Application of Optimization Tools in Hybrid Renewable Energy System

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ABSTRACT

The Hybrid Renewable Energy System is one of the rapid growing key sectors in the energy industry. However, according to previous literature articles explored, the most common drawbacks are the cost of energy production and the shape/size of hybrid energy. Therefore the purpose of this article is to find the applications of the optimization tools that are compatible with the Hybrid Renewable Energy System. In this paper, the traditional literature review method has been used. At the end of this research, best optimization Tool has recommended for increasing the Energy Production and reducing Size / Volume of the Hybrid Renewable Energy System.

Keywords: Energy, Optimization, Decision making, Application

1. INTRODUCTION

Energy is essential and electric energy is the most essential. Although technologies given the huge development to the all human living aspects, electricity plays a major role in it.Technology has become increasingly involved in natural pollution during this time. The whole universe will be moving towards natural electricity in the coming years because the crude oil is lacking every year and due to natural pollution. The most notable of these electric energy is known as Hybrid Renewable Energy
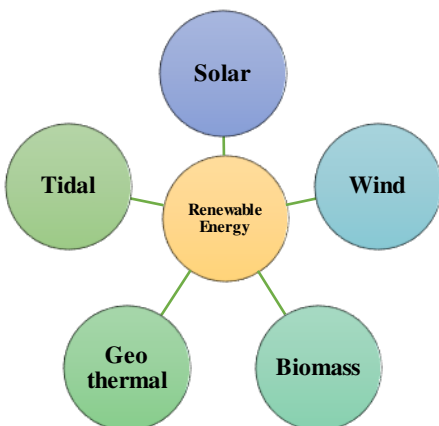

Figure No: 01 Renewable Energies

Optimization is considered the most essential in the field of technology. Optimization is the act of making the best or most efficient use of a situation or resource. This optimization technique reduces the sizing, cost, and increasing the performance by the Khan, M. J. point of view [1]. Optimization is having different kinds of tools. Such as important tools followed.

2. OPTIMIZATION TECHNIQUES BASED ON LITERATURE REVIEW
2.1 Artificial Neural Network (ANN)

It is an algorithm that finding out optimal sizing by harmony search, chaotic search and simulated annealing [2]. It is a learning algorithm. The simulation software has incorporated by the MATLAB. This technique mostly used in solar and wind hybrid projects. Thus the author tried to forecast RE but their failed to forecast the natural energy [3].

The Cadenas, E & Rivera, W. (2010) were described the origin of ANN algorithm that it is from the errors of ARIMA algorithm. By Both algorithms are forecasting the wind speed, time serious and errors. The author conclude on this paper that mean error, mean square error and mean absolute error may consider as better or equal result obtained compare with ANN [4]. Physical Hybrid Artificial Neural Network is one of forecast algorithm based on the ANN Algorithm. By these algorithms to solving the fundamental errors in renewable energy systems [5].

2.2 Dynamic Voltage Restorer

The DVR is the power optimal algorithm. It is used in wind and solar hybrid renewable energies. It is used in three phase medium voltage network that improve the power quality and low voltage riding capacity. The authors were successed their concept that PCC (point of common coupling) reduce the LVRT [6]. The load fluctuation withstands and controlled by this DVR algorithm. The voltage is calculated by the load input [7].

2.3 Geospatial approach

The geospatial approach more suitable for tropical country like India. The main concept of geospatial approach such as

- Minimize the cost of power
- Minimize the capital and
- Optimal sizing [8].

2.4 HOMER SOFTWARE

The HOMER stands Hybrid Optimization Model for Electric Renewable. This software gives the optimal size and minimizes the economical of capital in HRES. It also minimizes the total net present cost [9]. Fulzele, J. B., & Dutt,

S. states that the HOMER is best suitable for solar and wind in hybrid renewable energy system. The inverter and PV generator with battery is very expensive [10].

The HRES is very best optimization technique has HOMER for optimal size, capital, emission and technical [11]. On optimization the main factors are consider every condition such as annual electricity demand, reliability, net present cost, employments and the environmental factors [12]. This software also used for simulation [13]

2.6 HOMER PRO

The HOMER PRO is advanced version of HOMER software. The basic simulation only on HOMER software but HOMER PRO included the deep simulation. The HOMER pro analysis is consists of costing, optimization, sizing, and control strategy [14].

The MESCA stands Modified Electric System Cascade Analysis. Compare to MESCA the HOMER PRO software gives the best output [15]. The unit costs of energy (UCOE) outputs are basically compare with the HOMER PRO software [16]. HOMER PRO software is the primary model and simulation tool in HRES [17].

2.9 Genetic Algorithm (GA)

GA is the estimated process for multi objective problems in HRES [18]. Non-dominated Sorting Genetic (NSG) Algorithm is designed to turbines. It decreases the total cost and increase the performance [19]. It is the superior algorithm in HRES and it also optimal the size [20]. Compare to particle swarm optimization (PSO) algorithm the genetic algorithm gives the better result [21]. The genetic algorithm generally used for two purposes in HRES. The primary function has reduced the formulated objective function and load served depend upon reliability [22].

2.10 PSO

The PSO algorithm has the best suitable to solar and wind hybrid systems. The PI controllers are mainly based the PSO algorithm [23]. It is a biological inspired direct search method and find the optimal energy management solution [24]. The PSO algorithm technique has minimize the cost of energy and gives the best result for optimal the size [25]. The Fuzzy Logic Controller is also related to the PSO Algorithm. The PSO optimizes membership sequence of Fuzzy Logic Algorithm [26]. The PSO has mainly find out the objective functions of HRES [27].

2.11 Maximum Power Point Tracking (MPPT)

The Maximum Power Point Tracking algorithm gives the increasing optimal output voltage in HRES. This algorithm also used for tracking purpose in HRES [28]. In wind energy the maximum speed has ensured by the MPPT algorithm [29]. The MPPT enhance the efficiency of the hybrid renewable energy system. It is most suitable for solar and wind [30]. The MPPT used in solar and wind system as simultaneously for energy harvesting [31]. The MPPT optimizes the exact duty cycle of DC convertor based on current and voltage parameters [32].

2.11 DPSO

Dynamic particle swarm optimization has optimization algorithm that includes simulation module and sampling average techniques [33]. The main objective of Dynamic particular swarm optimization is to minimize the net present total cost [34]. The DPSO has also utilized to give solution the dynamic optimal power flow problems [35].

2.12 Cuckoo Search Algorithm

The cuckoo search optimization algorithm is the techno-economical simulation algorithm [36]. It minimizes the cost and optimal size of hybrid renewable energy system [37].

The size optimal is higher than compare to GA and PSO [38]. It solved the design problems in hybrid renewable energy system. It is similar to Genetic Algorithm and PSO algorithm. The cuckoo search algorithm is also solved the convex and non convex fossil fuel problems [39]. The cuckoo search algorithm is also used to forecast the power supply management [40]. The cuckoo search algorithm's advanced version is hybrid mimetic cuckoo search algorithm. It is used for forecasting for loading, predicts the result, efficiency and error rate [41]. Similarly the next version is grey wolf optimizer and cuckoo search. It balances the exploitation and exploration in hybrid systems [42].

The cuckoo search algorithm is also handling the non linear variation components of renewal energy system [43]. The third type of cuckoo search algorithm is biography based heterogeneous cuckoo search algorithm (BHCS). It is used for four parameters estimate problems. Such as two PV panel module, single diode model, double diode model and photovoltaic model [44]. The fuzzy logic controller is based on the cuckoo search algorithm. It is used to find out the power rate of batteries, solar and diesel generator [45].

2.13 TAGUCHI METHOD

It is used to estimate the steady state electrical distribution in solar and wind hybrid system [46]. The orthogonal experiments are done by the taguchi method. This method affects the load resistance and tilt angle in hybrid projects [47]. At a time, there are nine experiments conducted in taguchi method by standard orthogonal array [48]. The unit commitment problems are solved by the hybrid taguchi ant colony system [49]. Taguchi method is achieved the cooling mode operations using L_9 3^4 orthogonal arrays [50]. The design combinations and noise level are calculated by using taguchi method [51]. In multisource power system model are optimized by the hybrid taguchi genetic algorithm [52]. The phase angle, line flow, other metrics, means and standard deviation of power generation problems are estimate by the taguchi method [53].

3 FINDING AND DISCUSSION

The Table No:01 and Table No:02 are explored from the literature reviews. Moreover, from 100+ papers were explored in this article to the relevant field and following data tabulated. Senthil Kumar J, Charles Raja, S., Jeslin Drusila Nesamalar, J., & Venkatesh, P. states that the most countries are used solar and wind hybrid system as compare to other hybrid renewable energies [77]. By investigator point of view, this paper novelty of comparing best Suitable algorithm for solar and wind renewable energies such the cuckoo search algorithm and taguchi algorithm.

OPTIMIZATION TECHNI	APPLICATIONS	OPTIMIZATION TECHNI	SUITABLE HYBRID

2

QUES		QUES IN HRES	TYPE
Artificial Neural Network (ANN) & Dynamic Voltage Restorer (DVR)	Optimal power[3].	**Artificial Neural Network (ANN) replace** Dynamic Voltage Restorer (DVR)	Solar / wind [5]
Hydrogen Energy System	Technical And Economic[8]	Hydrogen Energy System	Photovoltaic (PV)/Wind Turbine/ Fuel Cell/Batteries [11]
Geospatial approach	Minimize size[12].	Study paper-geospatial approach	Rice Husk / Solar Energy[12]
Hybrid Optimization Model for Electric Renewable (HOMER) SOFTWARE	Optimal Cost/economical[14]	HOMER SOFTWARE	Wind / PV [16]
HOMER PRO	Optimal economical[19].	Motion analysis	Floating Offshore Wind Turbines (FOWT), Wave Energy Converters (WEC) [1]
Monte Carlo Simulation	Electrical and thermal test[24]	loss of power supply probability (LPSP) and the net present cost (NPC)	Solar /wind [1]
Adaptive Sine Cosine Algorithm (ASCA)	Current And Voltage Errors[29]	MONTE CARLO SIMULATION	Solar / wind [24]
Genetic Algorithm (GA)	Optimal the Loss of Power Supply Probability (LPSP) and the Levelized Cost Of Electricity (LCOE)[33].	Adaptive Sine Cosine Algorithm (ASCA)	Solar / wind [28]
HOMER Pro & Power Management Strategy (PMS)	Optimal economical & Power-Quality Valuation [21]	Hybrid Optimization Model for Electric Renewable (HOMER)	Solar /Wind/Bio Mass [21]
Particle Swarm Optimization (PSO)	Optimal economical [39]	Genetic Algorithm (GA)	Solar / wind [33]
Numerical Algorithm	Minimize Economical[41]	HOMER Pro & Power Management Strategy (PMS)	Solar / wind [20]
Division Algorithm (DA)	Minimize size [1]	Particle Swarm Optimization (PSO)	Solar/ Wind [39]
Stochastic Load Profile Model	Power Loss Minimize[57]	Numerical Algorithm	Solar/gas turbine [42].
Maximum Power Point Tracking (MPPT)	Control system is efficient and capable to maintain the power transfer [47]	Division Algorithm (DA)	Solar/wind [1]
Dynamic Particle Swarm Optimizati	Levelized cost of energy (LCOE) [51]	Stochastic Load Profile Model	Bio mass / Photovoltaic (solar)

on(DPSO) & Traditional solver (TS)			[57]
Accurate Iterative Methodology	Optimal size [52]	Maximum Power Point Tracking (MPPT)	Solar / wind [45]
Classical algorithm	Optimize Size [1]	Dynamic Particle Swarm Optimization (DPSO) & Traditional solver (TS)	Solar PV, Wind Power, Diesel Generator And Battery Storage [51]
Greedy Particle Swarm And BBO Algorithm (GPSBBO)	Improve The Performance Of Optimization Design [55]	Accurate Iterative Methodology	Solar/wind [1]
Numerical Model	Mathematical Error Finding [1]	Classical algorithm	Solar/wind [1]
Cuckoo Search Algorithm	Optimal Size And Economic [67]	Greedy Particle Swarm And BBO Algorithm (GPSBBO)	Solar/Wind [53]
Taguchi method	Electricity problems [88]	Numerical Model	Solar/ wind [42]
-	-	Cuckoo Search Algorithm	Solar/wind/diesel/battery[77]
-	-	Taguchi Method	Solar / wind/geothermal.[88].

TABLE NO:01 OPTIMIZATION TECHNIQUE/ALGORITHMS AND ITS APPLICATION IN HRES AND APPLICATION OF HYBRID ENERGIES

4 CONCLUSION

Hybrid Renewable Energy System (HRES) is the future power sources for upcoming generation. The best optimization techniques and hybrid renewable energies are tabulated. The best optimization techniques in hybrid renewable energy system are discussed in this article. Depend upon the researcher application their choose suitable optimation technique. However the cuckoo search algorithm and taguchi method has more optimal flexible technique for solar & wind energies. In HRES main and most common research gaps are consider as the following key points

- Size of hybrid system
- Capital cost of hybrid system
- Energy supply
- Levelized cost of energy
- Maintenance of hybrid system
- Voltage drop
- Load issues
- Battery storage issues.
- Cost of output power
- Energy demand
- Weather conditions
- Natural disasters and Environmental factors.

The Hybrid Renewable Energy System optimization techniques, application, and most hybrid renewable energies are reviewed successfully by this paper. Thus the novelty of this paper, best multi-algorithm for solar and wind energies has theoretically explained by relevant literature journals. It may form practically for give the maximum utilize the input sources and getting the better output.

ABBRIVIATION

HRES	Hybrid Renewable Energy System
ANN	**Artificial Neural Network**
DVR	Dynamic Voltage Restorer
HES	Hydrogen Energy System
GA	Geospatial Approach
ASCA	Adaptive Sine Cosine Algorithm
PSO	Particle Swarm Optimization
BBO	Biogeography Based Optimizations Algorithm
HOMER	Hybrid Optimization Model

	for Electric Renewable
MPPT	Maximum Power Point Tracking
DPSO	Dynamic Particle Swarm Optimization
PMS	Power Management Strategy
AIM	Accurate Iterative Methodology
CA	Classical algorithm
DA	Division Algorithm
GPSBBO	Greedy Particle Swarm & Biogeography-Based Optimizations Algorithm
ARIMA	Autoregressive Integrated Moving Average
PHANN	Physical Hybrid Artificial Neural Network
PLC	Program Logic Controller
SCADA	Supervisory Control And Data Acquisition
GIHRES	Grid independent hybrid renewable energy systems
TNPC	Total Net Present Cost
MATLAB	Matrix laboratory

References

[1] Khan, M. J. (2020). Review of Recent Trends in Optimization Techniques for Hybrid Renewable Energy System. Archives of Computational Methods in Engineering. https://doi.org/10.1007/s11831-020-09424-2.

[2] Zhang, W., Maleki, A., Rosen, M. A., & Liu, J. (2019). Sizing a stand-alone solar-wind-hydrogen energy system using weather forecasting and a hybrid search optimization algorithm. Energy Conversion and Management, 180, 609–621. https://doi.org/10.1016/j.enconman.2018.08.102

[3] Li, R. X. (2012). Design and realization of 3-DOF welding manipulator control system based on motion controller. In Energy Procedia (Vol. 14, pp. 931–936). https://doi.org/10.1016/j.egypro.2011.12.887

[4] Cadenas, E., & Rivera, W. (2010). Wind speed forecasting in three different regions of Mexico, using a hybrid ARIMA-ANN model. Renewable Energy, 35(12), 2732–2738. https://doi.org/10.1016/j.renene.2010.04.022

[5] Dolara, A., Grimaccia, F., Leva, S., Mussetta, M., & Ogliari, E. (2015). A physical hybrid artificial neural network for short term forecasting of PV plant power output. Energies, 8(2), 1138–1153. https://doi.org/10.3390/en8021138

[6] Benali, A., Khiat, M., Allaoui, T., & Denaï, M. (2018). Power Quality Improvement and Low Voltage Ride Through Capability in Hybrid Wind-PV Farms Grid-Connected Using Dynamic Voltage Restorer. IEEE Access, 6, 68634–68648. https://doi.org/10.1109/ACCESS.2018.2878493

[7] Molla, E. M., & Kuo, C. C. (2020). Voltage Sag Enhancement of Grid Connected Hybrid PV-Wind Power System Using Battery and SMES Based Dynamic Voltage Restorer. IEEE Access, 8, 130003–130013. https://doi.org/10.1109/ACCESS.2020.3009420

[8] Sannidhi, P. K., Mandla, V. R., Saladi, S. S. V., Chokkavarapu, N., & Peddinti, V. S. S. (2020). An integrated hybrid renewable energy system: potential of electricity—a geospatial approach. SN Applied Sciences, 2(10). https://doi.org/10.1007/s42452-020-03329-2

[9] Razak, N. A. B. A., Othman, M. M. Bin, & Musirin, I. (2010). Optimal sizing and operational strategy of hybrid renewable energy system using HOMER. PEOCO 2010 - 4th International Power Engineering and Optimization Conference, Program and Abstracts, (June), 495–501. https://doi.org/10.1109/PEOCO.2010.5559240

[10] Fulzele, J. B., & Dutt, S. (2011). Optimium Planning of Hybrid Renewable Energy System Using HOMER. International Journal of Electrical and Computer Engineering (IJECE), 2(1), 68–74. https://doi.org/10.11591/ijece.v2i1.157

[11] Bahramara, S., Moghaddam, M. P., & Haghifam, M. R. (2016). Optimal planning of hybrid renewable energy systems using HOMER: A review. Renewable and Sustainable Energy Reviews, 62, 609–620. https://doi.org/10.1016/j.rser.2016.05.039

[12] Negi, S., & Mathew, L. (2014). Hybrid Renewable Energy System: A Review. International Journal of Electronic and Electrical Engineering, 7(5), 535–542. Retrieved from http://www.irphouse.com

[13] Shezan, S. K. A., Das, N., & Mahmudul, H. (2017). Techno-economic Analysis of a Smart-grid Hybrid Renewable Energy System for Brisbane of Australia. Energy Procedia, 110(December 2016), 340–345. https://doi.org/10.1016/j.egypro.2017.03.150

[14] Singh, A., Baredar, P., & Gupta, B. (2015). Computational Simulation & Optimization of a Solar, Fuel Cell and Biomass Hybrid Energy System Using HOMER Pro Software. Procedia Engineering, 127, 743–750. https://doi.org/10.1016/j.proeng.2015.11.408

[15] Zahboune, H., Zouggar, S., Krajacic, G., Varbanov, P. S., Elhafyani, M., & Ziani, E. (2016). Optimal hybrid renewable energy design in autonomous system using Modified Electric System Cascade Analysis and Homer software. Energy Conversion and Management, 126, 909–922. https://doi.org/10.1016/j.enconman.2016.08.061

[16] Pradhan, A. K., Mohanty, M. K., & Kar, S. K. (2017). Techno-economic Evaluation of Stand-alone Hybrid Renewable Energy System for Remote Village Using HOMER-pro Software. International Journal of Applied Power Engineering (IJAPE), 6(2), 73. https://doi.org/10.11591/ijape.v6.i2.pp73-88

[17] Weber, J. A., Gao, D. W., & Gao, T. (2016). Affordable mobile hybrid integrated renewable energy system power plant optimized using HOMER Pro. NAPS 2016 - 48th North American Power Symposium, Proceedings, 1–6. https://doi.org/10.1109/NAPS.2016.7747951

[18] Steward, J. (2002). Northumbria Research Link. Nrl.Northumbria.Ac.Uk, 24(August), 23–35. http://nrl.northumbria.ac.uk/1019/1/Frequency conversion based on three-wave parametric solitons.pdf

[19] Sanajaoba Singh, S., & Fernandez, E. (2018). Modeling, size optimization and sensitivity analysis of a remote hybrid renewable energy system. Energy, 143(November), 719–731. https://doi.org/10.1016/j.energy.2017.11.053

[20] Maleki, A., Rosen, M. A., & Pourfayaz, F. (2017). Optimal operation of a grid-connected hybrid renewable energy system for residential applications. Sustainability (Switzerland), 9(8). https://doi.org/10.3390/su9081314

[21] Nafeh, A. E. S. A. (2011). Optimal economical sizing of a PV-wind hybrid energy system using genetic algorithm. International Journal of Green Energy, 8(1), 25–43. https://doi.org/10.1080/15435075.2010.529407

[22] García-Triviño, P., Gil-Mena, A. J., Llorens-Iborra, F., García-Vázquez, C. A., Fernández-Ramírez, L. M., & Jurado, F. (2015). Power control based on particle swarm optimization of grid-connected inverter for hybrid renewable energy system. Energy Conversion and Management, 91, 83–92. https://doi.org/10.1016/j.enconman.2014.11.051

[23] Pourmousavi, S. A., Nehrir, M. H., Colson, C. M., & Wang, C. (2010). Real-time energy management of a stand-alone hybrid wind-microturbine energy system using particle swarm optimization. IEEE Transactions on Sustainable Energy, 1(3), 193–201. https://doi.org/10.1109/TSTE.2010.2061881

[24] Mohammed, O. H., Amirat, Y., & Benbouzid, M. (2019). Particle swarm optimization of a hybrid wind/tidal/PV/battery energy system. Application to a remote area in Bretagne, France. Energy Procedia, 162, 87–96. https://doi.org/10.1016/j.egypro.2019.04.010

[25] Safari, S., Ardehali, M. M., & Sirizi, M. J. (2013). Particle swarm optimization based fuzzy logic controller for autonomous green power energy system with hydrogen storage. Energy Conversion and Management, 65, 41–49. https://doi.org/10.1016/j.enconman.2012.08.012

[26] Upadhyay, S., & Sharma, M. P. (2015). Development of hybrid energy system with cycle charging strategy using particle swarm optimization for a remote area in India. Renewable Energy, 77, 586–598. https://doi.org/10.1016/j.renene.2014.12.051

[27] Vincheh, M. R., Kargar, A., & Markadeh, G. A. (2014). A Hybrid Control Method for Maximum Power Point Tracking (MPPT) in Photovoltaic Systems. Arabian Journal for Science and Engineering, 39(6), 4715–4725. https://doi.org/10.1007/s13369-014-1056-0

[28] Abdullah, M. A., Yatim, A. H. M., Tan, C. W., & Saidur, R. (2012). A review of maximum power point tracking algorithms for wind energy systems. Renewable and Sustainable Energy Reviews, 16(5), 3220–3227. https://doi.org/10.1016/j.rser.2012.02.016

[29] Khan, M. J., & Mathew, L. (2019). Comparative study of maximum power point tracking techniques for hybrid renewable energy system. International Journal of Electronics, 106(8), 1216–1228. https://doi.org/10.1080/00207217.2019.1584917

[30] Saidi, A., & Chellali, B. (2017). Simulation and control of Solar Wind hybrid renewable power system. 2017 6th International Conference on Systems and Control, ICSC 2017, May, 51–56. https://doi.org/10.1109/ICoSC.2017.7958647

[31] Arther Jain, A., Rabi, B. J., & Darly, S. S. (2020). Application of QOCGWO-RFA for maximum power point tracking (MPPT) and power flow management of solar PV generation system. International Journal of Hydrogen Energy, 45(7), 4122–4136. https://doi.org/10.1016/j.ijhydene.2019.12.071

[32] Sharafi, M., & ElMekkawy, T. Y. (2015). Stochastic optimization of hybrid renewable energy systems using sampling average method. Renewable and Sustainable Energy Reviews, 52, 1668–1679. https://doi.org/10.1016/j.rser.2015.08.010

[33] Sarkar, J., & Bhattacharyya, S. (2012). Application of graphene and graphene-based materials in clean energy-related devices Minghui. Archives of Thermodynamics, 33(4), 23–40. https://doi.org/10.1002/er.

[34] Xie, S., Wang, X., Qu, C., Wang, X., & Guo, J. (2013). Impacts of different wind speed simulation methods on conditional reliability indices. International Transactions on Electrical Energy Systems, 20, 1–6. https://doi.org/10.1002/etep

[35] Abuelrub, A., Khamees, M., Ababneh, J., & Al-Masri, H. (2020). Hybrid energy system design using greedy particle swarm and biogeography-based optimisation. IET Renewable Power Generation, 14(10), 1657–1667. https://doi.org/10.1049/iet-rpg.2019.0858

[36] Sanajaoba, S., & Fernandez, E. (2016). Maiden application of Cuckoo Search algorithm for optimal sizing of a remote hybrid renewable energy System. Renewable Energy, 96, 1–10. https://doi.org/10.1016/j.renene.2016.04.069

[37] Nadjemi, O., Nacer, T., Hamidat, A., & Salhi, H. (2017). Optimal hybrid PV/wind energy system sizing: Application of cuckoo search algorithm for Algerian dairy farms. Renewable and Sustainable Energy Reviews, 70(November 2015), 1352–1365. https://doi.org/10.1016/j.rser.2016.12.038

[38] Basu, M., & Chowdhury, A. (2013). Cuckoo search algorithm for economic dispatch. Energy, 60, 99–108. https://doi.org/10.1016/j.energy.2013.07.011

[39] Dong, Y., Zhang, Z., & Hong, W. C. (2018). A hybrid seasonal mechanism with a chaotic cuckoo search algorithm with a support vector regression model for electric load forecasting. Energies, 11(4). https://doi.org/10.3390/en11041009

[40] Sengar, S., & Liu, X. (2020). Optimal electrical load forecasting for hybrid renewable resources through a hybrid memetic cuckoo search approach. Soft Computing, 24(17), 13099–13114. https://doi.org/10.1007/s00500-020-04727-9

[41] Long, W., Cai, S., Jiao, J., Xu, M., & Wu, T. (2020). A new hybrid algorithm based on grey wolf optimizer and cuckoo search for parameter extraction of solar photovoltaic models. Energy Conversion and Management, 203(November), 112243. https://doi.org/10.1016/j.enconman.2019.112243

[42] Anoune, K., Bouya, M., Astito, A., & Abdellah, A. Ben. (2018). Sizing methods and optimization techniques for PV-wind based hybrid renewable energy system: A review. Renewable and Sustainable Energy Reviews, 93(October 2017), 652–673. https://doi.org/10.1016/j.rser.2018.05.032

[43] Chen, X., & Yu, K. (2019). Hybridizing cuckoo search algorithm with biogeography-based optimization for estimating photovoltaic model parameters. Solar Energy, 180(December 2018), 192–206. https://doi.org/10.1016/j.solener.2019.01.025

[44] Berrazouane, S., & Mohammedi, K. (2014). Parameter optimization via cuckoo optimization algorithm of fuzzy controller for energy management of a hybrid power system. Energy Conversion and Management, 78, 652–660. https://doi.org/10.1016/j.enconman.2013.11.018

[45] Balasubbareddy, M., Sivanagaraju, S., & Suresh, C. V. (2015). Multi-objective optimization in the presence of practical constraints using non-dominated sorting hybrid cuckoo search algorithm. Engineering Science and Technology, an International Journal, 18(4), 603–615. https://doi.org/10.1016/j.jestch.2015.04.005

[46] Senthil Kumar, J., Charles Raja, S., Jeslin Drusila Nesamalar, J., & Venkatesh, P. (2018). Optimizing renewable based generations in AC/DC microgrid system using hybrid Nelder-Mead – Cuckoo Search algorithm. Energy, 158, 204–215. https://doi.org/10.1016/j.energy.2018.06.029

[47] Alsmadi, Y. M., Abdel-hamed, A. M., Ellissy, A. E., El-Wakeel, A. S., Abdelaziz, A. Y., Utkin, V., & Uppal, A. A. (2019). Optimal configuration and energy management scheme of an isolated micro-grid using Cuckoo search optimization algorithm. Journal of the Franklin Institute, 356(8), 4191–4214. https://doi.org/10.1016/j.jfranklin.2018.12.014

[48] Khoshgoftar Manesh, M. H., & Ameryan, M. (2016). Optimal design of a solar-hybrid cogeneration cycle using Cuckoo Search algorithm. Applied Thermal Engineering, 102, 1300–1313. https://doi.org/10.1016/j.applthermaleng.2016.03.156

[49] Meng, X., Chang, J., Wang, X., & Wang, Y. (2019). Multi-objective hydropower station operation using an improved cuckoo search algorithm. Energy, 168, 425–439. https://doi.org/10.1016/j.energy.2018.11.096

[50] Hasan, N., Nasirudin, I., & Farooq, S. (2019). Hybrid Taguchi Genetic Algorithm-Based AGC Controller for Multisource Interconnected Power System. Electric Power Components and Systems, 47(1–2), 101–112. https://doi.org/10.1080/15325008.2019.1576242

[51] Hong, Y. Y., Lin, F. J., & Yu, T. H. (2016). Taguchi method-based probabilistic load flow studies considering uncertain renewables and loads. IET Renewable Power Generation, 10(2), 221–227. https://doi.org/10.1049/iet-rpg.2015.0196

[52] Hasanien, H. M., & Muyeen, S. M. (2013). A Taguchi approach for optimum design of proportional-integral controllers in cascaded control scheme. IEEE Transactions on Power Systems, 28(2), 1636–1644. https://doi.org/10.1109/TPWRS.2012.2224385

[53] Exergy, J. (2017). Thermodynamic optimisation of a hybrid solar-geothermal power plant using Taguchi method Anil Erdogan and Duygu Melek Cakici Can Ozgur Colpan *. 23(1), 63–84.