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Reaching Maximum Electricity Sale Profit for A Thermal-Energy Storage-Renewable Power Plant System

Phu Ha Trieu[1] **Thang Trung Nguyen**[2]*

[1]*Faculty of Electronics and Telecommunications, Saigon University, Ho Chi Minh City, Vietnam*
[2]*Power System Optimization Research Group, Faculty of Electrical and Electronics Engineering,*
Ton Duc Thang University, Ho Chi Minh City, Vietnam
* Corresponding author's Email: nguyentrungthang@tdtu.edu.vn

Abstract: This study maximizes the total electric sale profit of a hybrid power system with one thermal power plant (TPP), one wind power plant (WPP), one solar power plant (SPP), and one pumped storage hydro plant (PSP) scheduled in one day. There are no inflows to the PSP, and the PSP only uses the pumped water to produce electricity. Two study cases are simulated using artificial hummingbird algorithm (AHA), war strategy optimization algorithm (WSO), and average and subtract-based optimization algorithm (ASBO). As a result, ASBO reaches the highest profit for the two cases. In addition, ASBO is also run for two other cases neglecting the operation of the PSP. The results indicate that PSP can support the system to reach a greater profit by $1859.8 and $1,577.7, respectively. Thus, the PSP is very useful for the hybrid system in reaching the maximum total profit of the electricity sale.

Keywords: Total profit, Pumped storage plant, Renewable power plants, Average and subtraction-based optimization algorithm.

1. Introduction

Conventional power plants, such as hydroelectric and thermal, face increasing load demand. Fossil fuels are costly; river water is only plentiful over a short period, such as months or seasons [1–3]. Renewable energies can become an adequate alternative solution for these power sources. However, integrating renewable power plants (RPP) into existing power systems is a complex process that requires careful planning, management, and collaboration between various stakeholders. One of the significant challenges of integrating RPPs into the power system is the intermittent nature of renewable energy sources such as wind and solar [4–6]. Unlike traditional power plants that can generate electricity continuously, renewable power plants' output varies based on environmental factors such as weather conditions, time of day, and seasonality. This variability can create instability in the grid, leading to frequency and voltage fluctuations, which can cause equipment damage and blackouts [7, 8]. Although renewables have made significant progress in recent years, they still face challenges in meeting the growing global demand for energy. In addition, integrating large amounts of intermittent renewable energy into existing power grids can take time and effort [9, 10].

To address this challenge, power system operators must employ advanced tools and techniques to ensure grid stability and reliability while maximizing the use of renewable energy sources. These tools include energy storage systems, demand response programs, and forecasting models that predict renewable energy output. Energy storage systems based on batteries can store energies for the case of excess renewable energy during low demand and discharge the stored energy during peak demand [11, 12]. Demand response programs incentivize consumers to reduce their energy consumption during high demand, reducing the need for fossil fuel power plants [2, 13]. Forecasting models that predict renewable energy output can help grid operators anticipate and plan for fluctuations in renewable energy supply, enabling them to balance supply and demand more effectively [14–16]. In [14], the authors propose a multi-objective cultural differential evolution algorithm to optimize hydrothermal power scheduling while integrating wind and photovoltaic power to reduce economic emissions. [15] addresses the economic dispatch problem by incorporating solar energy, aiming to minimize the total cost of power generation while considering the constraints of the power system. In [16], the authors propose a hybrid framework to forecast power generation from multiple renewable energy sources while addressing the challenge of integrating variable and uncertain energy sources into the power system.

Pumped storage plants (PSPs) are a solution that can address this challenge by storing excess renewable energy during periods of high generation and releasing it during periods of high load demand. Pumped storage plants use excess electricity to pump water from a lower reservoir to an upper reservoir. When the load demand is high, water is released from the upper reservoir and flows through turbines to generate electricity. This process can be repeated, allowing the PSPs to provide reliable and flexible energy storage. The PSPs offer several advantages to the power system. They can help balance the power by providing fast response times to load demand or supply changes, thereby improving grid stability and reducing the need for traditional peaking power plants [17, 18]. They also enable the integration of more renewable energy sources into the grid, which can help reduce greenhouse gas emissions and improve energy security [19, 20]. Furthermore, the PSPs can provide additional revenue streams to power plant owners by participating in electricity markets. They can buy electricity when it is cheap and sell it back to the grid when demand and prices are high, which can help reduce overall electricity costs and increase profitability [21]. In summary, PSP can be critical in transitioning to a more renewable energy-based power system. The advantages of integrating the PSPs into the power system have been widely recognized and adopted in various countries worldwide. Researchers have explored the use of the PSPs in combination with thermal and renewable power plants to optimize the efficiency of the combined system further. However, to maximize the daily profit of the power system, a coordinated operation strategy for multiple power plants needs to be developed [22]. Other studies considered more complex constraints or realistic constraints such as emission of thermal power plants [23], isolated areas [24], standalone power systems [25], technical and economic factors [26], and remote island power networks [27]. These studies have proved the significance of the PSPs, but the studies have not shown data of systems for improving solutions and methods.

This study solves a coordinated operation strategy for multiple power plants to maximize daily profit by using artificial hummingbird algorithm (AHA) [28], war strategy optimization algorithm (WSO) [29], and average and subtract-based optimization algorithm (ASBO) [30]. Two study cases of a hybrid system with different power plants are simulated to determine the best algorithm and prove the contributions of the PSPs. The study considers the novelty as follows:

- Construct a new problem model for hybrid systems with pumped storage, wind, solar and thermal plants considering the electric price and maximum profit.
- Try the performance of water storage for a PSP in the same hybrid system: The first scenario considers pumping water, but the second scenario ignores the function.
- Apply recent metaheuristic algorithms published in 2022 for the new problem to choose the best one.

The main contributions of the study can be summarized as follows:

- Find valid and effective solutions to the problem of maximizing the total profit for the hybrid system. The solutions satisfy all concerned constraints and reach the most effective profit.
- Find the most suitable algorithm, which is ASBO. ASBO can find greater profits and reach a more effective search performance than AHA and WSO for two study cases with two scenarios for each case.
- Demonstrate and clarify the benefits of PSPs in the hybrid system through various case studies: PSPs with water storage and generation functions can reach higher profits than other PSPs without the water storage function.

Other parts of the paper are as follows. Problem formulation in section 2 presents the considered target and all concerned constraints regarding power plants. Section 3 shows the main steps in the search process of ASBO. Numerical results are presented, analyzed, and discussed in section 4. Finally, section 5 summarizes the study's contributions, shortcomings, and future work.

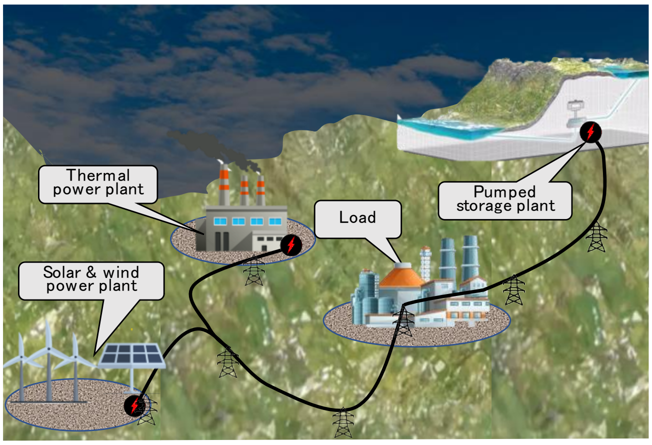

Figure. 1 Configuration of a hybrid applied system

2. Problem formulation

A pumped storage plant is a type of hydroelectric power plant that is used to generate electricity. It consists of two reservoirs located at different elevations. During low electricity demand, water is pumped from the lower reservoir to the upper reservoir, storing water as potential energy [31]. Then, during high electricity demand, the water is released from the upper reservoir through turbines, which generate electricity as the water flows back down to the lower reservoir. The PSP is working in a hybrid system as shown in Fig. 1. This problem must determine the optimal power generation or pumping mode for each hour of the day for each power plant and the power output of the pumped storage plants and thermal power plants within their respective capacity limits. Furthermore, it needs to ensure that the volume of water in the upper reservoir of the pumped storage plant is maintained at the same level at the start and end of the day's schedule. Hence, it is crucial to maintain the water level to operate the pumped storage plant efficiently. Finally, the system's power balance needs to be maintained, meaning that the total power generated by all the power plants should meet the load demand for each hour of the day.

2.1 The objective function

The objective function is a mathematical expression that quantifies the power system's total profit based on the power generation and pumping schedules determined for each power plant. The objective function of this problem is to maximize profit which can be expressed in the formula below.

$$Maximize\ TP = \sum_{t=1}^{T}\left(\left(P_t^w + P_t^s + P_t^t + Pg_t^{PSP}\right) \times Pr_t - Pr_t \times Pp_t^{PSP} - FC_t\right) \quad (1)$$

Where FC_t is a fuel cost function of the thermal power plant at the hour t, and it is represented as the following quadratic function equation:

$$FC_t = a + b \times P_t^t + c \times (P_t^t)^2 \quad (2)$$

2.2 The power output of renewable power plants

Rated power P_r^w, rated wind velocity, and cut-in wind speed, cut-out wind speeds, and the present wind speeds are critical factors directly influencing the power output of the wind power plant. The rated power is the maximum output the wind turbine can generate under ideal conditions. The rated wind velocity is the speed at which the wind turbine operates at its maximum capacity. The cut-in wind speed is the minimum required to start the wind turbine, while the cut-out wind speed is the maximum wind speed at which the turbine has to shut down to avoid damage. According to [14], the power output of wind power plants is determined by the given equation as follows:

$$P_t^w = \begin{cases} 0; & if\ (V_t^w < V_i^w)\ or\ (V_t^w > V_o^w \\ P_r^w \times \frac{(V_t^w - V_i^w)}{(V_r^w - V_i^w)}; & \\ & if\,(V_i^w < V_t^w < V_r^w) \\ P_r^w; & if\ (V_r^w < V_t^w < V_o^w) \end{cases} \quad (3)$$

The power output of a solar power plant depends on several factors, including the rated power generated by the solar power plant, the instant radiation, the constant radiation, and the standard radiation of SPP. According to reference [15], the amount of power generated by a solar power plant (SPP) can be calculated using the following equation:

$$P_t^s = \begin{cases} \frac{(Ir_t^s)^2}{CR \times SR} \times P_r^s\,; if\ (0 < Ir_t^s < SR) \\ \frac{Ir_t^s}{CR} \times P_r^s\,; if\ (Ir_t^s < SR) \end{cases} \quad (4)$$

2.3 The constraints of the PSP

The constraint of water storage capacity for the PSP ensures that the volume of water in the upper reservoir of the PSP remains within the specified limits. This is necessary to maintain the system's power balance and prevent the PSP from running out of water. That limits the volume of water in the upper reservoir at any given time. These constraint formulas are as follows:

$$Vol^l \leq Vol_t \leq Vol^h \quad (5)$$

$$Vol_t^{Start} = Vol_t^{End} \quad (6)$$

In addition, the PSP is also limited by discharge, generation, and pump power. At hours with generation mode, the PSP is constrained by discharge and generation, whereas it is constrained by pump power for hours with pumping mode. The constraints regarding generation, pump power, and discharge are expressed as follows [32]:

$$P_{PSP}^{low} \le Pg_t^{PSP} \le P_{PSP}^{high} \tag{7}$$

$$Pp_t^{PSP} = 0 \; or \; Pp_t^{PSP} = P_{PSP}^{high} \tag{8}$$

$$Dis_{Vol}^{low} \le Dis_t \le Dis_{Vol}^{high} \tag{9}$$

As shown in constraint (8), the PSP can stop pumping (i.e., $Pp_t^{PSP} = 0$) or run the pump with the highest power equaling the maximum generation (i.e., $Pp_t^{PSP} = P_{PSP}^{high}$). In the two statuses, the stored water is either zero or maximum, in which the maximum stored water is smaller than the maximum discharge due to the pump efficiency, which is 0.75 in the study. The stored water for hours with pumping mode is subject to:

$$Pump_t = 0 \; or \; Pump_t = \gamma_{pump}.Dis_{Vol}^{high} \tag{10}$$

The discharge at the hours with generation mode is obtained by:

$$Dis_t = \alpha_1 + \alpha_2 Pg_t^{PSP} + \alpha_3 (Pg_t^{PSP})^2 \tag{11}$$

As determining the stored water or discharge, the volume of reservoirs is calculated by:

$$Vol_t = Vol_{(t-1)} - Dis_t + Pump_t \tag{12}$$

2.4 The power balance and generation constraints

The power system is subject to power balance constraints. The constraints are dependent on the operating status of the PSP. For hours with the generation mode, the sum of generations from power plants must equal the demand of loads. For other hours with the pumping mode, the total generations from power plants must equal the pump power of the PSP and the demand of loads. The constraints corresponding to the hours with generation and pumping modes are expressed as follows:

$$(P_t^w + P_t^s + P_t^t + Pg_t^{PSP}) - PL_t = 0 \tag{13}$$

$$(P_t^w + P_t^s + P_t^t) - Pp_t^{PSP} - PL_t = 0 \tag{14}$$

The generation of power plants in the two constraints must be within a determined range as shown in the formulas below:

$$0 \le P_t^w \le P_r^w \tag{15}$$

$$0 \le P_t^s \le P_r^s \tag{16}$$

$$P_t^{low} \le P_t^t \le P_t^{high} \tag{17}$$

At hours with very low solar radiation (i.e., $\boldsymbol{Ir_t^s} \approx \mathbf{0}$), the generation of solar plants is zero as calculated by Eq. (4). Similarly, the generation of wind power plants is also zero for hours with lower values than cut-in speed or higher values than cut-out speed as shown in Eq. (3). However, the rated generations are the highest limits for the solar and wind plants. Unlikely, the lowest generation of thermal power plants can be higher than zero MW due to the constraints of economic issues.

3. The applied method

In ASBO, the population is divided into two subpopulations: one is updated using the average mechanism, and another is updated using the subtract mechanism. In the average mechanism, the new position of a candidate solution is calculated as the average of its current position and the position of the best solution found so far. In the subtract mechanism, the new position of a candidate solution is calculated as the difference between its current position and the position of the worst solution found so far. By combining these two update mechanisms, ASBO aims to balance exploration and exploitation of the search space. This process is repeated until a stopping criterion is met. The following equations will reveal the details for particular update methods on each phase:

In the first phase, all solutions are updated by employing the mathematical model given below:

$$S_n^{new,ph1} = \begin{cases} S_n + Rd.\left(MS^{ph1} - PhS.S_n\right); \\ \quad \text{if } \; FN_n^{new,ph1} < FN_n \\ S_n + Rd.\left(S_n - MS^{ph1}\right); \\ \quad \text{else} \end{cases} \tag{18}$$

$$MS^{ph1} = \frac{1}{2}.\left(S^{high} + S^{low}\right) \tag{19}$$

After the first phase, all the new solutions are continuously executed their update in the second phase by employing the following expression:

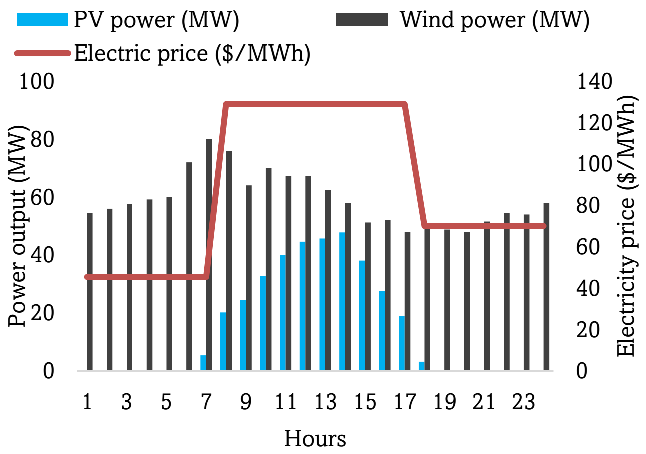

Figure. 2 Power output of wind and solar generators, and the electricity price

$$S_n^{new,ph2} = S_n - Rnd \times SA^{ph2} \tag{20}$$

$$SA^{ph2} = S^{high} - S^{low} \tag{21}$$

In the last phase, the update for all solutions is performed by using the following expression:

$$S_n^{new,ph3} = S_n - Rnd \times \left(S_n - PhS \times S^{high}\right) \tag{22}$$

4. Numerical results

This study presents a comprehensive approach to optimize the operation of a power system consisting of various power plants, including thermal, wind, solar, and pumped storage plants. The paper utilized metaheuristic algorithms, such as AHA, ASBO, and WSO, to maximize the profit of the power system. The power output of renewable energy sources was predicted in previous studies [14, 15], and the cost coefficients of thermal units and load demand data were obtained from a reliable source [33], and the electric price can be referred to [34]. The study used the MATLAB program to execute the simulation on a computer with a 2.4 GHz processor and 8 GB of RAM. The results showed that the proposed approach successfully optimized the power system operation and achieved the desired profit. The findings suggest that using metaheuristic algorithms can help power system operators to make more informed decisions and ensure efficient and maximum total profit power system operation.

4.1 Study case 1

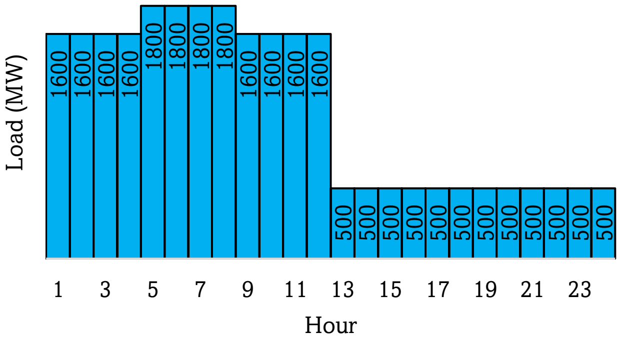

Figure. 3 Load demand within 24 hours

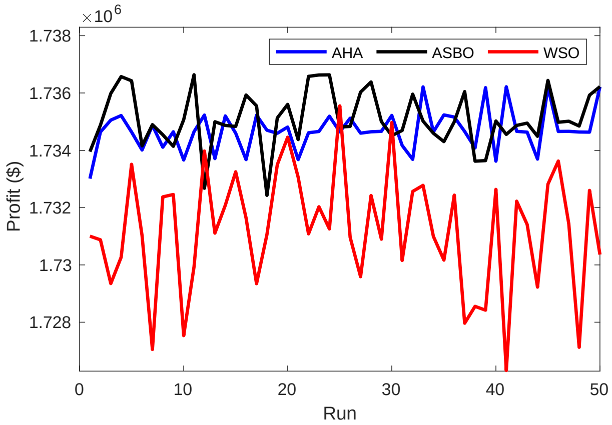

Figure. 4 The profit obtained by the three applied methods after 50 independent runs in case 1

In this case, the power output of wind and solar generators and the electricity price as the values shown in Fig. 2. The system will have data on a load demand shown in Fig. 3. The results of 50 surveys are presented in Fig. 4. The result makes it easy to see that AHA and ASBO can find optimal solutions better than WSO. The blue line represents the results obtained using the AHA algorithm, the orange line represents the results obtained using the ASBO algorithm, and the green line represents the results obtained using the WSO algorithm. It can be seen that both AHA and ASBO algorithms outperform the WSO algorithm in terms of finding the optimal solution.

Fig. 5, it can be observed that ASBO has the highest total profit across all three categories (maximum, mean, and minimum profit). In the case of maximum profit, ASBO achieved a total profit of $1736636.8, higher than AHA and WSO. For mean profit, ASBO again obtained the highest total profit of $1735105.5, followed closely by AHA with a total profit of $1733011.5. Finally, in the case of minimum profit, ASBO achieved the highest total profit of $1732639.4, followed by AHA and WSO. Overall, it can be concluded that ASBO is the most effective algorithm for maximizing the total profit of the system in this scenario. Fig. 6 shows the profit of the system without PSP, and the maximum profit obtained by three methods for systems with PSP. The total profit in systems with PSP is higher than those

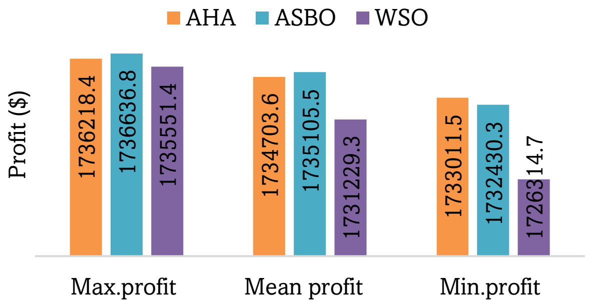

Figure. 5 Summary of total profit values obtained by the three applied methods for case 1

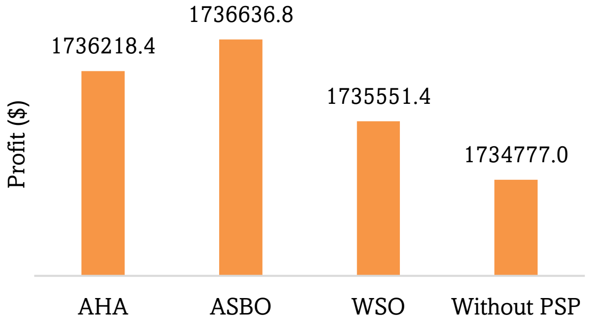

Figure. 6 The comparison of the profit of the system with and without PSP in case 1

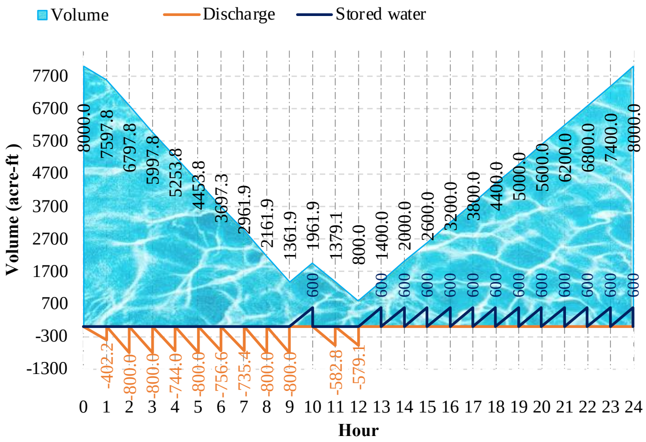

Figure. 7 The change in water level in PSP's upper reservoir in case 1

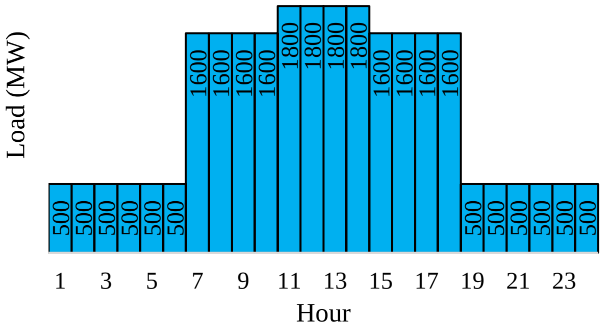

Figure. 8 Load demand within 24 hours used in case 2

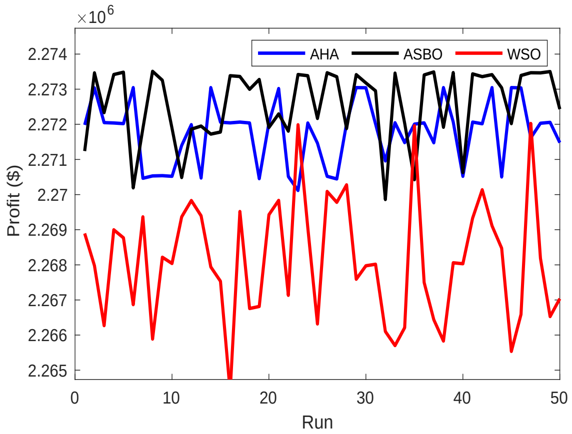

Figure. 9 The results obtained by the three applied method after 50 independent runs in case 2

without. Compared with without PSP, the Profits of ASBO, AHA, and WSO are higher, $1441.4, $1859.8, and $774.4, respectively. It should be emphasized that thanks to the water storage and additional generations of the PSP, the hybrid system can reach a higher profit by $1859.8, which is about 0.11% of the total profit from the system without the water storage function of the PSP.

The dynamic characteristics of the water level in the upper reservoir of PSP are calculated from the best solution of ASBO and shown in Fig. 7. The figure shows the operation statuses for each hour, the volume of discharged water, and the volume of pumping water belonging to PSP. Particularly, PSP is operated in the generating mode from hours 1 to 9 and from hours 11 to 12. In the remaining hours, PSP is all operated in the pumping mode. The water level in the schedule satisfies the balance of water level at the starting and ending points is still guaranteed. Besides, the observation in Fig. 7 also indicates that other constraints related to PSP are satisfied throughout the schedule.

4.2 Study case 2

To be suitable with the load demand in real life. Data a load demand shown in Fig. 8 are used in the system. Similar to Case 1, this case applies three optimal algorithm methods to solve this problem. The results of 50 surveys are presented in Fig. 9. Based on the results presented in Fig. 9, ASBO is again the best-performing algorithm, followed by AHA and WSO. This pattern is consistent with Case 1, indicating that ASBO and AHA may be more robust and effective in solving this problem.

Fig. 10 illustrates the Max.profit, mean profit, and Min.profit of AHA, ASBO, and WSO. The total profit obtained by ASBO is the highest, while the

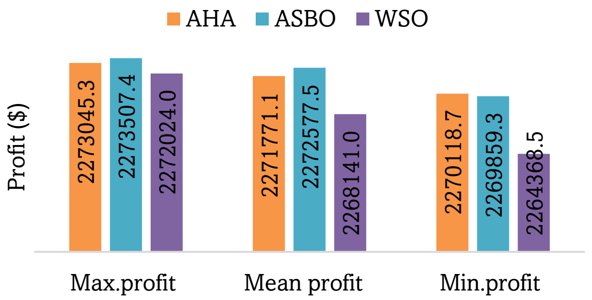

Figure. 10 Summary of total profit values obtained by the three applied methods for case 2

total profit obtained by WSO is the lowest. In Max.profit, ASBO can find the solution with a total profit of $2273507, while other values resulting from AHA and WSO are, respectively, $2273045.3 and $2272824. The profit of ASBO over AHA and WSO is, respectively, $462.1 and $1483.5. Regarding Mean profit, ASBO maintains its superiority over the two remaining methods. ASBO reached $2272577.5 of the Mean profit, while the similar results achieved by AHA and WSO are $2271771.1 and only $2268141.0, respectively. The extra profit from ASBO over AHA is $806.3 and $4436.5 over WSO. Finally, regarding the Min.profit, ASBO achieved a better value than WSO. Specifically, ASBO achieved $ 2269859.3 of the Min.profit, while the similar result obtained by WSO is only $2263368.5. As a result, ASBO is the most effective algorithm for maximizing the system's total profit.

The presence of PSP has a positive impact on the total profit of the power system shown in Fig. 11. The maximum profits obtained from ASBO, AHA, and WSO are higher in the system with PSP than in the system without PSP, in which the solution from ASBO led to a better profit by $1,577.7, which is about 0.07% of the total profit in the system without the PSP. Thus, it should be emphasized that the contribution of the PSP in getting high benefits for the hybrid system is significant as that in Study Case 1.

The variance in water level in PSP's upper reservoir was estimated from the best ASBO solution shown in Fig. 12. From hours 7 to 9 and 11 to 18, PSP is operated in generating mode, and the pumping mode is activated in the other remaining hours of the schedule. The variation of water level at each hour can be clearly seen; nonetheless, the water level at the starting point and the ending point is maintained the same, and all the related constraints such as the power output, the pumping limitation, the discharged water limitation of PSP are satisfied as well.

To clarify the power balance constraints shown in Eqs. (13) and (14), Table A is reported in Appendix to show the optimal generations from the thermal power plant and the generation/pump power of the pumped storage power plant. The generations of solar and wind power plants are shown in Fig. 2, while load demands are shown in Figs. 3 and 8. At hours with the generation mode of the PSP, the generation of PSP in the table are greater than 0 MW. Total generation from all plants supplies the load, satisfying Eq. (13). For hours with the pumping mode of the PSP, the pump power is -300 MW, and total generation from the thermal, wind, and solar power plants must supply the pump power and the load, satisfying Eq. (14). As a result, power balance constraint is satisfied for all operation cases of the pumped storage power plant.

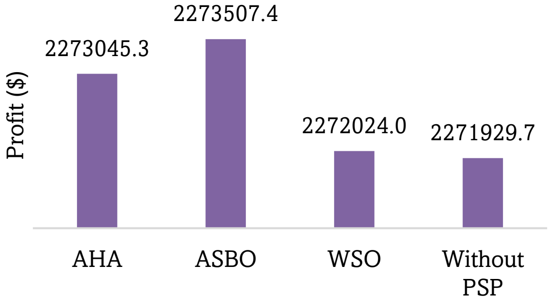

Figure. 11 The comparison of the profit of the system with and without PSP in case 2

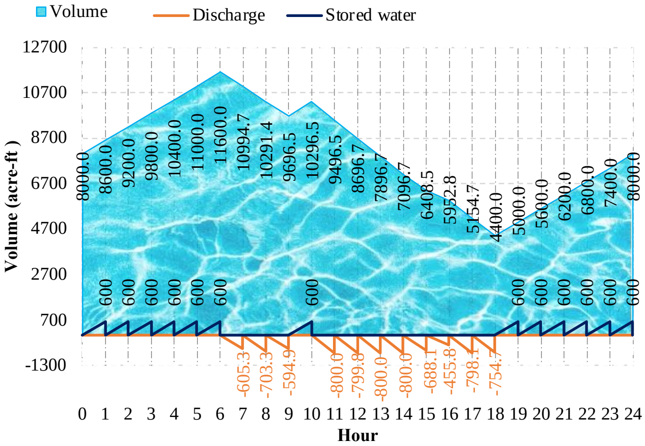

Figure. 12 The change of water level in PSP's upper reservoir in case 2

5. Conclusions

This paper has applied AHA, WSO and ASBO for solving the renewable plant and pumped storage hydrothermal plant scheduling problem and evaluating their effectiveness based on numerical results. Two study cases have been implemented, and the contributions of the paper can be summarized as follows:

- The applied algorithms could find effective operation solutions to the hybrid system for getting high profits. All constraints of the system were satisfied.
- The ASBO method was the most efficient for solving the combined scheduling problem of different types of power plants. ASBO has reached the highest total profit for two study cases, and it has found many higher-quality solutions than the two other applied algorithms.
- The operation of the PSP proved to be very effective. The hybrid systems with the PSP could reach higher profits than those without the PSP by 0.11% and 0.07% for two study cases.

However, the study has several limitations that need to be addressed for better quality in future publications, such as considering a large-scale combined power system with a more significant number of power plants, incorporating uncertainties associated with renewable energy power plants, and considering other objective functions besides maximizing total profit, such as minimizing total emissions and maximizing the penetration of renewable power plants. By addressing these drawbacks, future research can provide more comprehensive insights into the scheduling problem of different power plant types and help achieve a more sustainable and efficient power system.

Notation list

Parameters	**Notation**
P_t^w, P_t^t, P_t^s	Generation of the wind, thermal and solar power plants at the hour *t*
Pg_t^{PSP}	Generation of the PSP at the hour *t*
Pp_t^{PSP}	Pump power of the PSP at the hour *t*
Pr_t	Electricity price at the hours *t*
a, b, c	Coefficients of power generation function
P_r^w	Rated power of a wind power plant
V_r^w , V_i^w, V_o^w	Rated, cut-in and cut-out wind speeds
V_t^w, P_t^w	Wind speed and power output at the hour *t*
P_t^s, Ir_t^s	Generation and instant radiation of the solar power plant at the hour *t*
P_r^s	Rated generation of the solar power plant
CR, SR	Constant and standard radiations
Vol^l, Vol^h	The lowest and highest volumes of the reservoir
Vol_t, $Vol_{(t-1)}$	Volume of the upper reservoir at the end of the hours *t* and (*t*-1)
Vol_t^{Start}, Vol_t^{End}	Volume of the reservoir at the first and end points of the schedule
Dis_{Vol}^{low}, Dis_{Vol}^{high}	The lowest and highest volume of discharged water
Dis_t , $Pump_t$	Discharged and stored water at the hour *t*
P_{PSP}^{low}, P_{PSP}^{high}	The lowest and highest generating capacity of the PSP
γ_{pump}	Pumping efficiency
α_1, α_2, α_3	Coefficients of generation function of a pumped storage hydro plant
PL_t	Load demand at the hour *t*
S_n	The current solution n in the population
Rd, Rnd	Random values between 0 and 1
PhS	Scaling factor
MS^{ph1}	Mean solution in Phase 1
S^{high}, S^{low}	The highest and lowest solutions
$S_n^{new,ph1}$, $S_n^{new,ph2}$	The *nth* new solution in Phases 1 and 2
IP	Population dimension
SA^{ph2}	Subtraction solution in Phase 2
$S_n^{new,ph3}$	The *nth* new solution in Phase 3

Conflicts of interest

The authors declare no conflict of interest.

Author contributions

Conceptualization, PTH and TTN; methodology, TTN; software, PTH; writing—original draft preparation, PTH; writing—review and editing, TTN; supervision, TTN; funding acquisition, PTH.

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Appendix

Table A. Optimal solutions obtained by ASBO for the two study cases.

Hour *(t)*	*Study case* 1		*Study case* 2	
	P_t^t (MW)	Pg_t^{PSP}/Pp_t^{PSP} (MW)	P_t^t (MW)	Pg_t^{PSP}/Pp_t^{PSP} (MW)
1	1444.5	101.1	745.6	-300
2	1244.0	300	744.0	-300
3	1242.4	300	742.4	-300
4	1268.8	272.0	740.8	-300
5	1440.0	300	740.0	-300
6	1449.7	278.3	728.0	-300
7	1447.0	267.7	1312.0	202.6
8	1403.8	300	1252.1	251.7
9	1211.6	300	1314.2	197.5
10	1797.3	-300	1797.3	-300
11	1301.3	191.4	1392.7	300
12	1298.7	189.6	1388.3	299.9
13	691.9	-300	1391.9	300
14	694.2	-300	1394.2	300
15	710.7	-300	1266.6	244.1
16	720.4	-300	1392.5	127.9
17	733.1	-300	1234.1	299.0
18	746.8	-300	1269.4	277.4
19	751.2	-300	751.2	-300
20	752.0	-300	752.0	-300
21	748.4	-300	748.4	-300
22	745.6	-300	745.6	-300
23	746.0	-300	746.0	-300
24	742.0	-300	742.0	-300