Contents list available at IJRED website

International Journal of Renewable Energy Development

Journal homepage: https://ijred.undip.ac.id

Research Article

Electrical Energy Management According to Pricing Policy: A Case in Vietnam

Thi Tuyet Mai Nguyen[a*], Pham Nguyen Dang Khoa[b†], Ngoc Anh Huynh[c‡]

[a]*Academy of Political Regional II, Ho Chi Minh City, Ho Chi Minh, Vietnam*
[b]*PATET Research Group, Ho Chi Minh city University of Transport, Ho Chi Minh, Vietnam*
[c]*Faculty of Business Administration, HUTECH University, Ho Chi Minh, Vietnam*

Abstract. Electrical equipment is increasingly diversified in both types and capacity to meet the maximum needs of people in the 4th industrial revolution. This development has helped people to achieve many great scientific achievements, but this development has led to a rapid increase in the demand for electric energy in recent years. The traditional electricity supply from fossil fuels is gradually depleting, which has prompted the search for clean and renewable energy sources to gradually replace the dependence on this energy source. Prosumer, HEMS (home energy management system), and other solutions have been researched and applied to optimize electrical energy sources. However, for countries that mainly use fossil energy sources like Vietnam, these solutions are not effective. Policy on the management could help to solve this problem, in particular, the price policy is the solution that Vietnam has used to effectively manage this energy source. This article analyzes the issues of applicable pricing policy in Vietnam, proposes potential policies to improve and protect the electric energy system, as well as enhances the rate of renewable energy use in the electricity system in Vietnam.

Keywords: Electricity, Energy management, Pricing policy, Renewable energy

Received: 9th Feb 2022; Revised: 25th May 2022; Accepted:10th June 2022; Available online: 20th June 2022

1. Introduction

The demand for electricity is increasing in recent times due to the rapid development of electronic devices that serve people in daily life (Eldali *et al.,* 2020)(Sang Le & Hong Hieu, 2020)(Iqbal *et al.,* 2018). In fact, over the past two decades, energy demand has grown by about 2.5 percent. Traditional power grids are still operated mainly by fossil fuels and the consequences of this fact are increased pollution emissions, dramatic changes in climate as well as global warming (Bakır *et al.* 2022)(Hoang *et al.* 2022)(Malla *et al.,* 2022). Industrial revolution 4.0 is the 4th revolution in human history, and because of that, technology develops at an unprecedented rate. The most prominent technologies can be mentioned as the Internet of things (IoT) (H. P. Nguyen, Le, *et al.,* 2021), cyber-physical systems, cloud computing, and cognitive computing, the goal of the industrial revolution 4.0 is to turn familiar objects such as houses, vehicles, and electronic devices become intelligent and thereby optimize productivity as well as costs. In order to understand clearly the 4.0 revolution, based on unsupervised machine learning algorithms, Lee and Lim (Lee & Lim, 2021) studied and gave results that the data-driven methodology of this study was useful and efficient in supporting experts' ideas on Industry 4.0. Besides optimizing costs and productivity, technology also helped people to multi-task and overcome inherent weaknesses (Faheem *et al.,* 2018)(Khattak *et al.,* 2020). Rajamoorthy et al. (Rajamoorthy *et al.,* 2022) investigated and determined that Electric vehicles (EVs) and ITS systems should be combined, it also helped the transportation system grow and minimizes greenhouse gas emissions. However, electric vehicles are still quite new and only appear in developed countries mainly. Therefore, in addition to encouraging the use of EVs, finding a renewable fuel source is a possible direction (Nguyen *et al.* 2021). A study by Sharma et al. (Sharma *et al.*, 2022) searched for waste-derived fuels and third-generation algae biodiesel. The contribution of this research to the development of renewable energy sources was huge towards limiting the use of fossil energy. Additionally, the optimization of using renewable energy sources such as biomass, bioenergy, biohydrogen, biofuels, solar, wind …etc is also mentioned in a large number of studies (Hoang *et al.* 2021)(Hadiyanto *et al.*, 2022)(J. Liu *et al.*, 2019)(Chen *et al.*, 2021)*(Hoang et al.* 2021)(Gandhi *et al.*, 2022)(Le *et al.*, 2021). Indeed, Saida *et al.* (Said, Sharma, *et al.*, 2022) have just mentioned energy optimization and the combination with renewable energy that is one of the trends in energy optimization of the 4.0 industry, or the research of Said *et al.* (Said, Rahman, *et al.*, 2022), the utilization of multi-walled carbon nanotubes in a shell and tube heat exchanger

Corresponding author(s):
* Email: maintt@hcma2.edu.vn (T.T.M. Nguyen)
† Email: khoapnd@ut.edu.vn (N.D.K. Pham)
‡ Email: hn.anh@hutech.edu.vn (N.A. Huynh)

driven by solar energy might improve the heat exchanger's efficiency and lower its cost.

The emergence of more and more renewable energy sources in power systems, this opens many potential business models in the future, it is considered as a sagacious strategy towards clean and sustainable process (Nižetić *et al.*, 2021)(Hoang, Pham, *et al.*, 2021). One of them is the prosumer market, where prosumers can supply their excess energy to other consumers in peer-to-peer, prosumer-to-grid, or in special grids of the prosumer group (Parag & Sovacool, 2016). Consumers who own photovoltaic (PV) panels can generate economic benefits from participating in the open market (Narayanan *et al.*, 2016), however, by reducing the accuracy of forecasts with virtual customers, others can increase the benefits gained from the market (Vergados *et al.*, 2016). In addition, communities formed by prosumer groups make entering energy markets even easier (Koirala *et al.*, 2016). Furthermore, renewable energy suppliers with industrial scale and high capacity will become renewable energy prosumer for consumers (Choi & Min, 2018)(Park *et al.*, 2020). Currently, the major renewable energy sources being used include biomass, solar, geothermal, wind and hydroelectricity and they have been shown in this Figure 1 below (Anh *et al.* 2022)(Chen *et al.* 2022)(Avtar *et al.*, 2019)(Hoang, Nižetić, *et al.*, 2022).

Bioenergy is being researched and applied in order to partially replace fossil fuels. Much progress has been made in the research and development of this energy (Chen, Nižetić, *et al.*, 2022)(Hoang, Sirohi, *et al.*, 2022)(Jain *et al.*, 2022)(Hoang, Ong, *et al.*, 2021)(Ha *et al.*, 2020). Recently, with higher energy efficiency and less negative impact on the environment, generators powered by natural gas as well as combined heat and electricity (CHP) units are becoming increasingly popular. Some natural gas is very popular for electricity production because of its low cost, flexibility, and more environmental friendliness *(Zhou et al.*, 2015)(Unamuno & Barrena, 2015)(Eghtedarpour & Farjah, 2014). The maximum operating efficiency that CHP units can achieve is about 65% - 75%. This is a huge improvement when compared to the efficiency of only about 50% when electricity and gas are used separately (Radwan & Mohamed, 2017). Besides supplying electricity to consumers, CHP units can also be installed as a heating system. Conspicuously, an energy system that integrates electricity, natural gas, and heating networks makes the links between different energy sectors increasingly close and creates more economic benefits while minimizing pollution (Jiang *et al.*, 2018)**.** The two most widely known energy sources today are fossil energy and alternative energy. And although governments are making great efforts in searching for and using potential alternative energy sources, there is no denying that fossil energy is still dominant. The Alternative Energy Policy Group of the World Bank argues that the use of traditional toxic energy sources by rural communities will make negative health effects as well as a reduction in economic performance (Cecelski, 2002). In a recently reported study on the energy service delivery discourse, it is stated that complete reliance on centralized energy systems provided by developing country governments will restrict access to clean energy sources and will be a key driver of the poor growth of energy markets (Hoang, Nguyen, *et al.*, 2021). With the goal of sustainable development, the lack of clean energy supplies for rural areas also reduces the possibility of developing tourism services and negatively impacts the water-energy-food relationship. This situation even reduces the living ability of some deprived communities in developing areas. Many solutions have been proposed to replace dependence on centralized power grids controlled by operators, which have proven to be inefficient and extremely expensive to reach people really in need (Stevens *et al.*, 2016)(PWC, 2016)(Prinsloo *et al.*, 2018). One of them can be mentioned is the home energy management system (HEMS). The efficient use of distributed energy sources and energy storage devices provided by HEMS helps users not only reduce costs but also significantly reduce their dependence on the centralized power grid. Hemmati has designed a model that combines both battery power supply and energy storage (BESS) simultaneously and HEMS, by optimizing power bank mode and BESS capacity to significantly reduce costs to pay for annual household electricity use (Hemmati, 2017)(Hemmati & Saboori, 2017). In another study, Lokeshgupta analyzed the economic improvement of HEMS and BESS models using a load uncertainty model and the results of the study again confirm the outstanding performance of the model (Lokeshgupta & Sivasubramani, 2019). Golshannavaz offered another application of the HEMS strategy, which is to use the remaining power of electric vehicles as well as energy storage systems to replace the reactive power of household appliances, thereby optimizing system economics (Golshannavaz, 2018). Essa calculated the charge state of the photovoltaic (PV) cells used in HEMS and concluded that the energy consumption of the system can be reduced by up to 30% while still ensuring comfortable conditions for users (Al Essa, 2019). Mehrjerdi designed the HEMS system in conjunction with the hydrogen storage system and solar panels and calculated the optimal size and operation for the hydrogen storage and solar systems (Mehrjerdi, 2020). Li demonstrates that HEMS systems can even attain zero energy consumption if combined with rooftop PV, high-efficiency household heat pumps, fuel cell cogeneration systems, as well as other energy-consuming devices *(Li et al.*, 2020)(Zhao *et al.*, 2021). It can be seen that many studies are diverse in many aspects of the problem in order to achieve the ultimate goal of proposing a positive solution to problems related to energy sources such as renewable energy (Hoang, Sandro Nižetić, *et al.*, 2021)(Atabani *et al.*, 2021)(Hayakawa *et al.*, 2020), usability and optimization of energy system (Dincer *et al.*, 2017)(H. P. Nguyen, Hoang, *et al.*, 2021)(Subramanian *et al.*, 2021)(Dong & Nguyen, 2020)(Bukar & Tan, 2019).

Vietnam is a country possessing many fossil energy sources. This makes Vietnam currently have a surplus of primary energy supply, however, experts predict that with the strong growth rate of the economy in recent decades, energy demand will rapidly increase. Energy shortage may occur, and Vietnam will have to import energy from other countries. According to some calculations, Vietnam will change from a place of energy provider to an energy importer. This development is going to impair the security of energy supplies. It was predicted that the imported energy of Vietnam's share of the total primary energy supply is scheduled to expand to 37.5% in 2025 and 58.5% in 2035 (Danish Energy Agency, 2017). In addition, electricity demand will also increase, and Vietnam will need to import about 1.3% of total commercial energy demand from abroad (Do & Sharma, 2011)(Duc Luong, 2015).

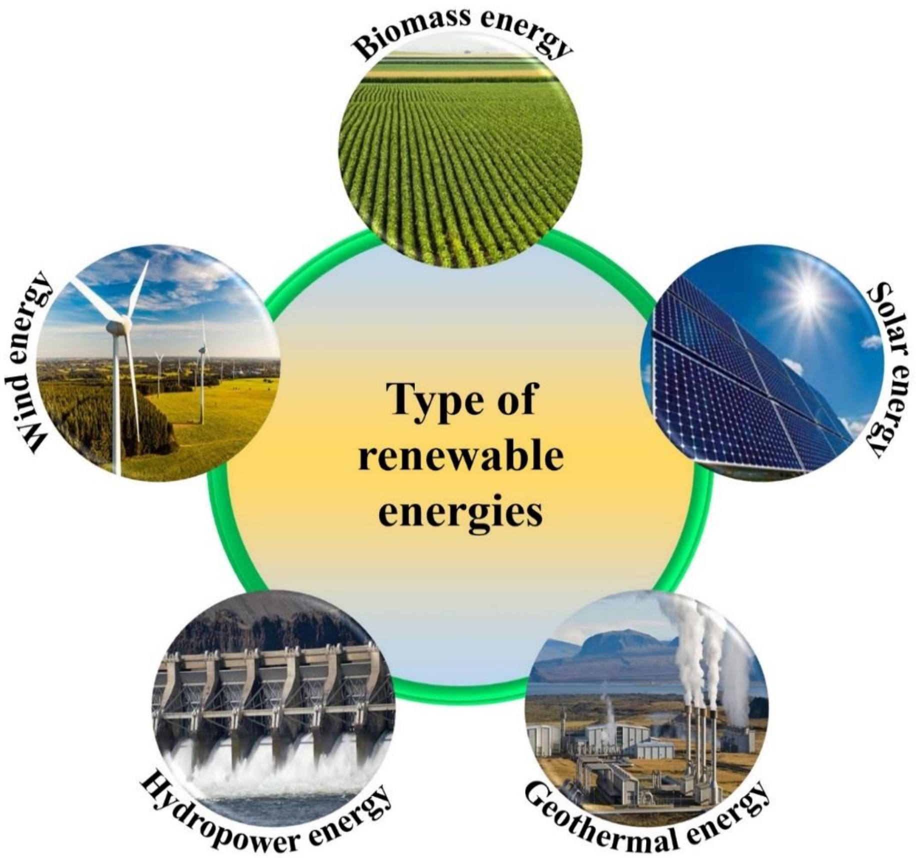

Fig. 1 Type of renewable energies (Avtar *et al.*, 2019).

To deal with the above challenges, a lot of research has been carried out to improve the efficiency of energy use, protection, and production in Vietnam. The energy sources used in Vietnam are mostly traditional energy sources, most notably thermal power, and hydroelectricity. Due to this dependency, Vietnam's GHG emissions are expected to rise dramatically by 2030 owing to Vietnam's fast economic growth and strong dependence on fossil fuel-fired power facilities (Roy *et al.*, 2022). While alternative energy sources exist but are not yet widely used and known. Therefore, policies to manage and use fossil energy resources in Vietnam are an urgent requirement. One of the government's policies to manage these energy resources is the pricing policy. In this article, the authors will refer to the policy of electric energy management through price management policy in Vietnam. In the article, the price management policies including the progressive price system, the three-price system, and the price policy for prosumers of the Vietnamese government will be mentioned. The pricing policy in Vietnam's electricity management will be presented in section 2 of this paper. Section 3 of the paper describes several applications and policies to improve electrical energy management through published research. Section 4 will discuss the latest policy on energy management in Vietnam as well as suggest potential policies to improve and protect the energy system in Vietnam. Finally, the last part will be the conclusion.

2. Pricing policy in Vietnam

2.1 Progressive price

The global petrol price website published annually the average electricity prices of 147 countries worldwide, including both residential and business electricity prices (Global Petrol Prices, 2021). According to data in June 2021, the world's average residential electricity price was 0.136 USD/kWh while the average electricity price of business units would be about 0.124 USD/kWh. According to the above data, the average electricity price in Vietnam ranked 101 out of 147 published countries (arranged in descending order). Specifically, the average price of residential electricity in Vietnam is about 0.083 USD/kWh, while the price of electricity for businesses is about 0.078 USD/kWh, 1.64 and 1.6 times lower than the average of the world respectively. The electricity price in Vietnam is obviously much lower than in the world, but it tends to go in the opposite direction. In detail, normally in the world, the selling price of business electricity will be lower than the selling price of residential electricity, but in Vietnam, the opposite was true. The electricity price management policy in Vietnam is divided into 4 categories: wholesale price, retail price, hourly price, and price for poor households. Regarding the form of sale, Vietnam is divided into 2 categories: selling at progressive prices and selling at three prices. Table 1 shows the progressive electricity price scales in Vietnam according to retail prices for consumers. Exchange rate: 1 USD = 23208 VND as of June 2022.

Table 1
Monthly progressive pricing policy (EVN, n.d.)

Tier	Corresponding power consumption (kWh) (1)	Price (USD/kWh) (2)	For ease of understanding, an example of the electricity price calculation is given below. A household consumes 500kWh of electricity in a month. The amount they have to pay will be calculated as follows.		
			Electricity bill without tax (USD) (1)*(2)	VAT (8%)	Total payment [(1)*(2)]*108%
1	0 – 50	0.073	3.65	8%	
2	51 – 100	0.076	3.80		
3	101 – 200	0.088	8.8		
4	201 – 300	0.11	11		
5	301 – 400	0.12	12		
6	Over 401	0.13	13		
Total			52.25 USD = 1212618 VND	8%	56.43 USD = 1309627.44 VND

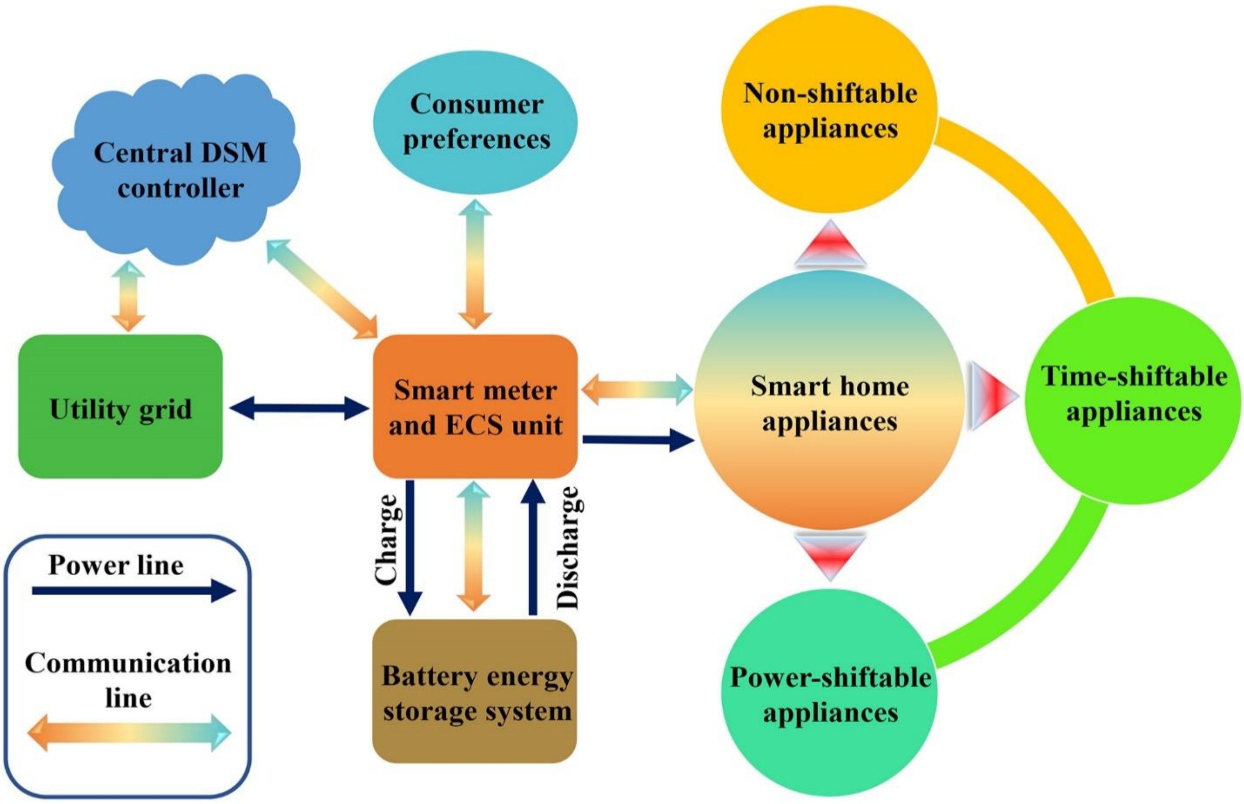

Fig. 2 Home energy management system (Lokeshgupta & Sivasubramani, 2019)

2.2 Three-price

In this work, a 3-price electricity model, also known as a real-time electricity price model, uses energy management systems designed to maximize power energy and minimize consumption costs. An overview literature review that details the fundamental aspects of the benefits, opportunities, costs, and risks of a real-time pricing strategy (Nezamoddini & Wang, 2017). By observation and calculation, the application of real-time electricity price calculation brings several advantages to the power system (Mbungu *et al.*, 2018). Experiments are observed in both peak hours, off-peak hours, and normal hours. In Vietnam, there are three types of customers, who can buy electricity with this form, including production and business establishments that consume an average of 2000 kWh/month or more in 3 consecutive months, electricity retailers in industrial parks, commercial - service - living complexes. The sale of electricity in the form above is only available to business units with high monthly electricity consumption. Therefore, household demand management (DSM) techniques are urgently needed for smart buildings to cope with their excessive energy consumption. Typically, service providers offer pricing policies to manage consumer energy consumption patterns. There are a variety of pricing models, including critical peak pricing, time-of-use (ToU) pricing, off-peak lows, pre-date pricing, and real-time pricing. DSM also has 2 different approaches: one is a price-based DSM, and the other is an incentive-based DSM. In the price-based DSM approach, consumers by household can switch controllable devices from peak to off-peak hours according to the price signal. With an incentive-based DSM approach, there is a contractual agreement between the supplier company and the consumer. As a result, utility companies can centrally control users' devices by providing preferential policies (Aghaei & Alizadeh, 2013)(Lokeshgupta & Sivasubramani, 2018)(Mohsenian-Rad & Leon-Garcia, 2010)(Lokeshgupta & Sivasubramani, 2019). Figure 2 shows the definition of home energy management.

However, current home energy management systems often only meet the ability to improve energy efficiency and meet the needs of individual homes without regard to utility data (such as load forecasting or TOU) to set schedules for devices. Besides, the coordination between management units to be able to capture and demand response (DR) in a residential community is also not common. Collecting and capturing demand from individual household customers opens the door to expanding DR programs to residential customers. Here, DR is understood as the change in electricity usage of end-users compared to their normal consumption according to changes in electricity prices over time (Kiliccote *et al.*, 2006)(US Department of Energy 2006)(Ozturk *et al.*, 2013). According to Nguyen *et al.* (Nguyen Duc *et al.*, 2022), the authors built a DR model based on the incentive payment pricing method. A contract would be signed between supplier and consumer to active the proposed DR project. Figure 3 illustrated the processing of implementing the proposed DR program.

2.3 Prosumer

The power grid was currently undergoing certain transformations, as passive users in the traditional distribution network gradually become 'prosumers', or active consumers. With ownership of on-site power generation or advanced energy storage systems, 'Prosumer' was more proactive in managing their energy consumption and energy production (Dimeas *et al.*, 2014). With contractual terms based on individually measured energy use, energy-storing 'prosumers' could only benefit from their on-site energy conversion (Yu & Xue, 2016). However, it would be a big mistake to ignore the additional value that could be achieved through the control of distributed energy storage systems thereby reducing losses and congestion (Mohd *et al.*, 2008). Besides, the coordination of local energy storage systems based on the wholesale energy market enabled them to meet the energy demand upstream (Ma *et al.*, 2014)(Morstyn & McCulloch, 2019). Prosumer referred to "energy users, who were able to produce renewable energy in their home environment and had the ability to store excess energy for future use or trade for those in need through the smart grid system" (Rathnayaka *et al.*, 2015). Clearly, the goal of these prosumers was not only energy consumption, but also renewable energy source production, and then to share or trade these energies with other consumers in the network (Zafar *et al.*, 2018)(Parag & Sovacool, 2016). In a nutshell, all of the above definitions of prosumers referred to energy users in the grid that are capable of generating energy (Espe *et al.*, 2018). Figure 4 distributed prosumer based on 2 aspects: communities and linkages of the prosumer.

With the aim of promoting citizens' use of renewable energy sources, particularly solar energy, the Vietnamese government has made decisions on importing solar power. Table 2 showed the purchase price of solar power in Vietnam, through which it can be seen that three principal sources of solar power purchase in Vietnam include floating solar power, terrestrial solar power, and rooftop solar power.

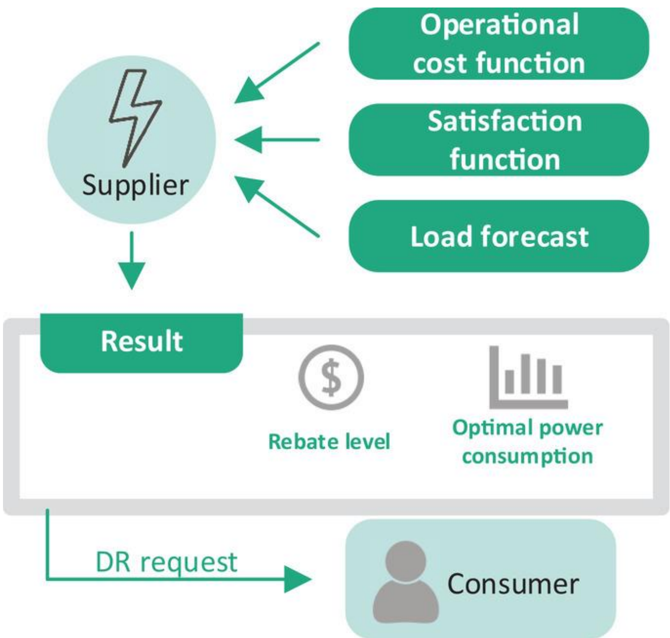

Fig. 3 The process of implementing the DR program (Nguyen Duc *et al.*, 2022)

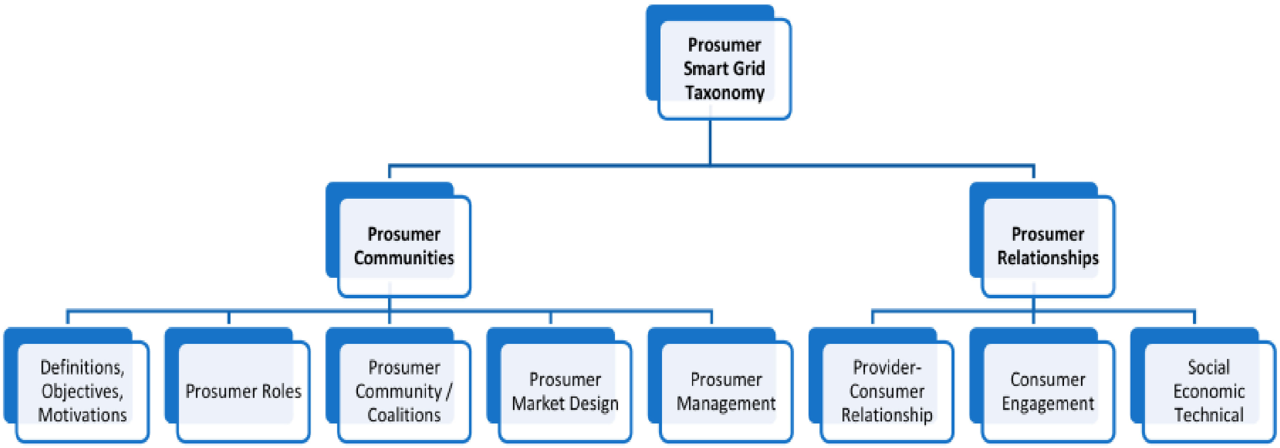

Fig. 4 Classification of prosumer (Espe *et al.*, 2018)

Table 2
Purchasing price of solar power in Vietnam (EVN, n.d.)

Solar power system	Purchase price (kWh/UScent)
Floating solar power project	7.69
Ground solar power project	7.09
Rooftop solar power system	8.38

3. Application to optimize electrical energy management

With the world's amazing development speed, coupled with the indiscriminate abuse of energy, the world's energy scarcity will become a near future without effective intervention to solve this problem. In this section, the researchers will highlight the policies that have been researched and published and suggest potential solutions to the above problem. These solutions not only use the price policy to manage, which is very popular but also aim at the management of energy resources, promising to optimize the use and help improve the energy management process. The reality also shows that pricing policies aimed at energy management are not really effective and lack safety. The target reason that these policies are aimed at collecting fees, is not solving the root cause of the problem, which is finding ways to regenerate energy sources as well as protect the environment.

Zhao et al. (Zhao *et al.*, 2021) researched and built a home energy management system (HEMS) as a bridge between users and power companies to describe the energy picture in Japan. In the same study, the authors introduced and developed a short-term household load predicting model based on a particle swarm optimization vector regressor algorithm to forecast energy consumption. The user's annual electricity bill would have three ways of pricing including multi-step electricity pricing (MEP), time-of-use (TOU) pricing, and real-time pricing (RTP). According to the calculation results obtained from the model, the annual electricity cost due to RTP would be lower when compared with MTP and TOU. Besides, after adjusting for peak user load and consolidating with fluctuating electricity prices in the future, the economic advantage of using RTP, namely annual electricity cost, was overwhelming when compared to MTP and TOU. The above research results encouraged the Japanese government to promote policies that support the RTP strategy in the future.

Prudhviraj and colleagues (Prudhviraj *et al.*, 2020) developed a stochastic framework model to conduct the energy of the microgrid thereby minimizing the cost of energy. This model calculated instability in solar photovoltaic (PV) generation, load demand, and electricity price. Monte Carlo simulations supported the calculation of parts of the uncertainty and thus the probability cases were reduced, and the calculation results were also more accurate. The study that the cost, as well as the voltage configuration, are significantly advanced in the case of applying the local power generation system and the battery storage system when compared with the base case. For boosting the planning accuracy and reducing the financial risk of the microgrid aggregator, a node price-based microgrid planning model was also built. The process was processed in two stages: first, node prices were evaluated based on the concept of marginal pricing, then, flexible load demand and local resources represented in the network are optimally planned.

In another study, to optimize energy management, Ramezani et al. (Ramezani *et al.*, 2020) introduced an optimal schedule for the use of consumer appliances based on the antlion optimization algorithm. Moreover, the schedule still ensured the comfort of the user and also reduces the cost. To prevent peaks, the ratio of peak-to-average should be considered as a limitation on the energy cost function. In addition, to accurately measure energy costs, two separate tariff signals were used including real-time pricing and critical peak pricing. When compared with other meta-heuristic algorithms such as the multi-objective swarm optimization algorithm, the second version of the undirected sorting genetic algorithm, and the basic antlion optimization algorithm, the results of this simulation showed the superiority, showing that it is possible to achieve an electricity bill rate of less than 80%.

Park et al. (Park *et al.*, 2020) introduced business and operational optimization options to enhance the economic benefits of prosumers by applying energy storage systems and secure contracts with household consumers under a progressive policy, in which the electricity unit price grows according to the amount of electricity consumed each month. Using the above method, a prosumer could follow a time-of-use pricing scheme to store excess renewable energy when prices are low and to use during periods of high prices. Moreover, the optimization options could specify the energy salary and unit price that the prosumer would provide, thereby significant decrease costs as users could avoid high price zones. The study took real data in Jeju Island, Korea for 30 days, then simulated and analyzed. The results showed that the cost for prosumers was reduced by up to 12%, and it was possible to offer a lower contract price for consumers. Lagrangian's Hessian function decreased optimization processing time by about 98.3%. Finally, a synthetic forecasting method outlines multiple possible scenarios to examine the uncertainty of renewables. The results showed that the uncertainty of renewable energy did not affect contract and energy prices.

In 2018, the concept of multistage energy management was proposed by Morstyn *et al.* (Morstyn & McCulloch, 2019), thereby allowing energy to be considered as a heterogeneous product, based on the properties of the source being consumed by the prosumers. This was the basis for a P2P energy marketplace platform that coordinated energy purchases between consumers in the distribution network as well as in the electricity trading market. Furthermore, this peer-to-peer marketplace platform enabled transactions between registered consumers and the wholesale electricity market, in order to minimize costs associated with battery loss and depreciation and for providing a value-added by taking into account consumers' individual desires for the source and destination of the energy they consumed as well as produce. The multi-stage energy management trouble has been parallelized using distributed price-directed optimization, providing scalability, and protecting prosumer data privacy. A receding horizon model of predictive control has been applied for real-time implementation.

Liu et al. (Y. Liu *et al.*, 2018) designed a new dynamic pricing method that provided a market-driven means to promote decentralized energy trading and optimized financial benefits for owners of dispersed energy resources. First, a model was studied for the price response for each delivered energy resource. In particular, a decoupled charge state function was built in to figure out the value of a single charge or discharge action for energy storage systems. In addition, an interoperable three-level framework was designed, including micro-grid equilibrium, aggregate scheduling, and transaction optimization. The framework above could easily optimize costs stemming from renewables, and at the same time provided price signals to assist stakeholders in taking timely responses and supported trading strategies. An experiment was conducted according to actual data, using a multi-agent model based on the Java agent development framework. The results showed the mentioned methodology support decentralized energy trading and easy marketization of microgrids with a high proportion of distributed energy resources.

Khatak et. al. (Khattak *et al.*, 2020) have built an energy management model applying modern blockchain technology. Current barriers to energy management included storing large amounts of relevant data, adjusting, falsifying, or even deleting the data in an unorthodox manner. Fortunately, blockchain technology could completely solve the above problems, while making the direct link between users and energy suppliers simple. The system was also improved and automatically transfers electricity directly from one resident (or service) to another according to their desires. the implementation of the exchange through smart contracts after examining the needs of the stakeholders. Each participant confirmed their claim at the time of registration and can update these thresholds. Using smart contracts would make the bidding processes for energy supply and demand-based transactions in smart cities smooth and automated. Besides, blockchain technology was not only the possibility of privacy but also the anonymity for users to provide dynamic pricing based on supply and demand at any given time.

4. Discussion

Energy Efficiency and Conservation (EE&C) has been promoted by the Vietnamese government in recent years. Energy Efficiency and Conservation (EE&C) is considered an attractive supplement to promote energy security and protect the environment. The institutional structure for EE&C implementation in Vietnam is shown in Figure 5. For the purpose of coordinating, monitoring, and managing the implementation of the national targeted program on Energy Efficiency and Conservation with the participation of government agencies, a national steering committee chaired by the Minister of Industry and Trade in charge has been established with members including representatives from the Ministry of Construction, Ministry of Transport (MOT), Ministry of Science and Technology (MOST), Ministry of Education and Training (MOET), Ministry of Culture, Sports and Tourism (MCST), Ministry of Information and Communication (Ministry of Planning and Investment (MPI), Ministry of Finance (MOF), Ministry of Justice (MOJ) and Union of Science and Technology Societies Vietnam (VUSTA) (Duc Luong, 2015).

The Government of Vietnam issued a draft national electricity development plan in February 2021: Draft Power Development Plan 8 (PDP 8) for the period 2021-2030. Draft Power Development Plan 8 (PDP 8) required expansion of wind and solar power capacity and increased the share of these alternative energy users in the country's electricity generation structure. The draft PDP 8 also prioritized the development of grid infrastructure to secure steady operation with a higher share of renewable energy. Half of Vietnam's electricity came from coal-fired power plants in 2020, and with electricity demand increasing everywhere in the country, Vietnam was also increasingly dependent on coal imports. In addition to thermal power, Vietnam had many hydroelectric power plants throughout the provinces, especially around large rivers such as the Mekong River. However, the annual drought reduced the reliability of hydropower plants. From the above fact, renewable energy from sources such as wind power and solar power was very necessary but has still not yet received appropriate attention. Renewable energy sources such as wind and solar accounted for only 5% of Vietnam's electricity production in 2020 (Johnson *et al.*, 2021). Figure 6 below shows the main energy consumption in Vietnam (Hannah & Max, 2020).

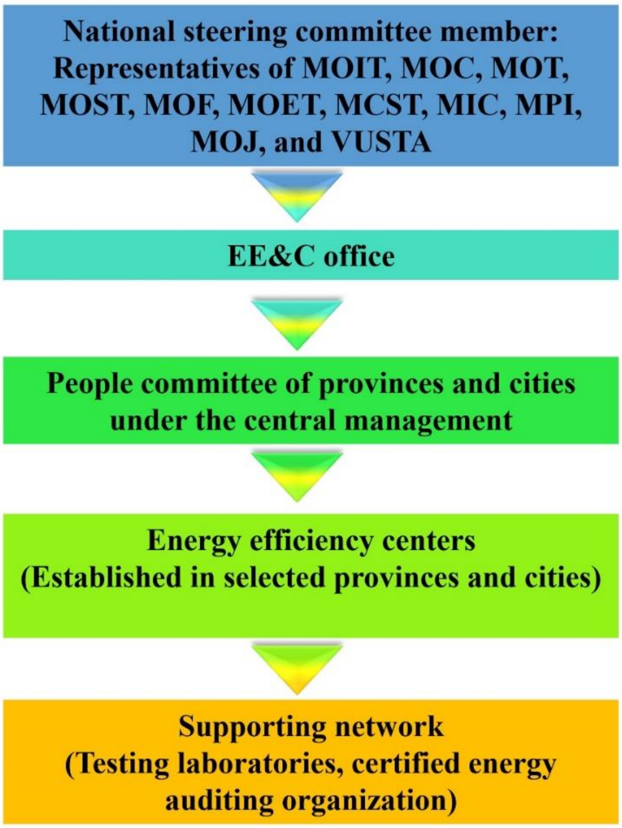

Fig. 5 Institutional structure for energy efficiency implementation in Vietnam (Duc Luong, 2015).

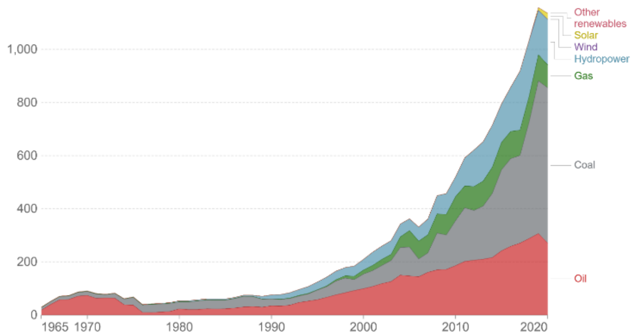

Fig. 6 Energy consumption by source in Vietnam (Hannah & Max, 2020)

According to Power Development Plan 8 (PDP 8), the share of renewable energy (excluding hydropower) will account for about 30% by 2030 while this share is only 16.3% in the revised PDP 7. Prominent changes include by 2030, onshore and nearshore wind power will develop a capacity of 9GW, offshore wind will develop a capacity of 2-3 GW, solar power will develop an additional capacity of 7 GW, biomass and small-scale hydropower will decrease by 0.5 GW and 1.8 GW, respectively. Besides, the draft PDP 8 also predicts that the demand for imported coal for power generation will increase from 47-52 million tons in 2030 to 75-96 million tons in 2045, depending on the baseload or high load scenarios. For LNG import demand for power generation, PDP 8 is also predicted to increase from 10-13 million m^3 in 2030 to 32-42 million m^3 in 2045 (NEWS GLOBAL COMPLIANCE, 2021). With the above highlights in the draft PDP 8, it can be seen that the Vietnamese government has paid the necessary attention to the search and use of new renewable energy sources instead of relying too much on other renewable energy sources. Traditional energy sources are toxic and increasingly scarce. This is also the general trend of the world in the current situation of fossil energy resources is gradually exhausted. With the above highlights in the draft PDP 8, it can be seen that the Vietnamese government has paid the necessary attention to the search and use of new renewable energy sources instead of relying too much on other fossil energy sources. Traditional energy sources are toxic and increasingly scarce. Besides the policies on increasing the search and use of renewable energy mentioned above, various types of bioenergy or research on optimal energy use have also been and are being directed by the Vietnamese government in order to ensure a stable energy supply. Simultaneously, research on using alternative means of transportation for vehicles using traditional fuel is also conducted and is also considered as one of the strategic steps to be able to manage energy effectively (H. P. Nguyen *et al*., 2020) to ensure fast and sustainable development of fast-growing countries like Vietnam.

5. Conclusion

The price policy in electricity energy management in Vietnam has resulted in the price of electricity for residential and commercial use being 1.64 and 1.6 times lower than the world average, ranking 101 out of 147 countries (according to data published by the global petrol price website, 2021). Price management policies and selling methods are divided into 4 types (wholesale price, retail price, hourly price, and price for poor households) and 2 types (progressive selling and 3-price selling). The 3-price electric model offers high efficiency in electrical energy management but it is currently limited to only three types of customers who can purchase electricity in this form. In order to promote the use of renewable energy sources, regulations and guidelines have been issued on the import of solar power, as well as the promulgation of the purchase price of solar power. This prompted people to get involved as prosumers. Currently, Vietnam's electric power comes mainly from coal-fired and hydroelectric power plants. Demand for electricity is increasing while hydroelectricity is causing drought to increase rapidly, which negatively affects people's lives. At the same time, more coal must be imported to meet the demand for thermal power. By issuing the Draft Power Development Plan 8 (PDP 8) for the 2021–2030 period, Vietnam is aiming for the share of renewable energy (excluding hydropower) to account for about 30%. These energy sources are predominantly wind energy, solar energy, biological energy, and optimal energy. In the article, in addition to the mentioned price policies, the article also mentions a number of policies and studies on the application and optimization of renewable energy in life as well as limiting the use of fossil fuel resources are running out. In the current trend of the 4.0 revolution, energy optimization, the use of renewable energy, or the use of electric vehicles are all inevitable directions towards an optimal and sustainable life. However, more specific studies are needed in the coming time to achieve the proportion of renewable energy as proposed in the draft.

References

Aghaei, J., & Alizadeh, M. (2013). Critical peak pricing with load control demand response program in unit commitment problem. *IET Generation, Transmission & Distribution*, *7*(7), 681–690. https://doi.org/10.1049/iet-gtd.2012.0739

Al Essa, M. J. M. (2019). Home energy management of thermostatically controlled loads and photovoltaic-battery systems. *Energy*, *176*, 742–752. https://doi.org/10.1016/j.energy.2019.04.041

Atabani, A. E., Tyagi, V. K., Fongaro, G., Treichel, H., Pugazhendhi, A., & Hoang, A. T. (2021). *Integrated biorefineries, circular bio-economy, and valorization of organic waste streams with respect to bio-products* (p. 1). Springer. https://doi.org/10.1007/s13399-021-02017-4

Avtar, S., Aggarwal, C., Kharrazi, Y., Dou, & Kurniawan. (2019). Exploring Renewable Energy Resources Using Remote Sensing and GIS—A Review. *Resources*, *8*(3), 149. https://doi.org/10.3390/resources8030149

Bakır, H., Ağbulut, Ü., Gürel, A. E., Yıldız, G., Güvenç, U., Soudagar, M. E. M., Hoang, A. T., Deepanraj, B., Saini, G., & Afzal, A. (2022). Forecasting of future greenhouse gas emissions trajectory for India using energy and economic indexes with various metaheuristic algorithms. *Journal of Cleaner Production*, 131946. https://doi.org/10.1016/j.jclepro.2022.131946

Bukar, A. L., & Tan, C. W. (2019). A review on stand-alone photovoltaic-wind energy system with fuel cell: System optimization and energy management strategy. *Journal of Cleaner Production*, *221*, 73–88.

Cecelski, E. (2002). Enabling Equitable Access to Rural Electrification: Current Thinking on Energy, Poverty and Gender. *Energia, January 2000*, 46.

Chen, W.-H., Nižetić, S., Sirohi, R., Huang, Z., Luque, R., M.Papadopoulos, A., Sakthivel, R., Phuong Nguyen, X., & Tuan Hoang, A. (2022). Liquid hot water as sustainable biomass pretreatment technique for bioenergy production: A review. *Bioresource Technology*, *344*, 126207. https://doi.org/10.1016/j.biortech.2021.126207

Chen, W.-H., Wang, J.-S., Chang, M.-H., Mutuku, J. K., & Hoang, A. T. (2021). Efficiency improvement of a vertical-axis wind turbine using a deflector optimized by Taguchi approach with modified additive method. *Energy Conversion and Management*, *245*, 114609.

Chen, W.-H., Wang, J.-S., Chang, M.-H., Tuan Hoang, A., Shiung Lam, S., Kwon, E. E., & Ashokkumar, V. (2022). Optimization of a vertical axis wind turbine with a deflector under unsteady wind conditions via Taguchi and neural network applications. *Energy Conversion and Management*, *254*, 115209. https://doi.org/10.1016/j.enconman.2022.115209

Choi, S., & Min, S.-W. (2018). Optimal Scheduling and Operation of the ESS for Prosumer Market Environment in Grid-Connected Industrial Complex. *IEEE Transactions on Industry Applications*, *54*(3), 1949–1957. https://doi.org/10.1109/TIA.2018.2794330

Danish Energy Agency. (2017). *VIETNAM Energy Outlook Report 2017*.

Dimeas, A., Drenkard, S., Hatziargyriou, N., Karnouskos, S., Kok, K., Ringelstein, J., & Weidlich, A. (2014). Smart Houses in the Smart Grid: Developing an interactive network. *IEEE Electrification Magazine*, *2*(1), 81–93. https://doi.org/10.1109/MELE.2013.2297032

Dincer, I., Rosen, M. A., & Ahmadi, P. (2017). *Optimization of energy systems*. John Wiley & Sons.

Do, T. M., & Sharma, D. (2011). Vietnam's energy sector: A review of current energy policies and strategies. *Energy Policy*, *39*(10), 5770–5777.

Dong, V. H., & Nguyen, X. P. (2020). A strategy development for optimal generating power of small wind-diesel-solar hybrid microgrid system. *2020 6th International Conference on Advanced Computing and Communication Systems (ICACCS)*, 1329–1334. https://doi.org/10.1109/ICACCS48705.2020.9074324

Duc Luong, N. (2015). A critical review on Energy Efficiency and Conservation policies and programs in Vietnam. *Renewable and Sustainable Energy Reviews*, *52*, 623–634. https://doi.org/10.1016/j.rser.2015.07.161

Eghtedarpour, N., & Farjah, E. (2014). Power Control and Management in a Hybrid AC/DC Microgrid. *IEEE Transactions on Smart Grid*, *5*(3), 1494–1505. https://doi.org/10.1109/TSG.2013.2294275

Eldali, F. A., Vadana D, P., Burkhardt, J., & Suryanarayanan, S. (2020). A data decomposition approach to design a dynamic pricing mechanism for residence-based plug-in electric vehicles in wind energy-rich grids. *ETransportation*, *4*, 100062. https://doi.org/10.1016/J.ETRAN.2020.100062

Espe, E., Potdar, V., & Chang, E. (2018). Prosumer communities and relationships in smart grids: A literature review, evolution and future directions. *Energies*, *11*(10). https://doi.org/10.3390/en11102528

EVN. (n.d.). *Vietnam Electricity*. Retrieved April 11, 2022, from https://en.evn.com.vn/

Faheem, M., Shah, S. B. H., Butt, R. A., Raza, B., Anwar, M., Ashraf, M. W., Ngadi, M. A., & Gungor, V. C. (2018). Smart grid communication and information technologies in the perspective of Industry 4.0: Opportunities and challenges. *Computer Science Review*, *30*, 1–30. https://doi.org/10.1016/J.COSREV.2018.08.001

Gandhi, A. M., Shanmugan, S., Kumar, R., Elsheikh, A. H., Sharifpur, M., Bewoor, A. K., Bamisile, O., Hoang, A. T., & Ongar, B. (2022). SiO2/TiO2 nanolayer synergistically trigger thermal absorption inflammatory responses materials for performance improvement of stepped basin solar stillnatural distiller. *Sustainable Energy Technologies and Assessments*, *52*, 101974.

Global Petrol Prices. (2021). *Electricity prices*. https://www.globalpetrolprices.com/electricity_prices/

Golshannavaz, S. (2018). Cooperation of electric vehicle and energy storage in reactive power compensation: An optimal home energy management system considering PV presence. *Sustainable Cities and Society*, *39*, 317–325. https://doi.org/10.1016/j.scs.2018.02.018

Ha, T. M., Fukada, S., Ueno, T., & Ho, D.-D. (2020). Vibration-Based Energy Harvester For Sustainable Structural Health Monitoring System: A Case Study On A Prestressed Concrete Girder. *Journal of Technology & Innovation*, *1*(1), 16–19. https://doi.org/10.26480/jtin.01.2021.16.19

Hadiyanto, H., Christwardana, M., Pratiwi, W. Z., Purwanto, P., Sudarno, S., Haryani, K., & Hoang, A. T. (2022). Response surface optimization of microalgae microbial fuel cell (MMFC) enhanced by yeast immobilization for bioelectricity production. *Chemosphere*, *287*, 132275. https://doi.org/10.1016/j.chemosphere.2021.132275

Hannah, R., & Max, R. (2020). *Vietnam: Energy Country Profile*. https://ourworldindata.org/energy/country/vietnam

Hayakawa, S., Fukue, T., Shirakawa, H., & Hiratsuka, W. (2020). CFD-Based Study On Relationship Between Cooling Performance Of Pulsating Flow And Rib Height Mounted In Mini Rectangular Channel. *Journal of Technology & Innovation*, *1*(1), 26–29. https://doi.org/10.26480/jtin.01.2021.26.29

Hemmati, R. (2017). Technical and economic analysis of home energy management system incorporating small-scale wind turbine and battery energy storage system. *Journal of Cleaner Production*, *159*, 106–118. https://doi.org/10.1016/j.jclepro.2017.04.174

Hemmati, R., & Saboori, H. (2017). Stochastic optimal battery storage sizing and scheduling in home energy management systems equipped with solar photovoltaic panels. *Energy and Buildings*, *152*, 290–300. https://doi.org/10.1016/j.enbuild.2017.07.043

Hoang, A. T., Foley, A. M., Nižetić, S., Huang, Z., Ong, H. C., Ölçer, A. I., Pham, V. V., & Nguyen, X. P. (2022). Energy-related approach for reduction of CO2 emissions: A critical strategy on the port-to-ship pathway. *Journal of Cleaner Production*, *355*, 131772. https://doi.org/https://doi.org/10.1016/j.jclepro.2022.131772

Hoang, A. T., Huang, Z., Nižetić, S., Pandey, A., Nguyen, X. P., Luque, R., Ong, H. C., Said, Z., & Le, T. H. (2021). Characteristics of hydrogen production from steam gasification of plant-originated lignocellulosic biomass and its prospects in Vietnam. *International Journal of Hydrogen Energy*.

Hoang, A. T., Le, T. H., Chitsomboon, T., & Koonsrisook, A. (2021). Experimental investigation of solar energy-based water distillation using inclined metal tubes as collector and condenser. *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, 1–17. https://doi.org/10.1080/15567036.2021.1966139

Hoang, A. T., Nguyen, X. P., Le, A. T., Huynh, T. T., & Pham, V. V. (2021). COVID-19 and the Global Shift Progress to Clean Energy. *Journal of Energy Resources Technology*, *143*(9). https://doi.org/10.1115/1.4050779

Hoang, A. T., Nižetić, S., Ng, K. H., Papadopoulos, A. M., Le, A. T., Kumar, S., Hadiyanto, H., & Pham, V. V. (2022). Microbial fuel cells for bioelectricity production from waste as sustainable prospect of future energy sector. *Chemosphere*, *287*, 132285. https://doi.org/10.1016/j.chemosphere.2021.132285

Hoang, A. T., Ong, H. C., Fattah, I. M. R., Chong, C. T., Cheng, C. K., Sakthivel, R., & Ok, Y. S. (2021). Progress on the lignocellulosic biomass pyrolysis for biofuel production toward environmental sustainability. *Fuel Processing Technology*, *223*, 106997. https://doi.org/10.1016/j.fuproc.2021.106997

Hoang, A. T., Pham, V. V., & Nguyen, X. P. (2021). Integrating renewable sources into energy system for smart city as a sagacious strategy towards clean and sustainable process. *Journal of Cleaner Production*, *305*, 127161. https://doi.org/10.1016/j.jclepro.2021.127161

Hoang, A. T., Sandro Nižetić, Olcer, A. I., Ong, H. C., Chen, W.-H., Chong, C. T., Thomas, S., Bandh, S. A., & Nguyen, X. P. (2021). Impacts of COVID-19 pandemic on the global energy system and the shift progress to renewable energy: Opportunities, challenges, and policy implications. *Energy Policy*, *154*, 112322. https://doi.org/10.1016/j.enpol.2021.112322

Hoang, A. T., Sirohi, R., Pandey, A., Nižetić, S., Lam, S. S., Chen, W.-H., Luque, R., Thomas, S., Arıcı, M., & Pham, V. V. (2022). Biofuel production from microalgae: challenges and chances. *Phytochemistry Reviews*. https://doi.org/10.1007/s11101-022-09819-y

Hoang, A. T., Varbanov, P. S., Nižetić, S., Sirohi, R., Pandey, A., Luque, R., Ng, K. H., & Pham, V. V. (2022). Perspective review on Municipal Solid Waste-to-energy route: Characteristics, management strategy, and role in circular economy. *Journal of Cleaner Production*, *359*, 131897. https://doi.org/10.1016/j.jclepro.2022.131897

Iqbal, J., Khan, M., Talha, M., Farman, H., Jan, B., Muhammad, A., & Khattak, H. A. (2018). A generic internet of things architecture for controlling electrical energy consumption in smart homes. *Sustainable Cities and Society*, *43*, 443–450. https://doi.org/10.1016/J.SCS.2018.09.020

Jain, A., Sarsaiya, S., Kumar Awasthi, M., Singh, R., Rajput, R., Mishra, U. C., Chen, J., & Shi, J. (2022). Bioenergy and bio-products from bio-waste and its associated modern circular economy: Current research trends, challenges, and future outlooks. *Fuel*, *307*, 121859. https://doi.org/10.1016/j.fuel.2021.121859

Jiang, T., Deng, H., Bai, L., Zhang, R., Li, X., & Chen, H. (2018). Optimal energy flow and nodal energy pricing in carbon emission-embedded integrated energy systems. *CSEE Journal of Power and Energy Systems*, *4*(2), 179–187. https://doi.org/10.17775/CSEEJPES.2018.00030

Johnson, S., Kien, C., & Lindsay, A. (2021). *Vietnam's latest power development plan focuses on expanding renewable sources*. https://www.eia.gov/todayinenergy/detail.php?id=48176

Khattak, H. A., Tehreem, K., Almogren, A., Ameer, Z., Din, I. U., & Adnan, M. (2020). Dynamic pricing in industrial internet of things: Blockchain application for energy management in smart cities. *Journal of Information Security and Applications*, *55*, 102615. https://doi.org/10.1016/j.jisa.2020.102615

Kiliccote, S., Piette, M. A., Watson, D. S., & Hughes, G. (2006). *Dynamic controls for energy efficiency and demand response: Framework concepts and a new construction study case in New York*. Lawrence Berkeley National Lab.(LBNL), Berkeley, CA (United States).

Koirala, B. P., Koliou, E., Friege, J., Hakvoort, R. A., & Herder, P. M. (2016). Energetic communities for community energy: A review of key issues and trends shaping integrated community energy systems. *Renewable and Sustainable Energy Reviews*, *56*, 722–744. https://doi.org/10.1016/J.RSER.2015.11.080

Le, T. H., Pham, M. T., Hadiyanto, H., Pham, V. V., & Hoang, A. T. (2021). Influence of various basin types on performance of passive solar still: A review. In *International Journal of Renewable Energy Development* 10(4), 789–802). https://doi.org/10.14710/IJRED.2021.38394

Lee, C., & Lim, C. (2021). From technological development to social advance: A review of Industry 4.0 through machine learning. *Technological Forecasting and Social Change*, *167*, 120653. https://doi.org/10.1016/j.techfore.2021.120653

Li, Y., Gao, W., Zhang, X., Ruan, Y., Ushifusa, Y., & Hiroatsu, F. (2020). Techno-economic performance analysis of zero energy house applications with home energy management system in Japan. *Energy and Buildings*, *214*, 109862. https://doi.org/10.1016/j.enbuild.2020.109862

Liu, J., Song, R., Nasreen, S., & Hoang, A. T. (2019). Analysis of the Complementary Property of Solar Energy and Thermal Power Based on Coupling Model. *Nature Environment & Pollution Technology*, *18*(5).

Liu, Y., Zuo, K., Liu, X. (Amy), Liu, J., & Kennedy, J. M. (2018). Dynamic pricing for decentralized energy trading in micro-grids. *Applied Energy*, *228*, 689–699. https://doi.org/10.1016/j.apenergy.2018.06.124

Lokeshgupta, B., & Sivasubramani, S. (2018). Multi-objective dynamic economic and emission dispatch with demand side management. *International Journal of Electrical Power & Energy Systems*, *97*, 334–343. https://doi.org/10.1016/j.ijepes.2017.11.020

Lokeshgupta, B., & Sivasubramani, S. (2019). Multi-objective home energy management with battery energy storage systems. *Sustainable Cities and Society*, *47*, 101458. https://doi.org/10.1016/j.scs.2019.101458

Ma, K., Hu, G., & Spanos, C. J. (2014). Distributed Energy Consumption Control via Real-Time Pricing Feedback in Smart Grid. *IEEE Transactions on Control Systems Technology*, *22*(5), 1907–1914. https://doi.org/10.1109/TCST.2014.2299959

Malla, F. A., Mushtaq, A., Bandh, S. A., Qayoom, I., Hoang, A. T., & Shahid-e-Murtaza. (2022). Understanding Climate Change: Scientific Opinion and Public Perspective. In *Climate Change* (pp. 1–20). Springer International Publishing. https://doi.org/10.1007/978-3-030-86290-9_1

Mbungu, N. T., Bansal, R. C., Naidoo, R., Miranda, V., & Bipath, M. (2018). An optimal energy management system for a commercial building with renewable energy generation under real-time electricity prices. *Sustainable Cities and Society*, *41*, 392–404. https://doi.org/10.1016/j.scs.2018.05.049

Mehrjerdi, H. (2020). Peer-to-peer home energy management incorporating hydrogen storage system and solar generating units. *Renewable Energy*, *156*, 183–192. https://doi.org/10.1016/j.renene.2020.04.090

Mohd, A., Ortjohann, E., Schmelter, A., Hamsic, N., & Morton, D. (2008). Challenges in integrating distributed Energy storage systems into future smart grid. *2008 IEEE International Symposium on Industrial Electronics*, 1627–1632. https://doi.org/10.1109/ISIE.2008.4676896

Mohsenian-Rad, A.-H., & Leon-Garcia, A. (2010). Optimal Residential Load Control With Price Prediction in Real-Time Electricity Pricing Environments. *IEEE Transactions on Smart Grid*, *1*(2), 120–133. https://doi.org/10.1109/TSG.2010.2055903

Morstyn, T., & McCulloch, M. D. (2019). Multiclass Energy

Management for Peer-to-Peer Energy Trading Driven by Prosumer Preferences. *IEEE Transactions on Power Systems*, *34*(5), 4005–4014. https://doi.org/10.1109/TPWRS.2018.2834472

Narayanan, A., Kaipia, T., & Partanen, J. (2016). Economic benefits of photovoltaic-based systems for residential customers participating in open electricity markets. *IEEE PES Innovative Smart Grid Technologies Conference Europe*. https://doi.org/10.1109/ISGTEUROPE.2016.7856298

NEWS GLOBAL COMPLIANCE. (2021). *Vietnam: Key highlights of new draft of national power development plan (Draft PDP8)*. https://www.globalcompliancenews.com/2021/03/13/vietnam-key-highlights-of-new-draft-of-national-power-development-plan-draft-pdp8-04032021-2/

Nezamoddini, N., & Wang, Y. (2017). Real-time electricity pricing for industrial customers: Survey and case studies in the United States. *Applied Energy*, *195*, 1023–1037. https://doi.org/10.1016/J.APENERGY.2017.03.102

Nguyen Duc, T., Tran Thanh, S., Do Van, L., Tran Quoc, N., & Takano, H. (2022). Impact of renewable energy integration on a novel method for pricing incentive payments of incentive-based demand response program. *IET Generation, Transmission & Distribution*, *16*(8), 1648–1667. https://doi.org/10.1049/gtd2.12391

Nguyen, H. P., Hoang, A. T., Le, A. T., Pham, V. V., & Tran, V. N. (2020). Learned experiences from the policy and roadmap of advanced countries for the strategic orientation to electric vehicles: A case study in Vietnam. *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, 1–10. https://doi.org/10.1080/15567036.2020.1811432

Nguyen, H. P., Hoang, A. T., Nizetic, S., Nguyen, X. P., Le, A. T., Luong, C. N., Chu, V. D., & Pham, V. V. (2021). The electric propulsion system as a green solution for management strategy of <scp> CO_2 </scp> emission in ocean shipping: A comprehensive review. *International Transactions on Electrical Energy Systems*, *31*(11). https://doi.org/10.1002/2050-7038.12580

Nguyen, H. P., Le, P. Q. H., Pham, V. V., Nguyen, X. P., Balasubramaniam, D., & Hoang, A.-T. (2021). Application of the Internet of Things in 3E (efficiency, economy, and environment) factor-based energy management as smart and sustainable strategy. *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, 1–23.

Nguyen, X. P., Le, N. D., Pham, V. V., Huynh, T. T., Dong, V. H., & Hoang, A. T. (2021). Mission, challenges, and prospects of renewable energy development in Vietnam. *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, 1–13. https://doi.org/10.1080/15567036.2021.1965264

Nižetić, S., Jurčević, M., Čoko, D., Arıcı, M., & Hoang, A. T. (2021). Implementation of phase change materials for thermal regulation of photovoltaic thermal systems: Comprehensive analysis of design approaches. *Energy*, 120546.

Ozturk, Y., Senthilkumar, D., Kumar, S., & Lee, G. (2013). An Intelligent Home Energy Management System to Improve Demand Response. *IEEE Transactions on Smart Grid*, *4*(2), 694–701. https://doi.org/10.1109/TSG.2012.2235088

Parag, Y., & Sovacool, B. K. (2016). Electricity market design for the prosumer era. *Nature Energy 2016 1:4*, *1*(4), 1–6. https://doi.org/10.1038/nenergy.2016.32

Park, L., Yoon, Y., Cho, S., & Choi, S. (2020). Prosumer Energy Management Considering Contract With Consumers Under Progressive Pricing Policy. *IEEE Access*, *8*, 115789–115799. https://doi.org/10.1109/ACCESS.2020.3004643

Prinsloo, G., Dobson, R., & Mammoli, A. (2018). Synthesis of an intelligent rural village microgrid control strategy based on smartgrid multi-agent modelling and transactive energy management principles. *Energy*, *147*, 263–278. https://doi.org/10.1016/j.energy.2018.01.056

Prudhviraj, D., B. S. Kiran, P., & M. Pindoriya, N. (2020). Stochastic Energy Management of Microgrid with Nodal Pricing. *Journal of Modern Power Systems and Clean Energy*, *8*(1), 102–110. https://doi.org/10.35833/MPCE.2018.000519

PWC. (2016). Electricity beyond the grid: Accelerating access to sustainable power for all. *PwC Global Power & Utilities*, 1–24.

Radwan, A. A. A., & Mohamed, Y. A.-R. I. (2017). Networked Control and Power Management of AC/DC Hybrid Microgrids. *IEEE Systems Journal*, *11*(3), 1662–1673. https://doi.org/10.1109/JSYST.2014.2337353

Rajamoorthy, R., Arunachalam, G., Kasinathan, P., Devendiran, R., Ahmadi, P., Pandiyan, S., Muthusamy, S., Panchal, H., Kazem, H. A., & Sharma, P. (2022). A novel intelligent transport system charging scheduling for electric vehicles using Grey Wolf Optimizer and Sail Fish Optimization algorithms. *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, *44*(2), 3555–3575. https://doi.org/10.1080/15567036.2022.2067268

Ramezani, M., Bahmanyar, D., & Razmjooy, N. (2020). A new optimal energy management strategy based on improved multi-objective antlion optimization algorithm: applications in smart home. *SN Applied Sciences*, *2*(12), 2075. https://doi.org/10.1007/s42452-020-03885-7

Rathnayaka, A. J. D., Potdar, V. M., Dillon, T., & Kuruppu, S. (2015). Framework to manage multiple goals in community-based energy sharing network in smart grid. *International Journal of Electrical Power & Energy Systems*, *73*, 615–624. https://doi.org/10.1016/j.ijepes.2015.05.008

Roy, S., Lam, Y. F., Hossain, M. U., & Chan, J. C. L. (2022). Comprehensive evaluation of electricity generation and emission reduction potential in the power sector using renewable alternatives in Vietnam. *Renewable and Sustainable Energy Reviews*, *157*, 112009. https://doi.org/10.1016/j.rser.2021.112009

Said, Z., Rahman, S., Sharma, P., Amine Hachicha, A., & Issa, S. (2022). Performance characterization of a solar-powered shell and tube heat exchanger utilizing MWCNTs/water-based nanofluids: An experimental, numerical, and artificial intelligence approach. *Applied Thermal Engineering*, *212*, 118633. https://doi.org/10.1016/j.applthermaleng.2022.118633

Said, Z., Sharma, P., Tiwari, A. K., Le, V. V., Huang, Z., Bui, V. G., & Hoang, A. T. (2022). Application of novel framework based on ensemble boosted regression trees and Gaussian process regression in modelling thermal performance of small-scale Organic Rankine Cycle (ORC) using hybrid nanofluid. *Journal of Cleaner Production*, *360*, 132194. https://doi.org/10.1016/j.jclepro.2022.132194

Sang Le, T.-, & Hong Hieu, L. (2020). A Comparison Of Lyapunov And Fuzzy Approaches To Tracking Controller Design. *Journal of Technology & Innovation*, *1*(2), 54–57. https://doi.org/10.26480/jtin.02.2021.54.57

Sharma, P., Sahoo, B. B., Said, Z., Hadiyanto, H., Nguyen, X. P., Nižetić, S., Huang, Z., Hoang, A. T., & Li, C. (2022). Application of machine learning and Box-Behnken design in optimizing engine characteristics operated with a dual-fuel mode of algal biodiesel and waste-derived biogas. *International Journal of Hydrogen Energy*. https://doi.org/10.1016/j.ijhydene.2022.04.152

Stevens, L., Wilcox, M., Leopold, A., Taylor, C., & Waters, L. (2016). *Poor People's Energy Outlook 2016*. Practical Action Publishing Ltd. https://doi.org/10.3362/9781780449357

Subramanian, M., Hoang, A. T., Kalidasan, B., Nižetić, S., Soloman, J. M., Balasubramanian, D., Subramaniyan, C., Thenmozhi, G., Metghalchi, H., & Nguyen, X. P. (2021). A technical review on composite phase change material based secondary assisted battery thermal management system for electric vehicles. *Journal of Cleaner Production*, 129079.

U S Department of Energy. (2006). Benefits of Demand Response in Electricity Markets and Recommendations for Achieving Them. *U.S. Department of Energy, February*, 122.

Unamuno, E., & Barrena, J. A. (2015). Hybrid ac/dc microgrids—Part I: Review and classification of topologies. *Renewable and Sustainable Energy Reviews*, *52*, 1251–1259.

https://doi.org/10.1016/j.rser.2015.07.194

Vergados, D. J., Mamounakis, I., Makris, P., & Varvarigos, E. (2016). Prosumer clustering into virtual microgrids for cost reduction in renewable energy trading markets. *Sustainable Energy, Grids and Networks*, *7*, 90–103. https://doi.org/10.1016/J.SEGAN.2016.06.002

Yu, X., & Xue, Y. (2016). Smart Grids: A Cyber–Physical Systems Perspective. *Proceedings of the IEEE*, *104*(5), 1058–1070. https://doi.org/10.1109/JPROC.2015.2503119

Zafar, R., Mahmood, A., Razzaq, S., Ali, W., Naeem, U., & Shehzad, K. (2018). Prosumer based energy management and sharing in smart grid. *Renewable and Sustainable Energy Reviews*, *82*, 1675–1684. https://doi.org/10.1016/j.rser.2017.07.018

Zhao, X., Gao, W., Qian, F., & Ge, J. (2021). Electricity cost comparison of dynamic pricing model based on load forecasting in home energy management system. *Energy*, *229*, 120538. https://doi.org/10.1016/j.energy.2021.120538

Zhou, J. H., Tian, L. G., & Pan, H. (2015). Study of planning and design of hybrid AC/DC micro-grid. *Journal of Hefei University of Technology (Natural Science)*, *38*(2), 166–170.