

Optimal Dispatch of the Energy Demand in Electrical Distribution Grid with Reserve Scheduling

Ngakan Ketut Acwin DWIJENDRA¹, Wongchai ANUPONG^{2*}, Ahmed Majed ALTHAHABI³,
Sabah Auda ABDULAMEER⁴, Waleed Khalid AL-AZZAWI⁵, Mustafa Musa JABER⁶,
Musaddak Maher ABDUL ZAHRA⁷, Zuhair I. Al MASHHADANI⁸

¹*Faculty of Engineering, Udayana University, Bali, Indonesia*

²*Department of Agricultural Economy and Development, Faculty of Agriculture, Chiang Mai University, Chiang Mai Province, Thailand*

³*Al-Manara College for Medical Sciences, Maysan, Iraq*

⁴*Ahl Al Bayt University, Kerbala, Iraq*

⁵*Department of Medical Instruments Engineering Techniques, Al-farahidi University, Baghdad, Iraq*

⁶*Department of Medical instruments engineering techniques, Dijlah University College, Baghdad, Iraq*

⁶*Department of Medical instruments engineering techniques, Al-Farahidi University, Baghdad, Iraq*

⁷*Computer Techniques Engineering Department, Al-Mustaqbal University College, Hillah, Iraq*

⁸*Al-Nisour University College, Baghdad, Iraq*

Received 14.06.2022; accepted 21.11.2022

Abstract – The operation of the electrical systems is a major problem for electrical companies' subject to uncertainties threatening. In this study, the optimal management of the energy demand in the electrical distribution grid is done by interval optimization approach under electrical price uncertainty. The management of the energy demand is implemented via incentive-based modelling of the demand response programs (DRPs). The incentive-based modelling as reserve, and based on bid price for reduction of the electrical demand at peak hours is proposed. The interval optimization approach is used for the minimization of the electrical price uncertainty effects. The main objective in the proposed approach is minimizing operation cost; epsilon-constraint method is utilized to solve the problem. Finally, an electrical distribution grid has been used at various case studies to numerical simulation results and positive effects of the proposed modelling under uncertainties.

Keywords – Electrical price uncertainty; epsilon-constraint method; interval optimization approach; incentive-based modelling; reserve.

Nomenclature

t, T	Time index	hour
n, N	DG index	–
NC	Consumer index	–
D_{eq}, D_{RE}	Total demand and demand reserve	kW
Ψ_{RE}	Bid price for reserve	\$
C_{RE}	Reserve price	\$

* Corresponding author.
E-mail address: anupong.w@cum.ac.th

σ, ω, λ	Fuel cost of DG	\$
P_n, P_{UG}	Power generation by DG and UG	kW
p_E	Electrical price	\$
Θ_{RE}	Binary variable for reserve implementing (1 = done and 0 = otherwise)	–
τ_{RE}, κ_{RE}	Binary variable for starting and ending reserve	–

1. INTRODUCTION

Currently, power grids are being developed using smart grid technologies and integrated with communication and information infrastructure, offering enormous possibilities for automation and control [1], [2]. In the smart grid framework, the role of end users with respect to power grids has changed to that of an active market player rather than a passive consumer [1]–[3]. Accordingly, end users are more actively involved in energy-trading mechanisms. To this end, an energy management system can be considered a cost effective tool to intelligently control the load demand of end users at the residential level [4]–[7]. Based on relevant input information (such as forecasted weather data, electricity price data, and limits for peak power), energy management is used in a smart home to regulate the energy consumption patterns of residential users under demand response (DR) strategies [7]. Also, with attention to incrementing environmental and economic issues, utilization of the smart grids and various approaches in many countries for energy saving are developing. In recent years, fossil fuels were the major sources for energy generation specially electricity energy [7]–[9]. Therefore, utilization of the different solutions is necessary to deal with all mentioned issues and challenges. Hence, smart grid has been provided, communication links among the electricity companies and the consumers to improve economic and technical indices [7]–[10]. As well, with integration of the smart grids in electrical grids, consumers can be participated in energy-saving subject to electricity prices signals [8]–[11]. The participation of the consumers can be considered as reserve source in electrical grids, in order to decreasing energy generation at peak demand [8]. In this solution, consumers have generator role, and power generation in power plans are reduced at peak demand [11].

The energy dispatch in electrical grids are studied by researchers in recent years, which number of them are proposed in this section. Authors in [12] focused on hub energy management based on appliances classification and minimizing the energy consumption expense. In [13] optimization of the energy is studied subject to emission and energy generation costs in electrical grids. The coordination of the electrical micro grids with optimal energy dispatch of the power plants is presented in [14]. The optimal energy dispatch in electrical grids with consideration of the Plug Electric Vehicles (PEVs) uncertainty is proposed in [15]. The local energy generation and demand management by consumers are used in [16] to reduction of the costs and maximizing reliability. In [17] self-scheduling of the energy resources subject to risk management under uncertainty of the demand is studied to maximizing energy-saving. The modelling hybrid optimization is used in [18] in order to load management in electrical grids at critical hours. The economic modelling of the electrical grids with optimal operation of renewable energy resources and demand scheduling is studied in [19]. The assessment of electrical systems for maximization of the energy efficiency using optimal configuration modelling is proposed in [20].

In this paper, economic load dispatch under uncertainty of the electrical price is proposed as reserve strategy in the electrical grids. The consumers by incentive-based strategy in the demand response programs (DRPs) have reserve role in energy system. The reserve strategy

is implemented based on bid price to consumers for managing self-demand at peak times. The interval optimization approach is utilized for covering electrical price uncertainty in energy market. In interval optimization, minimization of the deviation and average operation costs are considered as twofold modelling. Then, using epsilon-constraint method and decision making approach the maximum compatibility of the deviation and average operation costs have provided. Therefore, contributions and novelties can be expressed as follow:

1. Incentive-based strategy is considered as reserve in demand side for peak demand management.
2. Interval optimization approach is solved by epsilon-constraint method for covering uncertainty of the electrical price.
3. Decision making approach is proposed to maximization of the compatibility in deviation and average operation costs.

2. RESERVE MODELLING

In this section, incentive-based strategy is modelled as reserve in electrical grids via consumers' participation in energy saving. The reserve program is implemented subject to bid price to consumers for control and reduction of the self-consumption. The mathematical of the reserve is formulated as follow [20]–[22]:

$$C_{RE} = \sum_{t=1}^T \psi_{RE} \times D_{RE}(t) \times \theta_{RE}(t) \quad \forall t, \quad (1)$$

$$\tau_{RE}(t) - \kappa_{RE}(t) = \theta_{RE}(t) - \theta_{RE}(t-1) \quad \forall t. \quad (2)$$

Eq. (1) is operation cost of reserve modelling. Reserve times for demand reduction are modelled by Eq. (2).

3. UNCERTAINTY MODELLING OF THE ELECTRICAL PRICE

The modelling electrical price is implemented under uncertainty in energy market. The lognormal distribution function is used for modelling electrical price, which modelling of uncertainty is given as follow [14], [23]–[26]:

$$G(p_E, \mu, \sigma) = \frac{1}{p_E \sigma \sqrt{2\pi}} e^{\left(\frac{(\ln(p_E) - \mu)^2}{2\sigma^2} \right)}, \quad (3)$$

where μ , σ and p_E are mean value, standard deviation and distribution function parameter, respectively. The distribution function parameter (electrical price) as random variables is generated by Monte Carlo method at interval $[p_E^{\min}, p_E^{\max}]$ [27]–[30]:

$$p_E^{\min} \leq p_E(t) \leq p_E^{\max}. \quad (4)$$

4. OBJECTIVE FUNCTION MODELLING

The overview of the electrical distribution grid is depicted in Fig. 1. In this figure, generation side including diesel generators (DGs) and upstream grid (UG). The DGs are feed

by fossil fuels for electrical energy generation [31]–[35]. The power generation by UG has different prices at each hour of day. The modelling electrical price under uncertainty is formulated in Section 3.

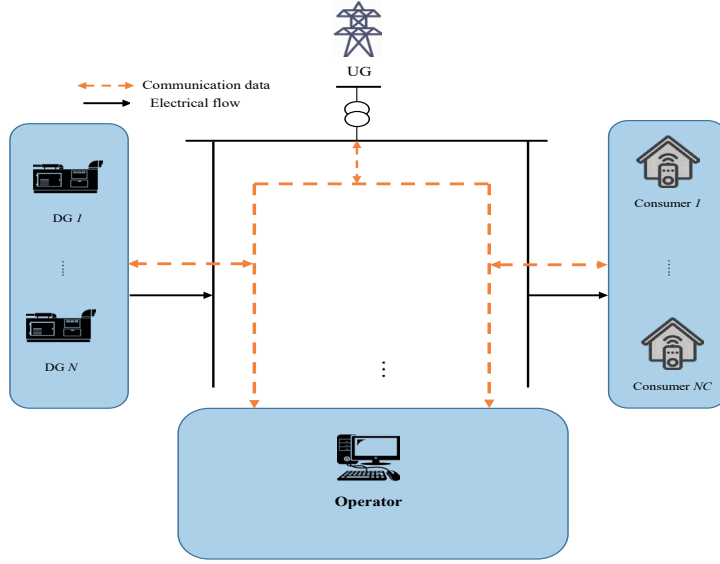


Fig. 1. Schematic of Electrical distribution grid.

The operator has coordinator role between generation side and consumers by communication data in the system [36]–[38]. The consumers can be had optimal participation in energy consumption via bid price for demand reduction and sent data from operator [39], [40]. Therefore, objective function in electrical distribution grid is formulated subject to minimizing the fuel cost of the DGs, UG cost and reserve cost:

$$\min f = \sum_{t=1}^T \left[\sum_{n=1}^N \left\{ \sigma P_n^2(t, n) + \omega P_n(t, n) + \lambda \right\} \right] + \sum_{t=1}^T [P_{UG}(t) \times p_E(t)] + \sum_t [C_{RE}], \quad (5)$$

where DGs operation cost, UG cost and reserve cost are modelled by first, second and third term of objective function (5), respectively.

4.1. Power balance constraint

The energy demand should be meet by generation side at any time. This constraint is provided by power balance as follow:

$$P_{UG}(t) + \sum_{n=1}^N P_n(t, n) = D_{eq}(t) - D_{RE}(t). \quad (6)$$

4.2. DGs capacity constraint

The minimum and maximum power production by DGs are limited by following constraint:

$$P_n^{\min} \leq P_n(n, t) \leq P_n^{\max}. \quad (7)$$

5. INTERVAL OPTIMIZATION APPROACH

In this section, interval optimization is modelled for solving objective function subject to electrical price uncertainty [41]–[45]. In this approach, maximum and minimum bounds of the objective function are modelled based on an uncertain parameter [46]–[53].

$$f^{\max}(x) = \max f(x), \quad (8)$$

$$f^{\min}(x) = \min f(x). \quad (9)$$

Then, deviation and average value of the objective function are modelled as two objective functions as follows:

$$f^d(x) = \frac{f^{\max}(x) + f^{\min}(x)}{2}, \quad (10)$$

$$f^a(x) = \frac{f^{\max}(x) - f^{\min}(x)}{2}, \quad (11)$$

where f^d and f^a are deviation and average value of the objective function, respectively. Therefore, objective function (operation cost) can be modelled by new objective function as follows:

$$\min f = \min [f^d(x), f^a(x)]. \quad (12)$$

6. EPSILON-CONSTRAINT METHOD

Since multi objective functions such as deviation and average costs are obtained by interval optimization, the epsilon constraint method is employed to generation Pareto front solutions of the objective functions. The formulation of the epsilon constraint method is as follows [7], [15]:

$$\min_{x \in X} f_j(x), \quad (13)$$

subject to:

$$f_z(x) \leq \varepsilon_z \quad z = 1, 2, \dots, Z \quad z \neq j, \quad (14)$$

where z, j and x are, other objectives, main objective and decision variable in optimization process.

6.1. Decision-making method

Generated Pareto front solutions of objectives by epsilon constraint method have different amount. Hence, operator can be used decision-making method for the select best solution with maximum compatibility among them. The modelling of the decision-making method is as follows [15], [54]–[60]:

$$\Gamma_z^k = \frac{f_z^{\max} - f_z(k)}{f_z^{\max} - f_z^{\min}}, \quad (15)$$

$$P_{\text{Ideal}} = \left\{ \min \Gamma_1^1 \quad \min \Gamma_2^2 \quad \dots \quad \min \Gamma_z^k \right\}, \quad (16)$$

$$\min Dis(k) = \sqrt{\left[\Gamma_1^1 - \min \Gamma_1^1 \right]^2 + \left[\Gamma_2^1 - \min \Gamma_2^2 \right]^2 + \dots + \left[\Gamma_z^k - \min \Gamma_z^k \right]^2}, \quad (17)$$

where $f(k)$ and Γ_z^k are value of objective in k^{th} solution and normalized z^{th} objective in the k^{th} solution, respectively. In this modelling, Eqs. (15)–(17) are normalization model of the solutions, ideal point of the solutions and minimum distance of the k^{th} solution from ideal point, respectively [15], [61]–[66]. In decision-making method, the best solution is found by Eq. (17) with minimum distance of the k^{th} solution from ideal point.

7. CASE STUDIES AND SIMULATION

In this section two case studies are carried out for numerical simulation of the proposed approach. The case studies are as follow:

- Case I) Optimization of the electrical energy without reserve.
- Case II) Optimization of the electrical energy with reserve.

The 15-node test system as electrical distribution grid is shown by Fig. 2. The electrical demand and bid price for reserve implementation are depicted by Fig. 3 and Fig. 4, respectively. The data of the DGs are extract from Refs [15]–[18]. The electrical price in UG is shown by Fig. 5, which it is generated by Monte Carlo simulation. The proposed optimization is done using GAMS software in MINLP program and DICOPT solver.

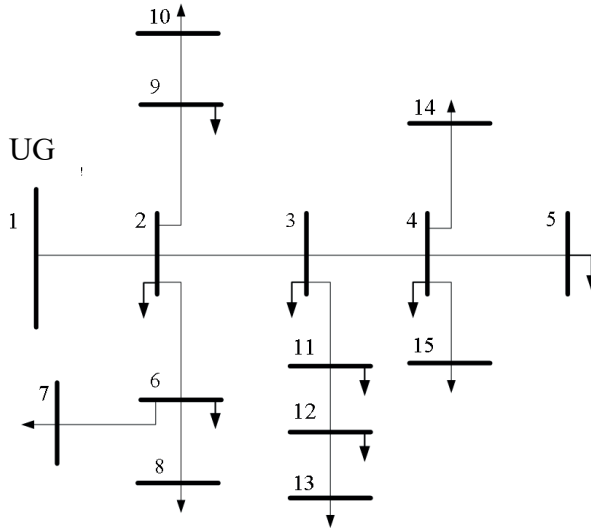


Fig. 2. Electrical distribution grid.

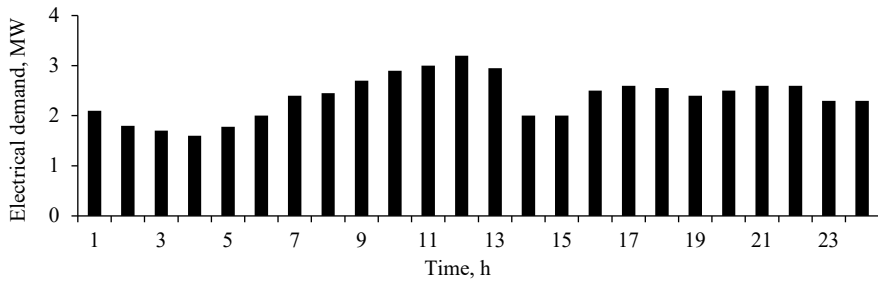


Fig. 3. Electrical demand.

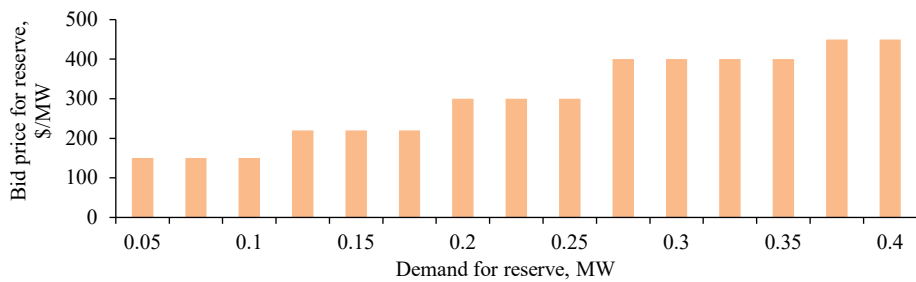


Fig. 4. Bid price for reserve implementation.

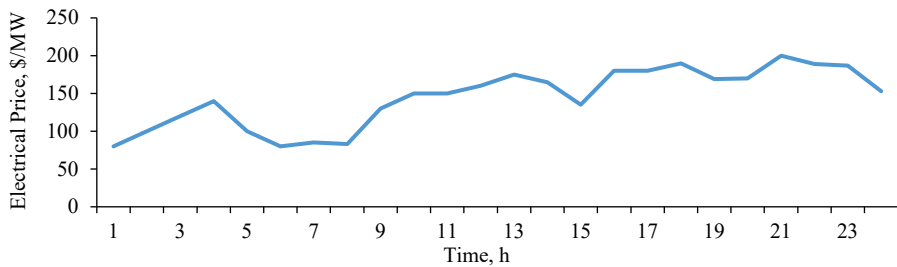


Fig. 5. Electrical price in UG.

7.1. Results and discussion

The results are investigated in this subsection to analyse validation of the proposed approach subject to mentioned case studies.

In Fig. 6 electrical demand with and without reserve implementation is shown. It is clear that with participation of the consumers in reserve strategy, electrical demand at peak hours is reduced. The reserve strategy is not implemented only at hours 14 and 15. However, maximum reserve is occurred at hours 5–13 and 16. The total power reduced by reserve strategy is equal to 1.23 MW for all hours. It can be inferred; reserve strategy is implemented at high price of the UG. The total cost of the reserve is equal to \$ 378.3.

In Table 1, Pareto front solutions of the average and deviation costs in Cases I and II are listed. The solutions are generated by epsilon constraint method and by decision-making approach; the best solution is selected (bold format is the best solution). In Case I, fourth solution as the best solution is chosen with minimum distance 0.67, in which value of the average and deviation costs are \$ 3235.3 and \$ 2.6, respectively. However, the average and deviation costs in Case II are equal to \$ 2865.3 and \$ 2.5, respectively. The minimum distance of the best solution from ideal point in Case II is 0.53. The reduction rate of the average and deviation costs in Case II than Case I are 11.43 % and 3.8 %, respectively. The operation costs of the DGs and UG in Case I are \$ 1538.1 and \$ 1697.2, respectively. On the other hand, in Case II, cost of the DGs and UG are reduced by 5.3 % and 10.3 % in comparison with Case I, respectively.

It can be concluded, with implementation of the reserve strategy, operation of the electrical distribution grid under electrical price uncertainty is reliable and robust.

In Fig. 7, electrical generation in case studies by UG and DGs is depicted. In Case II, electrical generation by UG and DGs are minimized by 15.3 % and 6.31 % in comparison with Case I, respectively. As well, UG in both case studies has more participation in meet demand, due to low capacity of the DGs.

A comparison of the results in Cases I and II is provided in Table 2. In Case II, due to implementation of the reserve strategy, more optimal results are obtained than in Case I.

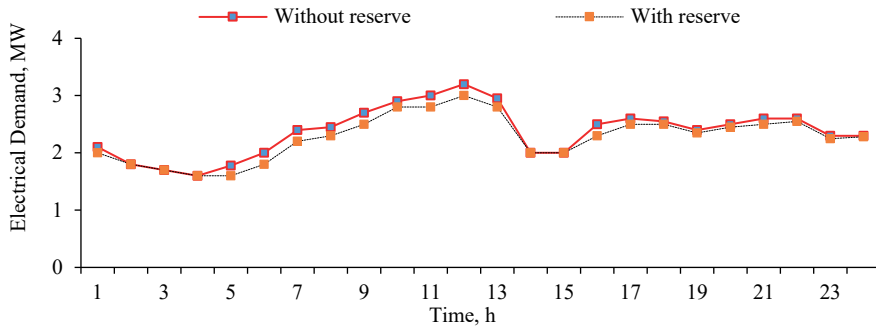


Fig. 6. Electrical demand with and without reserve.

TABLE 1. PARETO FRONT SOLUTIONS OF THE AVERAGE AND DEVIATION COSTS IN CASE STUDIES

Solutions	Case I		Case II	
	Average cost, \$	Deviation cost, \$	Average cost, \$	Deviation cost, \$
1	4324.2	1.9	4124.2	1.6
2	4025.3	2.01	3925.3	1.9
3	3865.3	2.3	3665.3	2.1
4	3235.3	2.6	3035.3	2.3
5	2965.3	2.8	2865.3	2.5
6	2635.3	3.3	2635.3	2.8

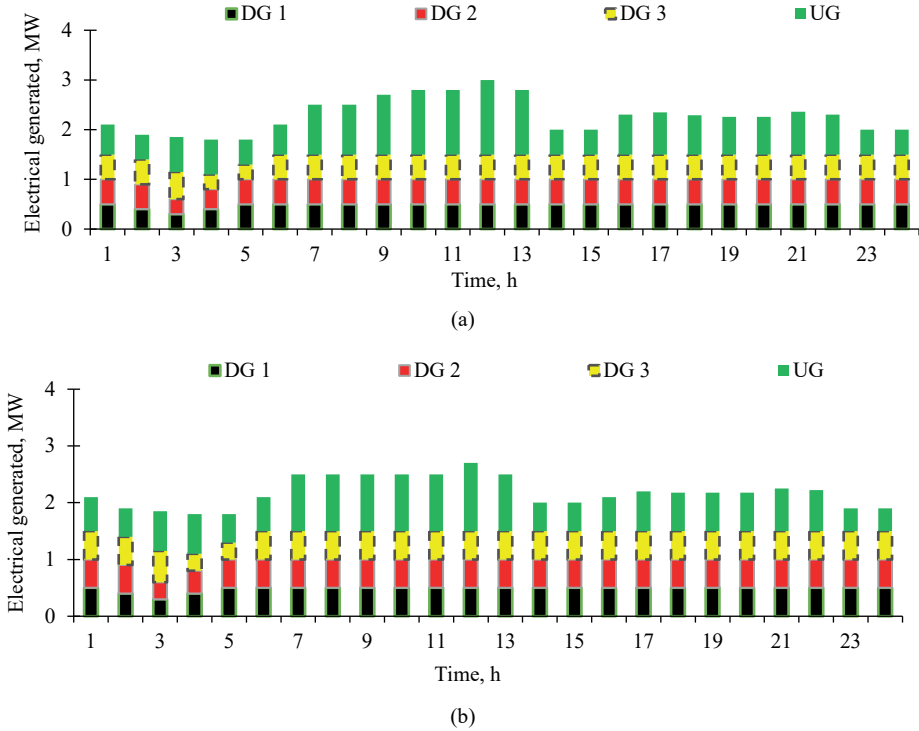


Fig. 7. Electrical generation: a) Case I and b) Case II.

TABLE 2. COMPARISON OF THE RESULTS

Results	Case I	Case II
Average cost, \$	3235.3	2865.3
Deviation cost, \$	2.6	2.5
Reduction of average cost, %	0	11.43
Reduction of deviation cost, %	0	3.8

8. CONCLUSION

In this study, the modelling uncertainty price-based in an electrical distribution grid is presented by the interval optimization framework. The deviation and average costs as multi-objective functions are proposed to covering electrical price uncertainty. As well, reserve strategy is used by consumers to energy management consumption at peak times. The epsilon constraint and decision making methods are employed to generation of the Pareto front solutions and opt the best solution among Pareto front solutions. The numerical simulation in two case studies is done as follows:

- Case I) In this case, reserve is not implemented. The results of the average and deviation costs are \$ 3235.3 and \$ 2.5, respectively.
- Case II) The reserve is implemented. The value of the average and deviation costs are reduced by 11.43 % and 3.8 %, respectively.

According to the results, it can be concluded that participation of consumers can provide optimal state of electrical distribution grid based on the prices' uncertainty in the energy market.

REFERENCES

- [1] Tseng C.-J., *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/rtuct-2022-0018>
- [2] Sibuea M. B., Sibuea S. R., Pratama I. The Impact of Renewable Energy and Economic Development on Environmental Quality of ASEAN Countries. *AgBioForum* 2021;15(23):12–21.
- [3] Jermstittiparsert K. Examining The Sustainable Energy And Carbon Emission On The Economy: Panel Evidence From ASEAN. *International Journal of Economics and Finance Studies* 2021;13(1):405–426.
- [4] Dwijendra N. K. A. Analyze of Symbolic Violence Practices in Balinese Vernacular Architecture, Bali Indonesia. *International Journal of Innovation, Creativity and Change* 2020;13(5). https://www.ijicc.net/images/vol_13/Iss_5/13543_Dwijendra_2020_E_R.pdf
- [5] Mostafaiepour A., *et al.* Energy efficiency for cooling buildings in hot and dry regions using sol-air temperature and ground temperature effects. *Journal of Engineering, Design and Technology* 2019;17(3):613–628. <https://doi.org/10.1108/JEDT-12-2018-0216>
- [6] Jafarian-Namin S., *et al.* Forecasting the wind power generation using Box–Jenkins and hybrid artificial intelligence: A case study. *International Journal of Energy Sector Management* 2019;13(4):1038–1062. <https://doi.org/10.1108/IJESM-06-2018-0002>
- [7] 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>
- [8] Dwijendra N. K. A., *et al.* Improving the transition capability of the low-voltage wind turbine in the sub-synchronous state using a fuzzy controller. *Clean Energy* 2022;6(4):682–692. <https://doi.org/10.1093/ce/zkac033>
- [9] Dwijendra N. K. A., *et al.* Economic Performance of a Hybrid Renewable Energy System with Optimal Design of Resources. *Environmental and Climate Technologies* 2022;26(1):441–453. <https://doi.org/10.2478/rtuct-2022-0034>
- [10] Mogano P., Mokoale N. South African Climate Change Adaptation Politics: Urban Governance Prospects. *International Journal of Social Sciences and Humanity Studies* 2019;11(1):68–83.
- [11] Rashidi D., *et al.* An economic and environmental optimization model in a micro grid with demand response. *Environmental and Climate Technologies* 2022;26:730–741. <https://doi.org/10.2478/rtuct-2022-0056>
- [12] 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>
- [13] 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(1):209–232. <https://doi.org/10.2478/rtuct-2020-0013>
- [14] 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>
- [15] 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>
- [16] 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>
- [17] 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>
- [18] 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>
- [19] Chamandoust H., *et al.* Energy Economic Management of Hybrid Energy System Based on Short-term Generation and Demand Response. *Environmental and Climate Technologies* 2020;24:653–668. <https://doi.org/10.2478/rtuct-2020-0040>
- [20] Chamandoust H., *et al.* Optimal Hybrid System Design Based on Renewable Energy Resources. *Proceedings of the IEEE Smart Grid Conference (SGC)* 2017. <https://doi.org/10.1109/SGC.2017.8308878>
- [21] Chamandoust H., *et al.* Scheduling of Smart Micro Grid Considering Reserve and Demand Side Management. *Proceedings of the IEEE Smart Grid Conference (SGC)* 2018. <https://doi.org/10.1109/SGC.2018.8777926>
- [22] 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.

- [23] 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).
- [24] 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):1–6. <https://doi.org/10.34109/ijefs.201911101>
- [25] Ngwenya C. T. S., Nkosi E. Implications of The Impact of Risk Management in Decision Making in Local Government: A Case of Ethekwini Municipality. *International Journal of Social Sciences and Humanity Studies* 2021;13(1):176–194.
- [26] Okon E. O. Consequence Of Environmental Policy on The Dynamics of Economic Growth and Environmental Degradation In Nigeria. *International Journal of Social Sciences and Humanity Studies* 2021;13(1):195–217.
- [27] Haghsheenas P., et al. 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). <https://doi.org/10.5829/IJE.2022.35.08B.12>
- [28] Golmohammadi A., et al. Proposing an efficient mathematical model for the continuous layout design in a cellular manufacturing system The real-case of BATA company. *Journal of Production and Operations Management* 2022;13(1):25–50. <https://doi.org/10.22108/jpom.2022.128431.1370>
- [29] Manakkadu S., Dutta S. On efficient resource allocation in the Internet of Things environment. In *Proceedings of the 8th International Conference on The Internet of Things* 2018:1–5. <https://doi.org/10.1145/3277593.3277623>
- [30] Golmohammadi A. M., et al. A Novel Cell Layout Problem with Reliability and Stochastic Failures. *International Journal of Supply and Operations Management* 2021;8(2):165–175.
- [31] Al-Nayili A., Majdi H. S., Albayati T. M., Saady N. M. C. Formic Acid Dehydrogenation Using Noble-Metal Nanoheterogeneous Catalysts: Towards Sustainable Hydrogen-Based Energy. *Catalysts* 2022;12(3):324. <https://doi.org/10.3390/catal12030324>
- [32] 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>
- [33] Dwijendra N. K. A., et al. Application of Experimental Design in Optimizing Fuel Station Queuing System. *Industrial Engineering & Management Systems* 2022;21(2):381–389. <https://doi.org/10.7232/iems.2022.21.2.381>
- [34] Dwijendra N. K. A., et al. The effect of various irrigation technologies and strategies on water resources management. *Journal of Water and Land Development* 2022;53(IV–VI):143–147. <https://doi.org/10.24425/jwld.2022.140790>
- [35] Ahmed A. A. A. et al. Multi Project Scheduling and Material Planning Using Lagrangian Relaxation Algorithm. *Industrial Engineering & Management Systems* 2021;20(4):580–587. <https://doi.org/10.7232/IEMS.2021.20.4.580>
- [36] Guan-Yuan W. The Brand Effect: A Case Study in Taiwan Second-Hand Smartphone Market. *Journal of Social and Economic Statistics* 2021;10(1–2):30–42. <https://doi.org/10.2478/jses-2021-0003>
- [37] Khan M. U. F., et al. Serum level estimation of some biomarkers in diabetic and non-diabetic COVID-19 infected patients. *Applied Nanoscience* 2022:1–8. <https://doi.org/10.1007/s13204-021-02167-x>
- [38] Assi L. N., Majdi A., Alhamadani Y., Ziehl P. Early properties of concrete with alkali-activated fly ash as partial cement replacement. *Proceedings of the Institution of Civil Engineers - Construction Materials* 2021;174(1):13–20. <https://doi.org/10.1680/jcoma.19.00092>
- [39] Majdi A., Vacareanu R. Evaluation of seismic damage to Iraqi educational reinforced concrete building using FEMA P-58 methodology. *IOP Conference Series: Earth and Environmental Science* 2021;664(1). <https://doi.org/10.1088/1755-1315/664/1/012110>
- [40] Goli A., Golmohammadi A. M. Multi-objective optimization of location and distribution in a closed-loop supply chain by considering market share in competitive conditions. *International Journal of Supply and Operations Management* 2022;9(4):483–495. [10.22034/ijsum.2021.109265.2285](https://doi.org/10.22034/ijsum.2021.109265.2285)
- [41] Zainal A. G. Community development communication model and improving the role of a gropolitan institutions. *International Journal of Scientific and Technology Research* 2020;8(12):2028–2034.
- [42] Zainal A. G., Karomani K., Yulianeta Y. The Communication Activities and Women's Roles in Rudat Culture Based on Adat Law. *Journal of Legal, Ethical and Regulatory Issues* 2021;24(7):1–12.
- [43] Manakkadu S., Joshi S. P., Halverson T., Dutta S. Top-k User-Based Collaborative Recommendation System Using MapReduce. In *2021 IEEE International Conference on Big Data (Big Data)*. IEEE, 2021.
- [44] Mahonge C. P., Nsenga J. V., Itani J., Kurosaki R. Resource Governance Using An Hybrid Institution In Momba District Tanzania: A Process Approach. *International Journal of Social Sciences and Humanity Studies* 2021;13(1):152–175.
- [45] Baballe M. A., Bello M. I. Gas Leakage Detection System with Alarming System. *Review of Computer Engineering Research* 2022;9(1):30–43. <https://doi.org/10.18488/76.v9i1.2984>
- [46] Golmohammadi A. M., et al. Machine reliability in a dynamic cellular manufacturing system: a comprehensive approach to a cell layout problem. *International Journal of Industrial Engineering & Production Research* 2018;29(2):175–196.
- [47] Golmohammadi A. M., et al. A bi-objective optimization model for a dynamic cell formation integrated with machine and cell layouts in a fuzzy environment. *Fuzzy Information and Engineering* 2020;12(2):204–222.

- [48] Mostafaiepour A., *et al.* Ranking locations based on hydrogen production from geothermal in Iran using the Fuzzy Moora hybrid approach and expanded entropy weighting method. *Journal of Renewable Energy and Environment* 2017;4(4):9–21.
- [49] 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>
- [50] Mustika N. M., Sueca N. P., Dwijendra N. K. A., Putra I. A. D. Sustainable Socio-cultural Aspect Within Green Building User Behavior in Bali, Indonesia. *IOP Conference Series: Earth and Environmental Science* 2021;933(1):012021. <https://doi.org/10.1088/1755-1315/933/1/012021>
- [51] Zhu P., Saadati H., Khayatnezhad M. Application of probability decision system and particle swarm optimization for improving soil moisture content. *Water Supply* 2021;21(8):4145–4152. <https://doi.org/10.2166/ws.2021.169>
- [52] Tao Z., Cui Z., Yu J., Khayatnezhad M. Finite difference modelings of groundwater flow for constructing artificial recharge structures. *Iranian Journal of Science and Technology, Transactions of Civil Engineering* 2022;46(2):1503–1514. <https://doi.org/10.1007/s40996-021-00698-5>
- [53] Zerafati M. E., *et al.* 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>
- [54] Jasim S. A., Catalan Opulencia M. J., Majdi A., Yusupova D. Z., Mustafa Y. F., Hammid A. T., Delir Kheirollahi Nezhad P. Investigation of croton aldehyde adsorption on pure and pd-decorated gan nanotubes: A density functional theory study. *Solid State Communications* 2022:348–349:114741. <https://doi.org/10.1016/j.ssc.2022.114741>
- [55] Salahdin O. D., Majdi A., Opulencia M. J., Taban T. Z., Hammid A. T., Zhao X. Oxygen reduction reaction on metal-doped nanotubes and nanocages for fuel cells. *Ionics* 2022;28:3409–3419. <https://doi.org/10.1007/s11581-022-04564-w>
- [56] Hussein A. A., Majdi A., Alsodani Z. A., Vacareanu R. Analysis of Relationship between Design and Implementation Stages within Construction Projects in Iraq. *IOP Conference Series: Earth and Environmental Science* 2021:664(1):012069. <https://doi.org/10.1088/1755-1315/664/1/012069>
- [57] Dwijendra N. K. A. From Tradition to Modernization in Morphological Process of Indigenous Settlement Patterns in Bali, Indonesia. *International Journal of Advanced Science and Technology* 2020;29(8s):172–184.
- [58] Dwijendra N. K. A. Meru as a Hindu Sacred Building Architecture with a High Roof and Resistant to Earthquakes in Bali, Indonesia. *Civil Engineering and Architecture* 2020;8(3):350–358.
- [59] Dwijendra N. K. A., *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>
- [60] Zainal A. G., Yulianto H., Yanfika H. Financial benefits of the environmentally friendly aquaponic media system. *IOP Conference Series: Earth and Environmental Science* 2021:739(1):012024
- [61] Xia J. S., Majdi A., Toghraie D. Molecular dynamics simulation of friction process in atomic structures with spherical nanoparticles. *Solid State Communications* 2022:346:114717. <https://doi.org/10.1016/j.ssc.2022.114717>
- [62] Al-Nayili A., Majdi H. S., Albayati T. M., Saady N. M. C. Formic Acid Dehydrogenation Using Noble-Metal Nanoheterogeneous Catalysts: Towards Sustainable Hydrogen-Based Energy. *Catalysts* 2022;12(3):324. <https://doi.org/10.3390/catal12030324>
- [63] Awad E. S., Imran N. S., Albayati M. M., Snegirev V., Sabirova T. M., Tretyakova N. A., Alsathy Q. F., Al-Furaiji M. H., Salih I. K., Majdi H. S. Groundwater Hydrogeochemical and Quality Appraisal for Agriculture Irrigation in Greenbelt Area, Iraq. *Environments* 2022;9(4):43. <https://doi.org/10.3390/environments9040043>
- [64] Aljumaily M. M., *et al.* Modification of Poly(vinylidene fluoride-co-hexafluoropropylene) Membranes with DES-Functionalized Carbon Nanospheres for Removal of Methyl Orange by Membrane Distillation. *Water* 2022;14(9):1396. <https://doi.org/10.3390/w14091396>
- [65] Jasim S. A., Ansari M. J., Majdi H. S., Opulencia M. J. C., Uktamov K. F. Nanomagnetic Salamo-based-Pd (0) Complex: an efficient heterogeneous catalyst for Suzuki–Miyaura and Heck cross-coupling reactions in aqueous medium. *Journal of Molecular Structure* 2022:1261:132930. <https://doi.org/10.1016/j.molstruc.2022.132930>
- [66] Liu T., Zhang D., Wang S., Wu T. Standardized modelling and economic optimization of multi-carrier energy systems considering energy storage and demand response. *Energy Conversion and Management* 2019;182:126–142. <https://doi.org/10.1016/j.enconman.2018.12.073>