; first EMS control using classical PID control with predefined gains (P=1, I=1), second, using AGA tuned PID based EMS control, third using BPSO tuned PID control for EMS, fourth FPA tuned PID Control and finally fifth HSS tuned PID Control under dynamic load and generation patterns.

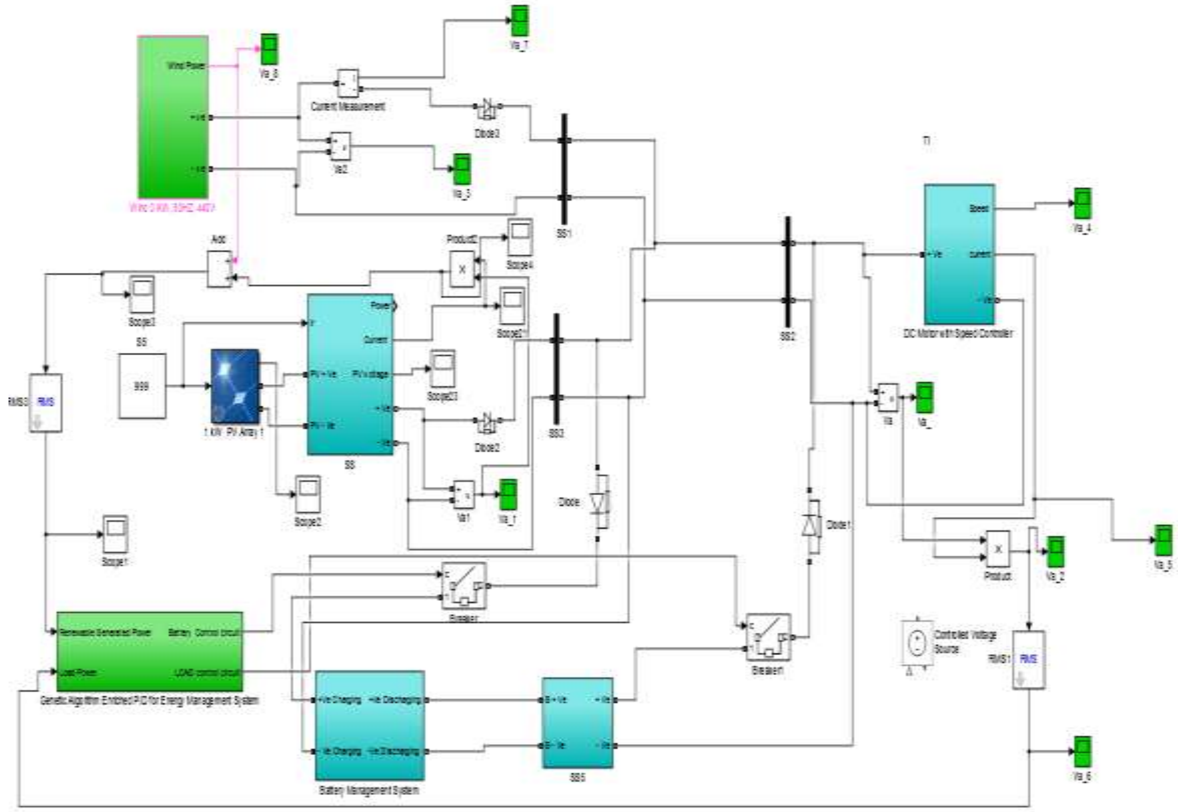


Fig. 11. Developed Hybrid-RES System Comprising Wind-Turbine and Photovoltaic Cells

In these research, a Simple PID controller is designed and it is tuned using different evolutionary algorithm approaches like Genetic Algorithm, Hyper spherical search, Flower Pollination Algorithm and Patricle Swarm Optimization process.The objective of the Multi criteria optimization problem is to minimize settling time, Rise Time and overshoot.Here the optimization algorithms tune the best PID Controller namely Kp, Ki, Kd.The various algorithms result set are as shown in the below Tables and it clearly indicates the HSS is the best algorithm among all the algorithms followed by PSO, FPA, and GA with minimum obejctive function value , settling time and Rise time.

Table 6. Result Set of HSS

HSS RESULTS	VALUES
Kp	**0**
Ki	**10**
Kd	**0.2892**
Population Size	50
Number of Iterations	100
Objective Function Value	**588.133**
Rise Time	**2073.4487**
Settling Time	**58077.349**
Settling Min	452.31742
Settling Max	1792.6760
Overshoot	257.55069
Peak	1792.6760
Peak Time	20015.00

Table 7. Result Set of PSO

PSO RESULTS	VALUES
Kp	**0**
Ki	**7.5117**
Kd	**0.1967**
Population Size	50
Number of Iterations	100
Objective Function Value	**588.7338**
Rise Time	**2261.378**
Settling Time	**58234.050**
Settling Min	482.8712
Settling Max	1794.856
Overshoot	235.2764
Peak	1794.8561
Peak Time	19865.00

Table 8. Result Set of FPA

Table 9. Result Set of GA

FPA RESULTS	VALUES
Kp	**1.3915**
Ki	**5.4137**
Kd	**0.3052**
Population Size	50
Number of Iterations	100
Objective Function Value	**685.07**
Rise Time	**2144.7726**
Settling Time	**59016.752**
Settling Min	454.61810
Settling Max	1737.4743
Overshoot	244.74795
Peak	1737.4743
Peak Time	19837.000

GA RESULTS	VALUES
Kp	**3.816**
Ki	**9.593**
Kd	**0.588**
Population Size	50
Number of Iterations	100
Objective Function Value	**691.36**
Rise Time	**2177.634**
Settling Time	**58994.87**
Settling Min	455.8427
Settling Max	1737.550
Overshoot	243.7992
Peak	1737.550
Peak Time	20009.00

The simulation with different control mechanisms and respective outcomes are discussed as follows:
Figure 1 shows the WECS power generation variation under different optimized WECS control. To achieve stable power generation while fulfilling load demands, controlling wind turbine speed is vital and hence we applied PID controller to control WT speed while considering load demands. PID controller controls speed by considering reference speed (1750 r/s) and the actual speed. The speed control output using classical PID is given in Fig. 2. The figure also shows the comparison of different algorithm optimized PID controller. Figure 3.presented Load side power (W) demand variation and Figure.4 represents the Electrical Torque of D.C Motor.

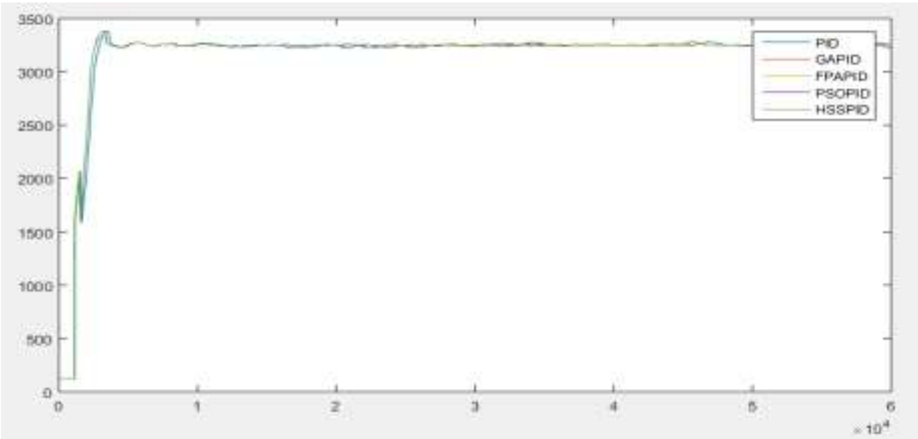


Fig. 12. Hybrid Wind/PV Generated Power (W)

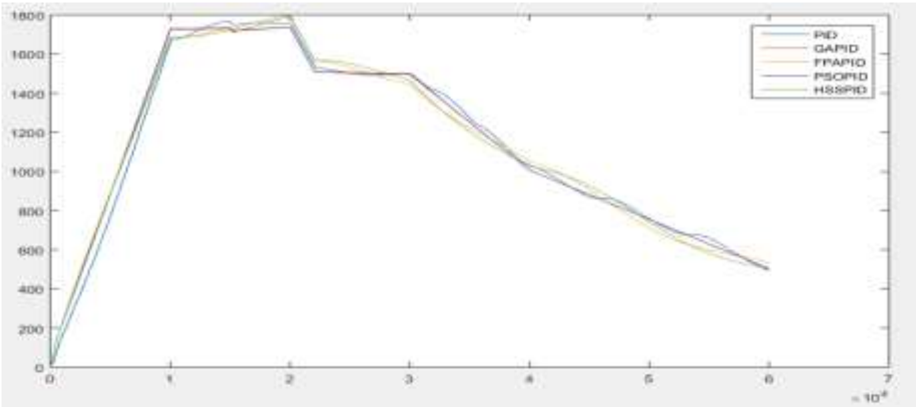


Fig. 13. Speed Control (r/s) Variation Comparison

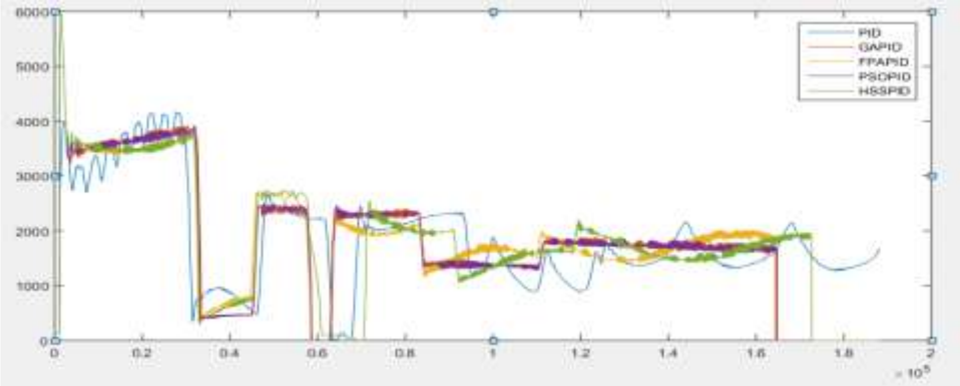


Fig. 14. Load Side Power (W) Demand Variation

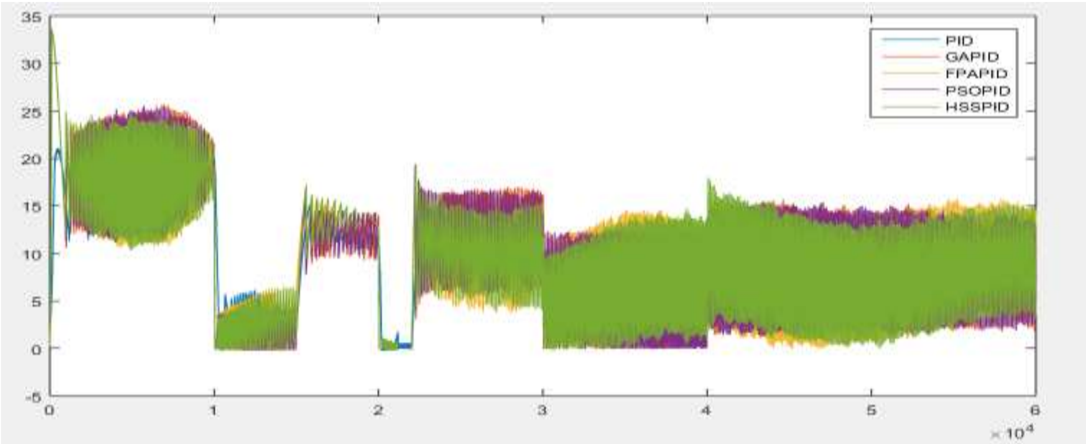


Fig. 15 .Electrical Torque (N-m) of a D.C Motor

5. CONCLUSION

In these Paper we have completely demonstrated the importance of Hybrid Renewable system comparing the economic factors to conventional energy source after evaluating the cost and realibity of Hybrid system, suitable Hybrid system is chosen but due to non-linear power generation and Load side variation the Hybrid system is still not used much due to these we have used EMS , where the charging and discharging of batteries is controlled through tuning of PID Parameters here the tuning of PID parameters are done through different approaches like Genetic Algorithm, Particle Swarm optimization, Hyper Spherical Search, Flower Pollination Algorithm, Finally after considering the Minimum objective function value, Rise time and settling time it is found HSS Algorithm is the best algorithm compared to all other followed by PSO, FPA, and GA. In future, more efficient evolutionary computing approaches could be explored for their efficacy to perform EMS control along with generator side control to assist reliable and quality power supply.

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BIBLIOGRAPHY OF AUTHORS

	Dr. S B Shivakumar was born July 8th1968. He received the B.E. degree in Electrical Engineering from the Gulbarga University, India, in 1983and M. Tech in Power system Engineering from the University of Mysore in 1991 and a Ph.D. degree from the Visveswaraya Technological University, Belagavi in 2008. He is having more than 23 years of experience. He is currently working as Principal in Proudhadevaraya Institute of Technology, Hosapete, and Karnataka, India. He has presented several National and International Journal Papers and attended conferences.
	Mr. Sampathkumar V Patil was born 15th june 1990. He received the B.E. degree in Electrical Engineering from the Visveswaraya Technological University, India, in 2012 and the M. Tech in Power system Engineering from Jawaharlal Technological University in 2014. He is Currently Pursuing Ph.D. from Vishweshwaraya Technological University, Belagavi.