Nat. Volatiles & Essent. Oils, 2021; 8(4): 3372-3379

NVEO
Natural Volatiles & Essential Oils

Energy Management Strategies in Micro Grid using Hybrid DEA,GA and BDC Theorem

[1]P.G.Anil Kumar, [2]P. ArunaJeyanth, [3]D. Devaraj

[1,2,3]Kalasalingam Academy of Research and Education, Krishnankoil, Tamil Nadu, India

Abstract

This paper evaluates hybrid differential evolution algorithmwith genetic algorithm and benders decomposition theorem of IAMG is used to solvethe large scale mixed integer programming problems. Hybrid GA with DE algorithm and BDC theorem is implemented in integer area Micro grids. IAMG synchronise with CAUGor as a separated system to the consumerisolated from CAUG.IAMG includes various IAERs to produce consumer needed power and Geneticalgorithm to selecthighest power with high benefit of precocious time. BDC theorem is implemented in the IA MG and CAUG maintain the prediction value of power plants .Used in transformation theory, Differential evolution theory maintain the correct power in IAMG and CAUG.So the load and power production is matching together. In the DE algorithm avoid the frequency disturbance of the integer area micro grid and maintain the frequency in 50 Hz. DE algorithm identify the fluctuations of sine wave in the integer area micro grid and regulate the fluctuating sine wave.Another one application of DE algorithm maintain the power quality of city area utility grid.DE algorithm maintain the synchronization of IAMG andCAUG and correct the current variation, voltage variationand energy variation.So the DE algorithm manage theenergy inIAMG and CAUG and avoid the loadshedding.

Keywords- Integer area micro grid (IAMG), Integer area energy resources (IAERs),Differential evolution algorithm (DEA), Genetic algorithm (GA) and City area utility grid (CAUG),Benders decomposition theorem(BDC).

I. Introduction

In the PV and wind maintain more power in the energy management system. In the Energy management system formulation can be included for the conditions only the IAREs (aggregated Wind Turbines (WTs) and photovoltaic units (PVs) output energy uncertainties' are taken in to account. In the IAMG power from solar PV panel. MPPT is,

$$P_{pv} = VMPPT \times AMPPT \quad (1)$$

$$VMPPT = VMPPT_{refr} \times V_{oc} (T_p - T_{pref)} \quad (2)$$

$$AMPPT = AMPPT_{ref} \times Isct_{ref} (T - T_{pref}) \quad (3)$$

The high energy production temperature of PVpanel $HEPT_p$ is given below:

$$HEPT_p(t) = HEPT_a(t) + gt \quad (4)$$

The wind turbines (WTs) connected to IAMG and the generator is named as permanent magnet synchronous generator (PMSG), which will produces AC output.The theoretical power of wind stream in relationship between the wind power and wind speed (WS) is determined by

$$WS=0.0Pav^3 \quad (5)$$

II. MG Architecture Cell Modelling

IAMG is an integration of various units. It consists of DG unit energy, storage units, controller unit and conventional loads. DG unit again comprise of various micro generating devices. IAMG modelling varies from one configuration to other depending on the components used.IAMG Small scale ranges from 4kw-10000kw.In this IAMG solves many problems existing power systems network. IAMG maintain the demand supply balance and lack of reliability. In IAMG energy management,system expression is

$$= \min \sum_{t=1}^{T} [\sum_{g=1}^{G} (D_{gt}^{E} + D_{gt}^{R}) + D_{t}^{RES} + \sum_{d=1}^{D} D_{dt}^{DR}] \quad (6)$$

where,

$$D_{gt}^{E} = a_g \cdot U_{gt} + b_g \cdot P_{gt} + C_g^{\sup} \cdot Y_{gt} + C_g^{sdn} \cdot Z_{gt} \quad (7)$$

$$D_{gt}^{R} = \sum_{q \in Q} \sum_{k \in K} C_{gqk}^{R} \cdot R_{gkr}^{ct} \quad (8)$$

$$D_{t}^{RES} = dw. \sum_{w=1}^{W} P_{wt}^{f} + dv. \sum_{v=1}^{v} P_{vt}^{f} \quad (9)$$

$$D_{dt}^{DR} = \sum_{n=1}^{N} d_{dn}^{DR} \quad (10)$$

2.1. Genetic Algorithm

Genetic algorithm is one of the most commonly used evolutiory algorithm for solving energy management problem for integer area micro grid. The various components of genetic algorithm is representation of the solution of variables. Fittness function, Genetic operator, Control parameter and Halting criteria. The above components are linked to integer area micro grid and select best power production. The base of Genetic algorithm is formed many energy in IAMG. Themain aim of GA is to minimize the resources and select best and reach best solution.The main works of GA is PI(Population initialization),E (Evolution),B(Best value), O(Operation) and MP (Modified population).

2.2. DE Algorithm

The main aim of DE algorithm is to maintain best power production. In this energy management strategies DE algorithm improve the quality of energy with regard to a given measure of quality.DE algorithm include Real code and Binary code conversion to string.DE is used to avoid the drawbacks of optimization problems such as original function is not a derivative nature, not efficient in handling having discrete variables,get struck to local optima and requirements mathematically week defined objective and constraint function. In this, DE algorithm is linked with IAMG and has lessparameters.

2.3. Benders Decomposition Theorem

Benders decomposition theorem is used to solve large scale integer problems such as Generating unit planning, Transmission planning, and real and reactive power planning. It has been successfully applied to take advantage of underlying problems. It is not used in linear items. So in order to overcome this problems hybrid DE algorithm and benders decomposition theorem is used. In this IAMG it maintain the prediction value of micro grid which is connected to RES. By using benders decomposition theorem satisfied for unit commitment problems.The limitations of benders decomposition theorem is without solving economic problems.

2.4 Hybrid GA, BDC Theorem and DE Algorithm

DE maintain which time which IAREs produce more power and GA select best power. Benders decomposition theoremmaintain the prediction value of integer area micro grid renewable sources. But this hole or combination produce more losses in integer area micro grid. Because in integer area micro grid current, voltage, power amplitude and frequency are not compensated. To apply Differential evolution algorithm in the integer area micro grid and eliminate the losses. So the current, voltage, power, frequency and amplitude are compensated. So the integer area micro grid efficiency is increases and the integer area gets more power. In another fact integer area avoid the load shedding operation. IAMG various RES to an optimization problem are represented by a real power or reactive power.

III Objective Function and Results

For the energy management problem IAMG isused to minimize the total cost of power production and produce more power, the excess power is transferred to city area and avoid the load shedding of cities. In this synchronization of IAMG and CAUG power, voltage, current, amplitude and frequency injection are complicated.DE maintain the correct injection of current, voltage, amplitude and frequency. BDC and GA support the energy management problem.This theorems are implemented with the help of PI controller. The objective function includes hybrid Genetic algorithm and DE algorithm in Energy management strategies in micro grid is used to minimize the cost and increase the production of electrical energy of Micro grid. Another one main objective is matching the load demand and Energy production of micro grid.

The total energy to consumer is match the addition of energy in wind, solar P and fuel cell

$$\sum_{min}^{max} \mathrm{LD} = \sum_{min}^{max} P_{Wt} + \sum_{min}^{max} P_{PVt} + \sum_{min}^{max} P_F + \sum_{min}^{max} P_B \quad (11)$$

LD- Load demand, P wind- Wind polar plant Power,P_F – Fuel cell power PV – Solar power plant power

P_B = Battery Power or electric vehicle power

Local Area Micro grid is connected in Grid connected mode, the main objective is to maximize the profit of micro grid power over a given time period.

The gain of micro grid is

$$Gain_s = \sum_{t=1}^{MP}\left(A_{s,t} - B_{s,t}\right) \quad (12)$$

$A_{s,t}$ - represent Gain of MG obtained from Grid connected mode

$B_{s,t}$ – represent the cost of RES Power generation.

In this grid connected mode, utility grid and MG mutually share the power. So the objective function includes Real & Reactive Power, Purchase and sold out power and working and maintenance cost.

The objective function as follows.

Min OE = $\sum_S E_S$

$$E_S = \quad \sum Cost_{Pro.Si} + \sum_m \; A\,x\,E_{Pur\,.an}\,E_{Sell.an} + Cost_{Pro.Si} \quad (13)$$

$$Cost_{Pro.Si} = Cost_{Pro.WT.Si} + Cost_{Pro.FC.Si} + Cost_{Pro.PV.Si} \quad (14)$$

Table 1. Energy Calculation from 1.06 AM to 11.59 AM

Parameters	1.05 am	1.55 am	2.55a m	3.55a m	4.55 am	5.55 am	6.55 am	7.55 am	8.55 am	9.55 am	11.55 am	11.59 am
Real power of wind (kW)	2.111	2.333	2.4444	2.4444	2.4454	2.6665	2.6654	2.775	2.6657	3.6654	3.66654	5.7765
Real power of solar (kW)	0.22	0.5554	0.9987	0.3324	0.6654	0.8876	0.88876	1.66754	3.7765	5.9987	23.8887	59.77776
Real power of fuel cell (kW)	61	61	61	61	61	61	61	61	61	61	61	61
Sold power (kW)	07	10	134	200	318	320	321	323	324	352	400	400

Sold cost (l/h)	99	101	111	124	311	321	341	345	391	400	520	601
Purchased power (kW)	101	99	96	94	93	92	91	88	44	33	31	11
Purchased power cost (l/h)	400	390	380	370	360	350	340	289	234	200	23	11
Total cost (l/h)	60.111	60.2222	60.16665	60.33333	61.4444	61.5555	61.555	61.998	61.9000	62.000	62.222	62.666

Table 2. Energy Calculation from 12.05 PM to 11.59 PM

Parameters	**12.05 pm**	**1.55 pm**	**2.55 pm**	**3.55 pm**	**4.55 pm**	**5.55 pm**	**6.55 pm**	**7.55 pm**	**8.55 pm**	**9.5pm**	**11.55 pm**	**11.59 pm**
Real power of wind (kW)	5.111	4.6654	3.77765	4.77765	23.7765	2.6654	2.6654	2.66654	2.5543	2.11111	2.11111	2.000087
Real power of solar (kW)	49.665	41.8876	23.7443	6.8876	5.8887	4.7765	1.665	0.11	0.11	0.11.11	0.11.11.	0.11
Real power of fuel cell (kW)	61	61	61	61	61	61	61	61	61	61	61	61
Sold power	400	324	323	321	320	286	241	120	34	21	10	07

(kW)												
Sold cost (l/h)	560	520	519	480	390	320	268	269	230	200	168	100
Purchased power (kW)	10	11	22	33	44	55	66	75	77	85	90	101
Purchased power cost (l/h)	18	19	26	45	67	67.98	69.654	81	85.998	89.5543	90.776	100.65
Total cost (l/h)	61.999	61.8888	61.777	61.555	61.4444	61.4444	61.3333	61.2444	61.22	61.111	60.443	60.4432

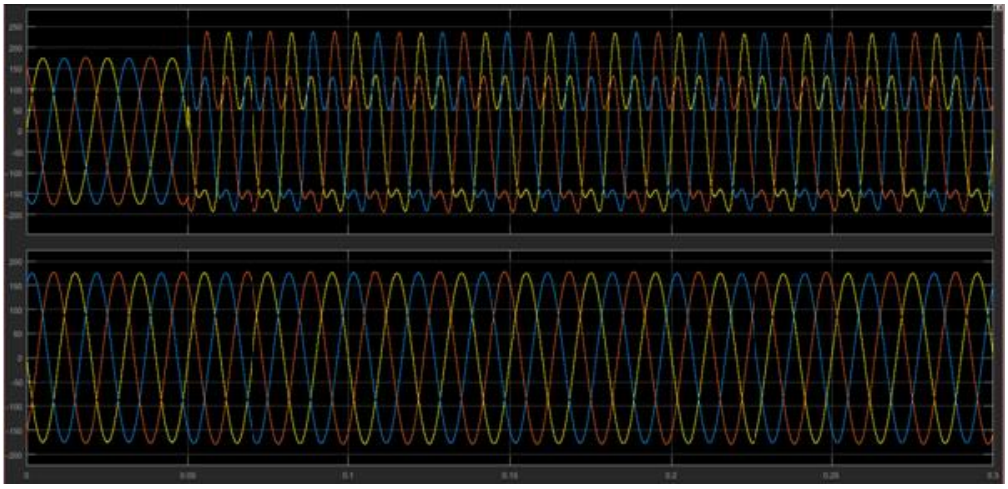

Figure 1. Current, Voltage and Frequency Compensation

IV Conclusion

The Differential evolution algorithm is used to avoid the variations in the integer area micro grid and city area utility grid.So the power production in IAMG and CAUG is good and synchronization is better and the power production – load demand matching together. In this DEA determine 11.55“o’ clock, 11.59 “o” clock and 1.05“0” clock power generation is better for IAMG and it is denoted. GA

select the better time of power production. But the combination of DEA and GA chooses the maximum power production time. In the 11.59 “o” clock is thebetter time of power for IAMG.BDC theorem is used to maintain the prediction value of IAMG. Excess power is transferred to CAUG and DE algorithm regulate energy management problem. The result of Synchronization in the city area utility grid and integer area micro grid is efficient, better and getting good current, voltage and frequency compensation. DEA is used to maintain the current, voltage and frequency compensation. This current, voltage and frequency compensation is also indicated.

References

Man, K.F, Tang, K.S & Kwong. S “Genetic algorithm concepts and applications, IEEE Transactions on industrial Electronics, 43(5),519-534,doi 10.1109/41538609.

Hernandez- Aramburo, T. C. Green, and N. Mugniot, “Fuel consumption minimization of a microgrid,” *IEEETrans. Ind. Appl.*, vol. 41, no. 3, pp. 673–681, May/Jun.2005

N. Ming, H. Wei, G. Jiahuan, and S. Ling, “Research on economic operation of grid-connected microgrid,” *PowerSyst. Technol*., vol. 34, no. 11, pp. 38–42, 2010

X.D. Li, “Efficient differential evolution using speciation for multimodel function optimization” in Genetic And evolutionary Computation Conference, GECCO 05. Washington DC, 2005.

Miranda and N.Fonseca “EPSO—evolutionryoptimization particleswarm optimization, a new algorithm with applications in power systems” in proc IEEE Power EngSoc Summer meeting, Chicago, 2012.

Ashwin, JS, and N. Manoharan. "Renewable Energy Based Micro-Grid System for Power Quality Improvement." International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)8.1, Feb 2018, 883- 888

Kumar, P. Sravan, Arvind Mittal, and Meena Agrawal. "Bi-Directional Grid-Connected Inverter for Micro-Grid Applications." International Journal of Electrical and Electronics Engineering Research (IJEEER) 4.2, Apr 2014, 339-348

Agrawal, M. E. E. N. A., and A. R. V. I. N. D. Mittal. "Deployment of microgrids in the developed countries: an appraisal." International Journal of Electrical and Electronics Engineering Research (IJEEER) 4.3 (2014): 23-34.

Kanwar, Paramjit Singh, and Rk Sharma. "Power Quality And Voltage Stability Of Transmission Line Using Statcom And Sssc." International Journal of Electrical and Electronics Engineering (IJEEE) 5, 4: 1 8 (2016).

Garg, Vijay Kumar, and Reena Dhanda. "Coordination Control of Ac/Dc Microgrid." International Journal of Electrical and Electronics Engineering (IJEEE)5.5, Aug – Sep 2016, 1-12

Mahanta, Arun, Hemanta KR Sarmah, and Gautam Choudhury. "Mandelbrot Set, the Mesmerizing Fractal with Integer Dimension." *International Journal of Applied Mathematics & Statistical Sciences* 6: 1.

Koul, Bharti, Kanwardeep Singh, and Yadwinder Singh Brar. "An Integration of Smart Grids with Demand Side Management and Renewable Energy: A Review." *International Journal of Mechanical and Production Engineering Research and Development (IJMPERD) ISSN (P)*: 2249-6890.

Hiremath, Basavaraj, and S. C. Prasannakumar. "Automated Evaluation Of Breast Cancer Detection Using Svm Classifier." *International Journal of Computer Science Engineering* 5.1 (2015): 7-16.

Azadeh, Yalda, and B. E. H. N. A. M. Mohammadi-Ivatloo. "Optimal Heat and Power Dispatch in Co-Generation Systems Using Firefly Algorithm." *TJPRC: International Journal of Power Systems & Microelectronics (TJPRC: IJPSM)* 2 (2016): 77-86.

Tazi, S. N., Mukesh Gupta, and Akansha Jain. "A Survey On Application Of Nature Inspired Algorithms." *International Journal of Computer Science Engineering* 4.4 (2014): 33-40.

Kamatchi, N., and D. Saravanan. "A hybrid algorithm using firefly and Cuckoo search algorithm for flexible open shop scheduling problem." *International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)* 7.2 (2017): 155-166.