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An Economic and Environmental Optimization Model in a Micro Grid with Demand Response

Dariush RASHIDI ZADEH[1], Ghasem DERAKHSHAN[2*], Seyed MEHDI HAKIMI[3], Babak ABDI[4]

[1-4]*Department of Electrical Engineering, Damavand Branch, Islamic Azad University, Tehran, Iran*

***Abstract* – To accommodate the current energy system with the renewable energy source, the concept of micro grid (MG) has been developed. Using such systems, different advantage such as minimization of power loss, operating cost, and emission can be achieved. In this paper, the 24-hour power and heat based MG scheduling is investigated under environmental aspects and economic issues as bi-objective modelling in the presence of demand response (DR) program for decreasing greenhouse gas emission and system operation cost. The investigation of the MG contains energy storage system, boiler and combined heat and power (CHP). For solving the problem, first the Pareto optimal solutions have been obtained by the weighted-sum technique, then the fuzzy satisfying approach has been used to get optimal trade-off result. To confirm the performance of the method, the problem is solved in two-case to demonstrate the effects of DR on MG scheduling.**

***Keywords* – Bi-objective modelling; Demand Response (DR) program; fuzzy satisfying approach; weighted sum technique**

Nomenclature		
h	Time	hour
i, N	CHP number	–
P^{CHP} ,H^{CHP}	Electrical and heat generated by CHP	MW
C_{CHP}	CHP operation cost	$
P^{G}	Upstream grid power	MW
P^{CH}, P^{DIS}	Charge and discharge power of storage system	MW
P^{r}_{ESS}	Power rate of ESS	MW
P^{D}	Electrical demand before DR	MW
P^{DR}	Electrical demand after DR	MW
DR	Factor of DR	%
ldr	Value of the demand transferred	MW
λ	Electrical price	$/MW
υ, χ, φ	Emission factors of the CHPs and upstream grid	kg/MW
u	Binary variable of storage system	–

* Corresponding author.
E-mail address: g.derakhshan.ac@gmail.com

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1. INTRODUCTION

For the purpose of accelerating the green and low-carbon transition and achieving green recovery development, the development of clean energy should be strongly supported. However, traditional power generation methods such as thermal power generation are widely used in most developing areas, which not only causes environmental pollution but also wastes resources [1]. With the rise of technologies such as wind power, photovoltaic power, and hydrogen fuel cell power in recent years, renewable energy generation has provided new ideas for the energy transition [2]. The Microgrids (MGs) are energy systems with controllable loads and distributed energy generators (DEGs), which can be operated in stand-alone or grid-connected modes [3]. Based on uncertainty of energy price in energy markets [4], demand response (DR) programs have great influence on the integration of generation sides and balance between demand and supply [4], [5].

Some studies have been conducted on the operation of MGs in recent researches. In Ref. [6], the impact of the DR program is investigated on large consumers' energy procurement. In [7] implementation of DR program is investigated on a real MG to optimal power scheduling. Reference [8] establishes a hybrid energy storage capacity configuration optimization model with economic cost as the objective function. This model is applicable to the capacity configuration optimization of hybrid energy storage systems, which can reduce the power fluctuation of microgrids and extend the service life of energy storage systems. The operation of combined heat and power (CHP) units in a MG is implemented in [9] with the reliability and economy indices. In reference [10], a hybrid energy storage system consisting of a battery, flywheel, and super-capacitor is established. Reference [11] establishes an analytical simulation model of the energy storage system, and optimizes the control strategy, considering the system objectives, construction costs, energy storage safety and other factors. The optimized model makes the energy storage system more economical and environmentally friendly and improves the service life and storage capacity of the energy storage battery. Reference [12] maximizes the benefits of energy distribution systems with power flow allocation strategy in several renewable energy distribution systems with the optimization objectives of installation cost, energy balance, and system losses. References [13]–[16] uses a multi-objective genetic algorithm incorporating an NDX crossover operator and a differential evolution operator to optimize the number of devices by establishing three objective functions: initial investment cost, the ratio of renewable energy curtailment, and the load loss ratio. References [14], [15] establishes an integrated charging station of hydrogen storage based on the charging station and defines three objective functions: operating cost, the purchase of electricity, and hydrogen consumption. References [16]–[20] establishes an independent multi-energy hub model consisting of a wind turbine, photovoltaic, CHP unit, supplementary heat boiler, and hydrogen storage tank, and proposes three objective functions: system economic cost, renewable energy utilization, and energy supply reliability.

In this paper, optimal planning of a power and heat based in a grid connected mode is investigated considering economic and environmental issues. The MG consists of storage devices, boiler and CHP units. The electrical and heat energies are stored during low price periods using storage devices. To minimize the operating cost and emission of the considered case study, a bi-objective model is developed based operating cost and environmental issues. To solve the model, the weighted sum (WS) approach is utilized to get the Pareto solution, then the fuzzy satisfying approach is used to select the trade-off solution. In addition, the time-of-use (TOU) rate of DR program is proposed to decrease total operating cost and emission. To demonstrate such programs' effect, the planning of MG is carried out in with and without DR program cases.

2. Problem Formulation

In MG modelling, different components are considered including an energy storage system and CHP units. Fig. 1 presents the structure of the MG. It worth to remind that the MG is connected to the upstream grid [21]–[25].

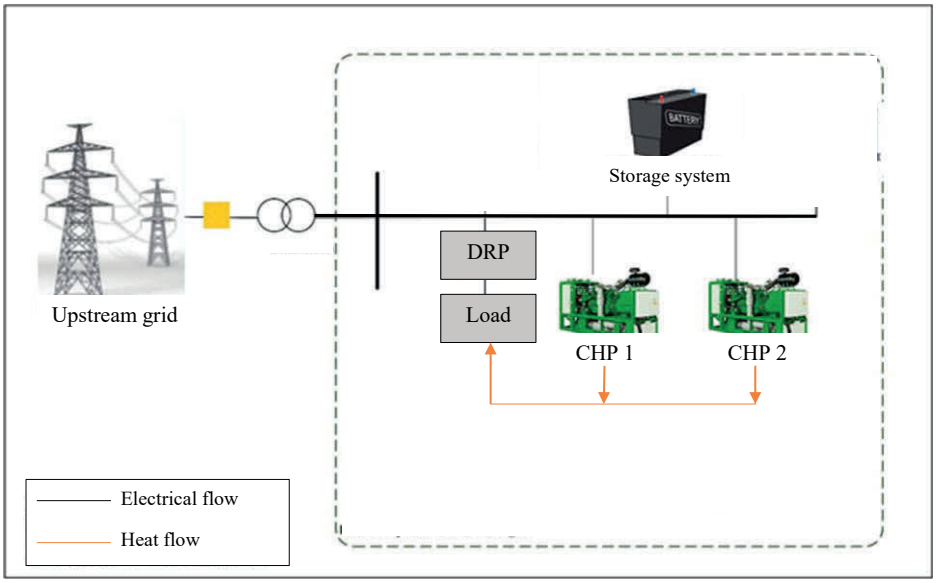


Fig. 1. MG overview.

2.1. Objective function

In the proposed multi-objective modelling, the two objective functions which are developed to model operation cost is presented by f_1 and emission polluting is defined as f_2. Eq. (1) describes the first objective function.

$$\min f_1 = \sum_{h=1}^{24} \left\{ \lambda_h \times P_h^{\mathrm{G}} + \sum_{i=1}^{N_{\mathrm{CHP}}} C_{\mathrm{CHP}} \times \left[P_h^{\mathrm{CHP}} + H_h^{\mathrm{CHP}} \right] \right\} \tag{1}$$

Eq. (2) presents the emission of the generation units as the objective function. It is obvious that Eq. (2) is defined as aggregation of emission of generation units and upstream grid that should be minimized [26]–[30]:

$$\min f_2 = \sum_{h=1}^{24} \left\{ E_h^{\mathrm{CHP}} + E_h^{\mathrm{G}} \right\}, \tag{2}$$

where

$$E_h^{\mathrm{CHP}} = \left\{ \upsilon P_{i,h}^2 + \chi P_{i,h} + \varphi \right\}, \tag{3}$$

$$E_h^{\mathrm{G}} = \left\{ \upsilon \left(P_h^{\mathrm{G}} \right)^2 + \chi P_h^{\mathrm{G}} + \varphi \right\}. \tag{4}$$

2.2. Power balance constraint

The following formula for the power balance constraint can be derived from the principle of conservation of energy. Therefore, equation (6) is provided to demand and supply electrical balance.

$$P_h^{\mathrm{G}} + \sum_{i=1}^{N_{\mathrm{CHP}}} P_{i,h}^{\mathrm{CHP}} + P_h^{\mathrm{DIS}} = P_h^{\mathrm{DR}} + P_h^{\mathrm{CH}} \tag{5}$$

Note that in Eq. (5), the load is considered after implementing DR. It should be mentioned; heat energy balance is considered as well as Eq. (5) in heat generation and heat demand.

2.3. DR program modelling

The DR program shifts load from expensive and peak periods to inexpensive and off-peak periods. Among different designed programs, TOU-DR program is proposed to decrease system cost and emission which is modelled by Eq. (6) [31]–[34].

$$P_h^{\mathrm{DR}} = P_h^{\mathrm{D}} + ldr_h \tag{6}$$

Eq. (7) is utilized which calculates product of initial load demand and participation factor [35].

$$ldr_h = DR_h \times P_h^{\mathrm{D}} \tag{7}$$

In the TOU, it is assumed that the summation of shifted load during the period should be zero that is model by Eq. (8). In addition, the participation factor of DR is limited by Eq. (9) [36].

$$\sum_{h=1}^{24} ldr_h = 0\,, \tag{8}$$

$$DR_h^{\min} \le DR_h \le DR_h^{\max}\,. \tag{9}$$

The participation of the demand side in DR program in $DR^{\min}$ and $DR^{\max}$ are assumed to −30 % and +30 %, respectively.

2.4. Storage system modelling

The modelling storage system is given by Eq. (10) and Eq. (11). These equations impose charge and discharge limits, respectively [37]:

$$0 \le P^{\mathrm{CH}}(t) \le [1 - u(t)] \times P_{\mathrm{ESS}}^r, \tag{10}$$

$$0 \le P^{\mathrm{DIS}}(t) \le u(t) \times P_{\mathrm{ESS}}^r. \tag{11}$$

3. SOLUTION METHOD

In this paper, total operation cost and emission functions have been considered as main objective functions. As said before, the developed bi-objective model is solved using the WS method to obtain the Pareto results, and the fuzzy-satisfying method is used to the select best trade-off solution [38]. In WS method, all of independent objective functions are turned to a single function by assigning proper weights [39], [40]. The objective functions under weighted-sum techniques is modelled as follow.

$$\min[OF] = w_1 \times F_{1,pu} + w_2 \times F_{2,pu}, \tag{12}$$

$$w_1 + w_2 = 1, \tag{13}$$

where w_1 and w_2 are weight coefficients and $F_{1,pu}$ and $F_{2,pu}$ are normalized objective, computed according to fuzzy-satisfying approach.

The fuzzy-satisfying technique is utilized to get the best trade-off solution between the provided Pareto optimal solutions which is explained in next section.

3.1. Fuzzy satisfying method

The Fuzzy satisfying method is used to opt the best trade-off solution out of the provided Pareto solutions. In this approach, a fuzzy membership is devoted to each Pareto front solution some value between 0 and 1 which is calculated by (14) [41]–[43].

$$OF_{k,pu} = \begin{cases} 1 & OF_k \le OF_k^{\min} \\ \dfrac{OF_k^{\max} - OF_k}{OF_k^{\max} - OF_k^{\min}} & OF_k^{\min} \le OF_k \le OF_k^{\max} \\ 0 & OF_k^{\max} \le OF_k \end{cases} \tag{14}$$

Then, the best trade-off solution is opted by the mean of the max-min method. In first step, the min value of each per unitized objective functions, in this case $F_{1,pu}$ and $F_{2,pu}$, is determined. In the next and last step, the maximum value of determined min values of ($F_{1,pu}$, $F_{2,pu}$) is chosen as the best trade-off solution to the problem [44]–[49].

4. SIMULATION RESULTS

As it was stated before, the TOU-DR program is applied to decrease the system operating cost and emission. To clarify the effect of DR program, two following cases are considered in the solving the problem:

Case 1: MG scheduling without DR program,

Case 2: MG scheduling with DR program.

The proposed optimization model is solved using the GAMS optimization software under the SBB solver. The information of introduced case study in the previous sections are taken from [50]–[59]. The two CHP units are considered in optimization modelling. The load demands of the electrical and heat of the system are shown in Fig. 2. The electric and heat prices in the system are depicted in Fig. 3.

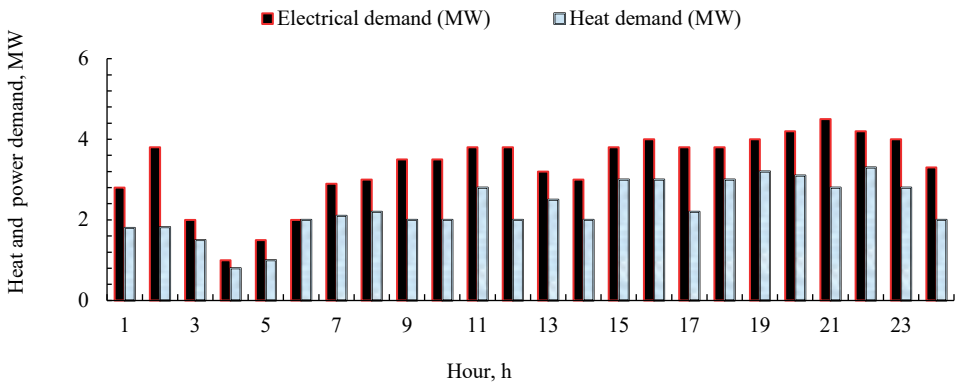


Fig. 2. Heat and power load of the system.

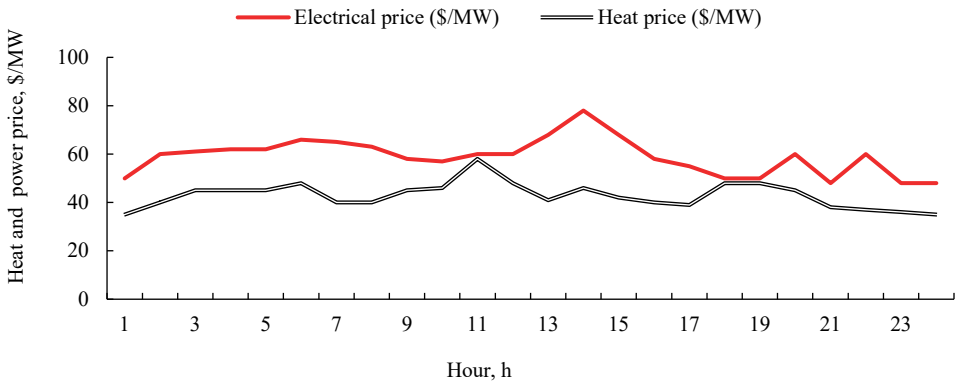


Fig. 3. Heat and electric power prices.

4.1. Simulation Result

Fig. 4 presents the optimal Pareto solutions for both cases. The Pareto optimal solution is generated by 12-iteration. According to max-min decision making method, 0.8615, Solution #10, is the highest value between the minimum values of membership function in the first case. In this case, $ 4843.9 for system operating cost and 4.0980 kg emission are reported as final results. In the with DR case, the highest value of membership function minimums is recorded as, 0.872 in Solution #11. According to the described method, it is selected as the optimal trade-off solution in this case with system operating cost $ 4708.6 and emission 4.092 kg. Comparing solution of two cases shows that implementing DR have an economically and environmentally effects, whereby 2.8 % of the operation cost and 0.14 % of the emission are reduced than Case 1, respectively.

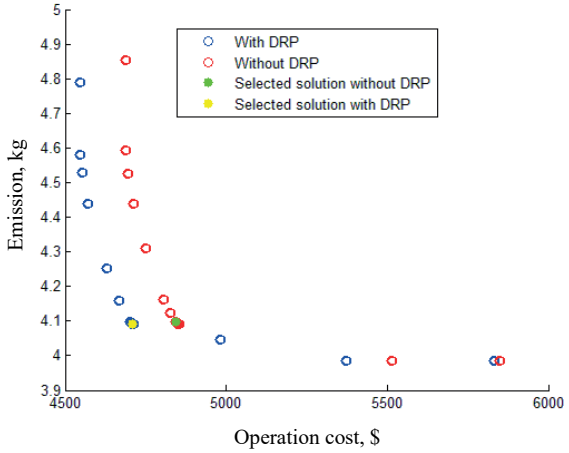


Fig. 4. Obtained results of each iteration.

Fig. 5 depicts electrical load in both cases. Clearly, the DR program shifts demand from expensive periods to inexpensive times. Turning to Fig. 2, hours 10–17 are considered as expensive periods. Therefore, it was expected that DR program transfers demand from this period to hours 19–23 when the power has high price.

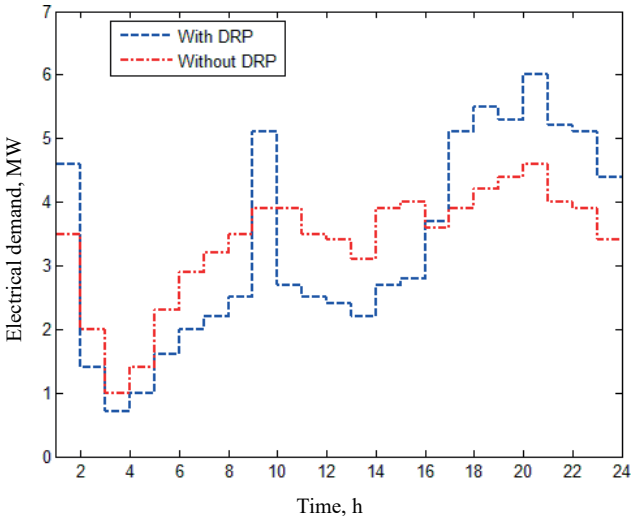
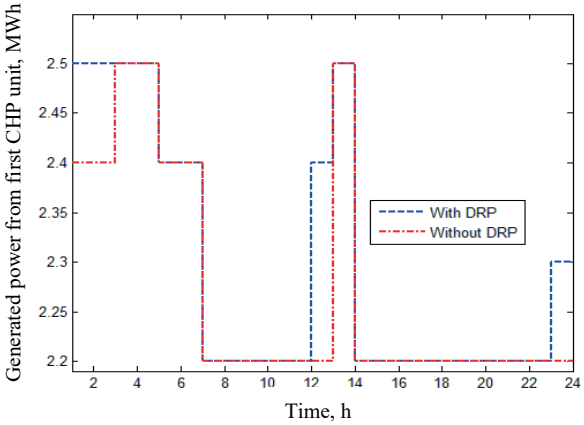
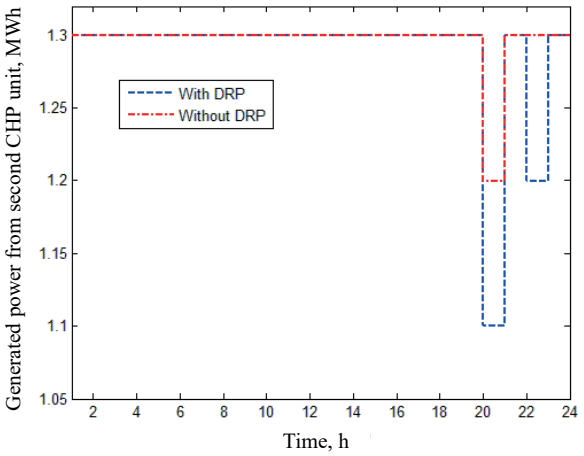


Fig. 5. Electrical load without and with DR.

Fig. 6 shows power output of CHP units. It can be seen that in both cases, generated power generated by the CHP 1 in Fig. 6 (a) is 2.5 MWh for hours 3–5 and 13–14. In with DR case, during hours 1–3 and 12 and 24, scheduled power of the CHP is increased. Fig. 6(b) shows output power of the CHP unit 2. Clearly, there is a slight change in output power of CHP-unit 2.



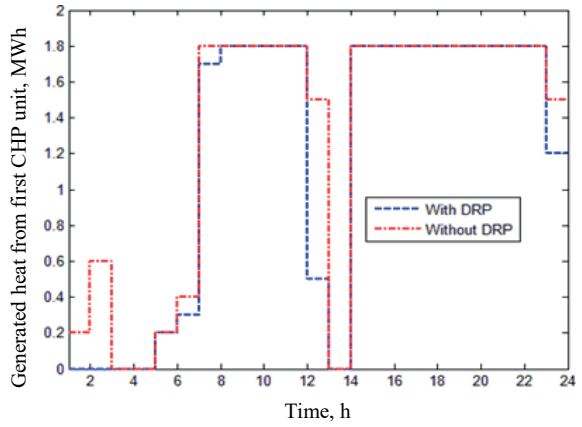
(a)



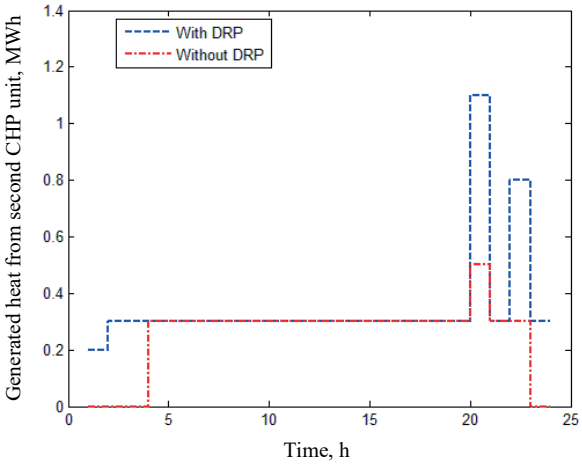
(b)

Fig. 6. Electrical generated by CHP units: (a) CHP 1 and (b) CHP 2.

Fig. 7 presents the heat output of CHP unit 1 and CHP unit 2, respectively. As it was explained, the CHP units heat output is fully relying and dependent to their power output. Therefore, the heat output change in the CHP unit is in accordance with the power output of these units.



(a)



(b)

Fig. 7. Heat generated by CHP units: (a) CHP 1 and (b) CHP 2.

5. CONCLUSION

In this study, the optimal heat and power planning of a MG is carried out under DR program. To show the impact of TOU rate of DR program the electricity demand of the system has been supplied. In order to minimizing environmental and economic indices, a bi-objective function is proposed. The WS method is applied to get Pareto solutions and the fuzzy satisfying method utilized to determine best solution. The two case studies are investigated to evaluate of proposed MG the with and without TOU-DR program. The best solution without implementing DR program (Case 1) to operation cost is equal to $ 4843.9 and emission is 4.098 kg. This while, in DR case (Case 2), operation cost has value $ 4708.6 and emission is equal to 4.092 kg. In Case 2, electrical demand is modified, due to implementing DR program which leads to reduce the operation cost and emission by 2.8 % and 0.14 % than Case 1, respectively.

REFERENCES

[1] Tseng Cheng-Jui *et al.* Optimal Energy Management in a Smart Micro Grid with Demand Side Participation. *Environmental and Climate Technologies* 2022:26(1):228–239. https://doi.org/10.2478/rtuect-2022-0018.
[2] Mustika N. M., *et al*. Sustainable Socio-cultural Aspect Within Green Building User Behavior in Bali, Indonesia. In *IOP Conference Series: Earth and Environmental Science* 2021:933(1):012021. IOP Publishing. https://doi.org/10.1088/1755-1315/933/1/012021
[3] Sifatu W. O. *et al.* Innovative work behaviors in pharmacies of Indonesia: Role of employee voice, generational diversity management and employee engagement. *Systematic Reviews in Pharmacy* 2020:11(2):725–734.
[4] Primadewi S. P. N., *et al.* Emerging Architect's Design Method in Designing Tourist Accommodation Case Study: Tourist Accommodation in Ubud, Bali. *Civil Engineering and Architecture* 2021:9(2):271–280. https://doi.org/10.13189/cea.2021.090201
[5] Mohammadzadeh A., Castillo O., Band S. S., Mosavi A. A novel fractional-order multiple-model type-3 fuzzy control for nonlinear systems with unmodeled dynamics. *International Journal of Fuzzy Systems* 2021:23(6):1633–1651. https://doi.org/10.1007/s40815-021-01058-1
[6] Wang Z., *et al.* Monthly streamflow prediction using a hybrid stochastic-deterministic approach for parsimonious non-linear time series modeling. *Engineering Applications of Computational Fluid Mechanics* 2020:14(1):1351–1372. https://doi.org/10.1080/19942060.2020.1830858
[7] Ma C., Mohammadzadeh A., Turabieh H., Mafarja M., Band S. S., Mosavi A. Optimal type-3 fuzzy system for solving singular multi-pantograph equations. IEEE Access. 2020:8:225692–225702. https://doi.org/10.1109/ACCESS.2020.3044548
[8] Madvar H. R., Dehghani M., Memarzadeh R., Salwana E., Mosavi A., Shahab S. Derivation of optimized equations for estimation of dispersion coefficient in natural streams using hybridized ANN with PSO and CSO algorithms. *IEEE Access* 2020:8:156582–156599. https://doi.org/10.1109/ACCESS.2020.3019362
[9] Rjoub H., Türsoy T., Günsel N. The effects of macroeconomic factors on stock returns: Istanbul Stock Market. *Studies in Economics and Finance* 2009:26(1). https://doi.org/10.1108/10867370910946315
[10] Tursoy T., Gunsel N., Rjoub H. Macroeconomic factors, the APT and the Istanbul stock market. *International Research Journal of Finance and Economics* 2008:22:49–57.
[11] Rjoub H., Civcir I., Resatoglu N. G. Micro and macroeconomic determinants of stock prices: The case of Turkish banking sector. *Romanian Journal of Economic Forecasting* 2017:20(1):150–166.
[12] Rjoub H. Stock prices and exchange rates dynamics: Evidence from emerging markets. *African Journal of Business Management* 2012:6(13):4728–4733. https://doi.org/10.5897/AJBM11.2761
[13] Adebayo T. S., Rjoub H., Akinsola G. D., Oladipupo S. D. The asymmetric effects of renewable energy consumption and trade openness on carbon emissions in Sweden: new evidence from quantile-on-quantile regression approach. *Environmental Science and Pollution Research* 2022:29(2):1875–1886. https://doi.org/10.1007/s11356-021-15706-4
[14] Alnaimi A. M. M., Rjoub H. Perceived organizational support, psychological entitlement, and extra-role behavior: The mediating role of knowledge hiding behavior. *Journal of Management & Organization* 2021:27(3):507–522. https://doi.org/10.1017/jmo.2019.1
[15] Safi A., Chen Y., Wahab S., Zheng L., Rjoub H. Does environmental taxes achieve the carbon neutrality target of G7 economies? Evaluating the importance of environmental R&D. *Journal of Environmental Management* 2021:293:112908. https://doi.org/10.1016/j.jenvman.2021.112908
[16] Adebayo T. S., *et al*. Wavelet analysis of impact of renewable energy consumption and technological innovation on CO_2 emissions: evidence from Portugal. *Environmental Science and Pollution Research* 2022:29(16):23887–23904. https://doi.org/10.1007/s11356-021-17708-8
[17] Adebayo T. S., *et al.* Modeling the dynamic linkage between renewable energy consumption, globalization, and environmental degradation in South Korea: Does technological innovation matter? *Energies* 2021:14(14):4265. https://doi.org/10.3390/en14144265
[18] Akhmadeev R., *et al.* Modeling Social Impacts of High-Rise Residential Buildings during the Post-Occupancy Phase Using DEMATEL Method: A Case Study. *Buildings* 2021:11(11):504. https://doi.org/10.3390/buildings11110504
[19] Sibuea M. B., Sibuea S. R., Pratama I. The impact of renewable energy and economic development on environmental quality of ASEAN countries. AgBioForum. 2021:23(1):12–21.
[20] Athiyaman A., Magapa T. Market intelligence from the internet: an illustration using the biomass heating industry. *International Journal of Economics and Finance Studies* 2019:11(1):1–16. https://doi.org/10.34109/ijefs.201911101
[21] Jermsittiparsert K. Linkage between energy consumption, natural environment pollution, and public health dynamics in ASEAN. *International Journal of Economics and Finance Studies* 2021:13(2):1–21.
[22] Nguyen-Chi H., Chuong H. N., Pham-My D., Nguyen-Anh T., Tra-Van T. Spatial clustering of manufacturing firms in vietnam. *International Journal of Economics and Finance Studies* 2022:14(1):116–137.
[23] Phumsiri N. Exploratory factor and structural equation modelling analysis of increasing efficiency of accounting officers with deming cycle. *International Journal of Economics and Finance Studies* 2022:14(1):239–258.

[24] Van Hoa N., Duyen N. T. H., Huyen V. N., Quang H. V., Van Huong N., Tu N. T. C., Nguyet B. T. M. Impact of Trained Human Resources, Adoption of Technology and International Standards on the Improvement of Accounting and Auditing Activities in the Agricultural Sector in Viet Nam. *AgBioForum* 2022:24(1):59–71.
[25] Boni A., Gunn M. Building and leveraging the innovation ecosystem and clusters: universities, startups, accelerators, alliances, and partnerships: A "From the Boardroom" Perspective by the Special Edition Co-Editors. *Journal of Commercial Biotechnology* 2021:26(1). https://doi.org/10.5912/jcb963
[26] Oladele M. F., Nubong G. The Contribution of private investment to economic growth and development in south africa. *International Journal of Economics and Finance Studies* 2022:14(1):88–115.
[27] Masrour A. Global Alliances to Accelerate Innovation at Plug and Play Technology Center. *Journal of Commercial Biotechnology* 2021:26(1):102–103. https://doi.org/10.5912/jcb976
[28] Richardson T. M., Marion J. W., Anantatmula V. S., Gibson J. R. Insights from the Field: Project Execution Success and Failure. *The Journal of Modern Project Management* 2022:9(2). https://doi.org/10.19255/JMPM02707.
[29] Ahmadi Z., Haghighi M., Validi Z. A Novel Approach for Energy Optimization in Distributed Databases in Wireless Network Applications. *Journal of Management and Accounting Studies* 2020:8(3). https://doi.org/10.24200/jmas.vol8iss3pp50-55
[30] Irandoost A., Kargar S. An integrated optimization of routing and scheduling of liner ships in offshore logistics management. *Journal of Research in Science, Engineering and Technology* 2021:9(02):17–35.
[31] Zainal A. G. Community development communication model and improving the role of agropolitan institutions. *International Journal of Scientific and Technology Reseacrh* 2020:8(12):2028–2034.
[32] Zainal A. G., Yulianto H., Yanfika H. Financial benefits of the environmentally friendly aquaponic media system. In *IOP Conference Series: Earth and Environmental Science* 2021:739(1):012024. IOP Publishing. https://doi.org/10.1088/1755-1315/739/1/012024
[33] Seyedhosseini S. M., Esfahani M. J., Ghaffari M. A novel hybrid algorithm based on a harmony search and artificial bee colony for solving a portfolio optimization problem using a mean-semi variance approach. *Journal of Central South University* 2016:23:181–188. https://doi.org/10.1007/s11771-016-3061-9.
[34] Ghaffari M., Javadian N., Narimani F. An improvement approach for bullwhip effect in multi-product and multi stage supply chains. In 6th International Conference on Information Systems Logistics and Supply Chain. 2016.
[35] Mirfani A. M., Kurniady D. A., Ahmed A. A. A., Shichiyakh R. A., Kadhim M. M., Hasan A. Y., Ghaffari M. An Integrated Multi-Objective Approach to Managing Supply Risks in a Flexible Supply Chain. *Industrial Engineering & Management Systems* 2021:20(4):596–603. https://doi.org/10.7232/iems.2021.20.4.596
[36] Patmal M. H., Shiran H. Public awareness and their attitudes toward adopting renewable energy technologies in Afghanistan. *International Journal of Innovative Research and Scientific Studies* 2021:4(2):82–91. https://doi.org/10.53894/ijirss.v4i2.61
[37] Frysa Wiriantari., *et al.* Transformation of Catuspatha in Bali Indonesia: Alteration Ideas from Empty Space to Aesthetic Element of City. *Rupkatha Journal on Interdisciplinary Studies in Humanities* 2020:12(6). https://doi.org/10.21659/rupkatha.v12n6.15
[38] Molajou A., *et al.* A new paradigm of water, food, and energy nexus. *Environmental Science and Pollution Research* 2021. https://doi.org/10.1007/s11356-021-13034-1
[39] Nourani V., Rouzegari N., Molajou A., Baghanam A. H. An integrated simulation-optimization framework to optimize the reservoir operation adapted to climate change scenarios. *Journal of Hydrology* 2020:587:125018. https://doi.org/10.1016/j.jhydrol.2020.125018
[40] Molajou A., Nourani V., Afshar A., Khosravi M., Brysiewicz A. Optimal design and feature selection by genetic algorithm for emotional artificial neural network (EANN) in rainfall-runoff modeling. *Water Resources Management* 2021:35(8):2369–2384. https://doi.org/10.1007/s11269-021-02818-2
[41] Molajou A., Pouladi P., Afshar A. Incorporating social system into water-food-energy nexus. *Water Resources Management* 2021:35(13):4561–4580. https://doi.org/10.1007/s11269-021-02967-4
[42] Haghshenas P., Sahraeian R., Golmohammadi A. M. A state-of-the-art model of location, inventory, and pricing problem in the closed-loop supply chain network. *International Journal of Engineering Transactions B: Applications* 2022:35(8):1558–1570. https://doi.org/10.5829/IJE.2022.35.08B.12
[43] Golmohammadi A. M., Rasay H., Akhoundpour Amiri Z., Solgi M., Balajeh N. Soft computing methodology to optimize the integrated dynamic models of cellular manufacturing systems in a robust environment. *Mathematical Problems in Engineering* 2021. https://doi.org/10.1155/2021/3040391
[44] Zerafati M. E., Bozorgi-Amiri A., Golmohammadi A. M., Jolai F. A multi-objective mixed integer linear programming model proposed to optimize a supply chain network for microalgae-based biofuels and co-products: a case study in Iran. *Environmental Science and Pollution Research* 2022:1–23. https://doi.org/10.1007/s11356-022-19465-8
[45] Zheng B., Wang H., Golmohammadi A. M., Goli A. Impacts of logistics service quality and energy service of Business to Consumer (B2C) online retailing on customer loyalty in a circular economy. *Sustainable Energy Technologies and Assessments* 2022:52:102333. https://doi.org/10.1016/j.seta.2022.102333
[46] Jafarian-Namin S., Goli A., Qolipour M., Mostafaeipour A., Golmohammadi A. M. Forecasting the wind power generation using Box–Jenkins and hybrid artificial intelligence: A case study. *International Journal of Energy Sector Management* 2019:13(4). https://doi.org/10.1108/IJESM-06-2018-0002

[47] Chamandoust H. *et al.* Tri-objective optimal scheduling of smart energy hub system with schedulable loads. *Journal of Cleaner Production* 2019:236:117584. https://doi.org/10.1016/j.jclepro.2019.07.059.

[48] Chamandoust H. *et al.* Multi-objective performance of smart hybrid energy system with Multi-optimal participation of customers in day-ahead energy market. *Energy & Buildings* 2020:216:109964. https://doi.org/10.1016/j.enbuild.2020.109964

[49] Chamandoust H. *et al.* Multi-objectives Optimal Scheduling in Smart Energy Hub System with Electrical and Thermal Responsive Loads. *Environmental and Climate Technologies* 2020:24:209–232. https://doi.org/10.2478/rtuect-2020-0013.

[50] Chamandoust H. *et al.* Tri-objective scheduling of residential smart electrical distribution grids with optimal joint of responsive loads with renewable energy sources. *Journal of Energy Storage* 2020:27:101112. https://doi.org/10.1016/j.est.2019.101112.

[51] Chamandoust H. *et al.* Multi-objective operation of smart stand-alone microgrid with the optimal performance of customers to improve economic and technical indices. *Journal of Energy Storage* 2020:31:101738. https://doi.org/10.1016/j.est.2020.101738.

[52] Chamandoust H. *et al.* Energy management of a smart autonomous electrical grid with a hydrogen storage system. *International Journal of Hydrogen Energy* 2021:46(34):17608–17626. https://doi.org/10.1016/j.ijhydene.2021.02.174.

[53] Chamandoust H. *et al.* Day-ahead scheduling problem of smart micro-grid with high penetration of wind energy and demand side management strategies. *Sustainable Energy Technologies and Assessments* 2020:40:100747. https://doi.org/10.1016/j.seta.2020.100747.

[54] Chamandoust H. *et al.* Optimal hybrid participation of customers in a smart micro-grid based on day-ahead electrical market. *Artificial Intelligence Review* 2022:55:5891–5915. https://doi.org/10.1007/s10462-022-10154-z

[55] Chamandoust H. *et al.* Energy Economic Management of Hybrid Energy System Based on Short-term Generation and Demand Response. *Environmental and Climate Technologies* 2020:24(1):653–668. https://doi.org/10.2478/rtuect-2020-0040.

[56] Chamandoust H., Hashemi A., Derakhshan G., Abdi B. Optimal Hybrid System Design Based on Renewable Energy Resources. IEEE Smart Grid Conference (SGC), Dec 2017. https://doi.org/10.1109/SGC.2017.8308878.

[57] Chamandoust H. *et al.* Scheduling of Smart Micro Grid Considering Reserve and Demand Side Management. IEEE Smart Grid Conference (SGC), 2018. https://doi.org/10.1109/SGC.2018.8777926.

[58] Nazari-Heris M., Abapour S., Mohammadi-Ivatloo B. Optimal economic dispatch of FC- CHP based heat and power micro-grids. *Applied Thermal Engineering* 2017:114(5):756–769. https://doi.org/10.1016/j.applthermaleng.2016.12.016

[59] Blumberga A., Timma L., Blumberga D. System Dynamic Model for the Accumulation of Renewable Electricity using Power-to-Gas and Power-to-Liquid Concepts. *Environmental and Climate Technologies* 2016:16:54–68. https://doi.org/10.1515/rtuect-2015-0012.