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AN INTRA-DAY AND DAILY ROLLING ECONOMIC DISPATCHING MODEL FOR ENERGY STORAGE SYSTEMS IN INDUSTRIAL PARK MICROGRIDS

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Abstract: Aiming at the electricity-purchase-cost optimization demand of park microgrids equipped with distributed photovoltaics, two sets of energy-storage dispatching models are established for intra-day deterministic dispatching and long-term day-by-day rolling optimization. With the objective of minimizing daily total electricity-purchase cost, the intra-day dispatching model considers power balance, energy-storage charge-discharge power, capacity limits and daily cyclic constraints. Linear programming is adopted to solve electricity-purchase and energy-storage operation strategies under 10-minute time granularity, followed by feasibility verification and sensitivity analysis of key parameters. For long-term rolling dispatching, load forecasting is realized via historical same-week load weighting and deviation damping correction. A safety margin for planned electricity purchase and high-price emergency purchase penalty mechanism are introduced to realize annual-scale optimal operation of microgrid energy storage. Numerical results prove that energy-storage greatly cuts microgrid electricity-purchase expenditure. Charge-discharge efficiency dominates dispatching performance, and a 3% reserved ratio for planned purchase balances economic cost and power shortage risk. This work provides theoretical support for practical engineering dispatching of park-microgrid energy storage.
Keywords: Park microgrid; Energy-storage economic dispatching; Linear programming; Rolling optimization; Sensitivity analysis

1 INTRODUCTION

Driven by the “dual-carbon” strategy, distributed photovoltaics are widely integrated into park microgrids. With the capability of cross-time-period electric-energy transfer, energy storage acts as vital equipment to smooth source-load fluctuations and reduce external electricity-purchase costs [1-3]. The operation of park microgrids is jointly affected by time-of-use electricity prices, user-load volatility and the intermittency of photovoltaic output. Realizing economical energy-storage dispatching under the premise of guaranteed power-supply reliability is of practical significance for improving the comprehensive energy-utilization benefit of parks [4-5].

Extensive research has been carried out on microgrid energy-storage dispatching at home and abroad. Some studies establish day-ahead deterministic optimization models to solve energy-storage charge-discharge strategies under fully known source-load information and obtain theoretically optimal dispatching schemes [6-7]. To cope with uncertainties from new-energy and load forecasting, existing researches adopt rolling-dispatching approaches such as model predictive control and robust optimization to mitigate operational risks induced by forecasting deviations [8-10]. Nevertheless, most rolling-dispatching studies focus on algorithm-framework improvement with insufficient attention to practical engineering scenarios. A complete dispatching chain integrating statistical historical-load rules, safety margin of planned electricity purchase and high-price emergency-purchase penalty is rarely constructed, which limits its direct application in practical park-engineering computation.

To fill the above research gaps, this paper develops two sets of models: intra-day deterministic linear-programming model and long-term day-by-day rolling-optimization model. The intra-day model targets the minimum electricity-purchase cost, and incorporates power-balance equations, energy-storage capacity-power constraints as well as daily cyclic boundary conditions to obtain dispatching solutions and conduct parameter-sensitivity analysis. For long-term rolling dispatching, load forecasting is implemented via same-week weighting and historical-deviation damping correction. A reserved margin for planned electricity purchase together with the emergency-purchase penalty mechanism is introduced to realize full-year-scale simulation. Numerical examples verify model effectiveness and analyze the influence of key parameters on dispatching economy. This work can provide references for practical engineering dispatching of similar park microgrids with energy storage.

2 ESTABLISHMENT AND SOLUTION OF INTRA-DAY SCHEDULING MODEL

Discretize the data into 144 time intervals with a 10-minute step, and convert power values into electric energy. Taking the purchased electricity, charge/discharge energy of energy storage and utilized photovoltaic power of each time interval as decision variables, a linear programming model is established to minimize the total daily electricity purchase cost, subject to energy balance and energy storage operation constraints. The linprog solver is adopted for model solving. Finally, the electricity purchase and charge-discharge scheduling schemes of each time interval are output, followed by

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consistency verification and sensitivity analysis of the results. The solution flowchart of the intra-day model is shown in Figure 1.

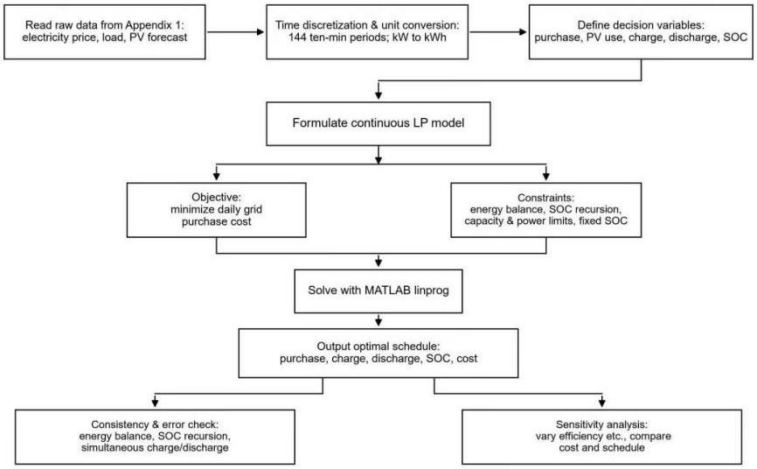


Figure 1 Flowchart of the Intra-Day Scheduling Model

2.1 Data Preprocessing

One day is divided into 144 time intervals, denoted as:

$$t=1,2,...,144 \tag{1}$$

The duration of each time interval is:

$$\Delta t=\frac{10}{60}=\frac{1}{6}\text{h} \tag{2}$$

The units of load power and photovoltaic forecast power in Appendix 1 are kW, which need to be converted into electric energy within each 10-minute interval. The load energy and photovoltaic power generation energy of the t-th interval are:

$$L_t=P_t^L\Delta t \tag{3}$$

$$R_t=P_t^{PV}\Delta t \tag{4}$$

The maximum charge/discharge power of energy storage is 5000 kW, so the maximum charge or discharge energy within a single 10-minute interval is:

$$M=5000\times\frac{1}{6}=833.333\text{kWh} \tag{5}$$

The first row of data in Appendix 1 corresponds to 00:10, representing the time segment 00:00–00:10; the last row marked "0:00+1" corresponds to 23:50–24:00.

2.2 Characteristic Analysis of Raw Data

To intuitively analyze the intra-day variation characteristics of electricity price, load and photovoltaic power in the intra-day model, time-series curves of the three variables are plotted, as shown in the figure. The load power and photovoltaic forecast power are represented by the left vertical axis, while electricity price is represented by the right vertical axis. Figure 2 shows the time series curves of typical daily electricity price, load, and predicted photovoltaic power generation.

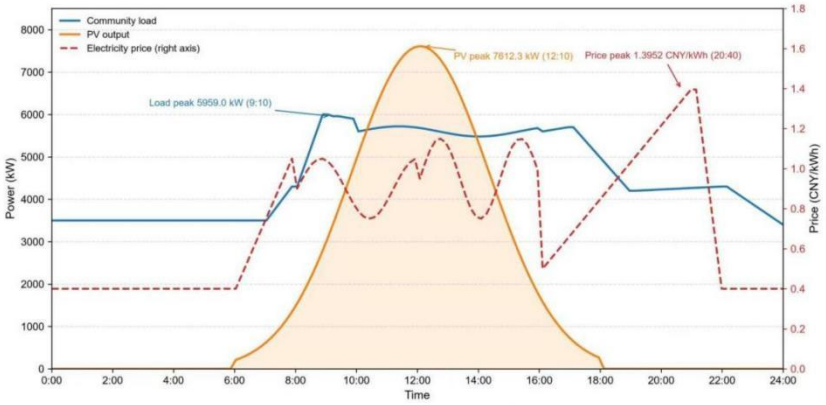


Figure 2 Time-Series Curves of Typical Daily Electricity Price, Load and Photovoltaic Forecast Power

As shown in the figure, photovoltaic power generation mainly concentrates in daytime and is nearly zero at night. The community load exists throughout the whole day with a peak value of about 5958.97 kW, which does not fully coincide with the peak of photovoltaic output. The electricity price presents obvious peak-valley difference with a peak-valley gap

of 0.9839 CNY/kWh. Due to the temporal mismatch among photovoltaic output, load demand and electricity price variation, the system needs to realize energy transfer via grid power purchase and energy storage charge-discharge. Therefore, this paper establishes an optimization model targeting the minimum total daily electricity purchase cost, incorporating energy balance, energy storage state transition, capacity and power constraints.

2.3 Decision Variables

The decision variables are defined as follows: G_t: external purchased electricity of the t-th interval; U_t: actually utilized photovoltaic energy of the t-th interval; C_t^+: charging energy of energy storage in the t-th interval; C_t^-: discharging energy of energy storage in the t-th interval; S_t: stored energy of energy storage at the end of the t-th interval. To facilitate the expression of net energy change of energy storage, define:

$$C_t=C_t^+-C_t^- \tag{6}$$

where C_t^+ and C_t^- are both non-negative variables.

2.4 Objective Function

The intra-day model aims to minimize the total external electricity purchase cost under the premise of meeting community load demand and energy storage operation constraints. The electricity purchase cost of the t-th interval is p_tG_t, so the total daily electricity purchase cost is:

$$Z=\sum_{t=1}^{144} p_tG_t \tag{7}$$

The optimization objective is:

$$minZ=min\sum_{t=1}^{144} p_tG_t \tag{8}$$

2.5 Constraint Conditions

(1) Microgrid energy balance constraint: Within the t-th interval, electric energy sources of the microgrid include grid purchased power, photovoltaic generation and energy storage discharge; electric energy consumption includes community load supply and energy storage charging. Thus:

$$G_t+U_t+C_t^-=L_t+C_t^+,t=1,2,...,144 \tag{9}$$

Equation (9) guarantees that the community load demand can be satisfied in each 10-minute interval.

(2) Photovoltaic utilization constraint: The actually utilized photovoltaic energy cannot exceed the photovoltaic power generation energy of the corresponding interval:

$$0\le U_t\le R_t,t=1,2,...,144 \tag{10}$$

If $R_t > U_t$, the difference represents the curtailed photovoltaic energy:

$$W_t=R_t-U_t \tag{11}$$

(3) Energy storage state transition constraint: The charging efficiency and discharging efficiency are both set as:

$$\eta=0.9 \tag{12}$$

During charging, the actual energy stored in the battery is $0.9C_t^+$. During discharging, to supply C_t^- to the microgrid, the energy storage consumes $C_t^-/0.9$ internally. Therefore, the energy storage state transition equation is:

$$S_t=S_{t-1}+0.9C_t^+-\frac{C_t^-}{0.9},t=1,2,...,144 \tag{13}$$

(4) Energy storage capacity constraint: The stored energy of the energy storage device shall be maintained between 1200 kWh and 10800 kWh:

$$1200\le S_t\le 10800,t=1,2,...,144 \tag{14}$$

(5) Charge and discharge power constraint: Restricted by the maximum charge/discharge power, the charging energy and discharging energy within a single interval shall not exceed the maximum transferable energy M = 833.333kWh:

$$0\le C_t^+\le 833.333,t=1,2,...,144 \tag{15}$$

$$0\le C_t^-\le 833.333,t=1,2,...,144 \tag{16}$$

(6) Non-negativity constraint: The purchased electricity from the external grid cannot be negative:

$$G_t\ge 0,t=1,2,...,144 \tag{17}$$

(7) Initial and final stored energy constraint. The initial stored energy of energy storage is a fixed value:

$$S_0=6000 \tag{18}$$

To ensure that the energy storage state at 24:00 is consistent with that at 00:00:

$$S_{144}=S_0=6000 \tag{19}$$

This constraint prevents the model from excessively discharging before the end of the day to artificially reduce the total daily electricity purchase cost.

2.6 Solution of the Intra-Day Model

The specific solution steps are as follows. Step1: Call linear programming solver. Rearrange the objective function and constraints into the standard form required by the linprog function in MATLAB:

$$\min_x f^Tx \tag{20}$$

subject to:

$$A_{eq}x=b_{eq} \tag{21}$$

$$l\leq x\leq u \tag{22}$$

where: f denotes the coefficient vector of the objective function; A_{eq} and b_{eq} represent the equality constraint matrix and equality constraint vector respectively; l and u are the lower and upper bounds of decision variables.

This paper uses the linprog function in MATLAB to solve the above model. When the solver returns the optimal state, extract variables from the decision vector to obtain the purchased electricity, charging energy, discharging energy, utilized photovoltaic energy and energy storage state for the 144 ten-minute intervals.

Step2: Result extraction and interval aggregation. According to the solution results, the total daily purchased electricity and total daily electricity purchase cost are calculated as:

$$G_{day}=\sum_{t=1}^{144} G_t \tag{23}$$

$$Z_{day}=\sum_{t=1}^{144} p_t G_t \tag{24}$$

To meet the result format requirements, aggregate the 144 ten-minute intervals into 4-hour blocks. For example, the 00:00–04:00 period corresponds to the first 24 intervals, and its total charging and discharging energy are:

$$C_{0-4}^{+}=\sum_{t=1}^{24} C_t^{+} \tag{25}$$

$$C_{0-4}^{-}=\sum_{t=1}^{24} C_t^{-} \tag{26}$$

The charging and discharging energy of other 4-hour intervals are calculated in the same way. The purchased electricity of specified intervals, charge-discharge energy of each time block, and stored energy at 00:00 and 24:00 are filled into the result table.

Step3: Verification of solution results. To verify the reliability of the optimal solution, the following checks are performed.

Supply-demand balance check:

$$e_t=G_t+U_t+C_t^{-}-L_t-C_t^{+} \tag{27}$$

Check whether e_t of all intervals is close to zero. Energy storage range check

$$1200\leq S_t\leq 10800 \tag{28}$$

Upper limit check of charging and discharging

$$0\leq C_t^{+},C_t^{-}\leq 833.333 \tag{29}$$

Initial-final energy storage state check

$$S_0=S_{144}=6000 \tag{30}$$

Simultaneous charge and discharge check. Check whether any interval satisfies:

$$C_t^{+}>10^{-6}\text{and}C_t^{-}>10^{-6} \tag{31}$$

If no such interval exists, the result has no simultaneous charge-discharge phenomenon. If such interval exists, additional mutual exclusion constraints for charging and discharging or two-stage optimization shall be adopted.

2.7 Model Solution Results

The optimal electricity purchase and energy storage scheduling scheme for the typical day is obtained. The model results show that the total daily purchased electricity is G_{day} = 59482.70kWh. The total daily electricity purchase cost is Z_{day} = 35126.95CNY. Table 1 shows the microgrid's electricity purchase volume, total daily electricity purchase amount, and total electricity cost. Table 2 shows the charging and discharging energy of the energy storage system over the specified time period, as well as the storage energy at 00:00 and 24:00.

Table 1 Purchased Electricity of the Microgrid, Total Daily Purchased Electricity and Total Electricity Cost

Time Interval	Purchased electricity/kWh	Time Interval	Purchased electricity/kWh	Time Interval	Purchased electricity/kWh
10:00-10:10	0.00	12:00-12:10	486.40	14:00-14:10	0.00
16:00-16:10	394.93	18:00-18:10	636.98	20:00-20:10	0.00
Total daily purchased electricity	59482.70	Total daily electricity cost (CNY)	35126.95		

Table 2 Charge and Discharge Energy of Energy Storage in Specified Intervals, Stored Energy at 00:00 and 24:00

Time Interval	Charging energy/kWh	Discharging energy/kWh	Time Interval	Charging energy/kWh	Discharging energy/kWh
00:00-04:00	4500.00	0.00	04:00-08:00	833.33	6365.84
08:00-12:00	4787.96	1703.00	12:00-16:00	5286.04	91.10
16:00-20:00	0.00	5780.13	20:00-24:00	3333.33	2859.87
Stored energy at 00:00	6000.00		Stored energy at 24:00	6000.00	

The results indicate that under the condition of fully known load and photovoltaic forecast for the typical day, the optimal microgrid scheduling presents an obvious "charge at low price and discharge at high price" feature: concentrated power purchase to charge energy storage during early morning low-price intervals; priority consumption of photovoltaic surplus

and supplementary charging of energy storage at noon; energy storage discharge to supply most of the load during evening high-price intervals, and the grid purchased electricity in high-price periods is suppressed to a low level.
The total purchased electricity is 59482.70 kWh with a cost of 35126.95 CNY. Without energy storage configuration, the electricity purchase cost to meet the same load demand is 48052.05 CNY. After introducing energy storage, the daily cost is reduced by 12925.10 CNY, with a cost saving rate of 26.90%. The charge and discharge energy of energy storage in all intervals are within allowable ranges, and the stored energy returns to 6000 kWh at both 00:00 and 24:00, which verifies the physical feasibility of the scheduling scheme.

2.8 Economic Analysis

To evaluate the operation economy of energy storage equipment, a benchmark case without energy storage is set. In the no-storage case, photovoltaic power generation is used to meet community load preferentially; the insufficient power is supplemented by the external grid, and surplus photovoltaic power will not be stored.
The total daily electricity purchase cost of the benchmark case without energy storage is $Z_{base} = 48052.05$CNY. The total daily electricity purchase cost of the energy storage optimization scheme is $Z_{opt} = 35126.95$CNY. Therefore, the cost saved by energy storage optimization is $\Delta Z = Z_{base} - Z_{opt} = 48052.05 - 35126.95 = 12925.10$CNY. The cost saving rate is $r = \frac{\Delta Z}{Z_{base}} \times 100$. Table 3 compares the energy storage optimization scheme with the baseline scheme without energy storage.

Table 3 Comparison between Energy Storage Optimization Scheme and Benchmark Scheme without Energy Storage

Index	Benchmark scheme without energy storage	Energy storage optimization scheme	Variation
Total daily purchased electricity/kWh	61789.94	59482.70	-2307.24
Total daily electricity purchase cost/CNY	48052.05	35126.95	Saved 12925.10
Total charging energy of energy storage/kWh	0	20740.67	Increased 20740.67
Total discharging energy of energy storage/kWh	0	16799.94	Increased 16799.94
Total curtailed photovoltaic energy/kWh	0.00	0.00	0.00
Electricity purchase cost saving rate	—	26.90%	—

3 ESTABLISHMENT AND SOLUTION OF INTRA-DAY SCHEDULING MODEL

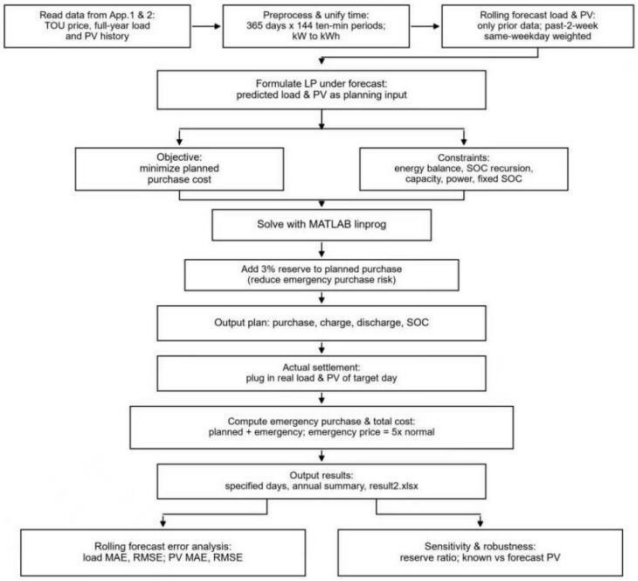


Figure 3 Flowchart of the Day-by-Day Rolling Model

The day-by-day rolling model adopts day-by-day linear programming for solution. The electricity price remains identical every day, while load and photovoltaic power change day by day. The microgrid formulates the daily planned electricity purchase strategy at 00:00 every day, and guarantees that power supply shall not be lower than load demand. In case of power shortage, emergency electricity is purchased at five times the normal electricity price. On the basis of the intra-day model, the rolling plan is formulated day by day, the emergency power purchase mechanism is introduced, and finally the total annual electricity purchase cost and results of specified dates are summarized. Figure 3 shows the flowchart of the daily rolling model.

3.1 Load Forecasting Model Based on Same-Week Historical Data with Damping Deviation Correction

Step1: Base forecasting. Residential electricity consumption has obvious weekly periodic characteristics. Therefore, the actual load data of the same weekday in the previous week and the week before last are adopted for forecasting. The base load forecast value of the t-th interval on day n is:

$$P_{0,t}^{n}=\frac{2}{3}P^{n-7,t}+\frac{1}{3}P^{n-14,t} \tag{32}$$

where: $P^{n-7,t}$: actual load power of the t-th interval on the same weekday one week before the target day; $P^{n-14,t}$: actual load power of the t-th interval on the same weekday two weeks before the target day; $\frac{2}{3}$ and $\frac{1}{3}$: forecast weights of corresponding historical dates. Since data closer to the target day usually has higher reference value, a larger weight is assigned to the data of the previous week.

Step2: Calculation of historical forecast deviation. Only using historical data of the same weekday for weighted average assumes that the recent load level remains stable. However, residential load may have a gradual rising or falling trend, which leads to systematic deviation in the base forecast. For day $n-i$ before the target day, base forecasting is performed using the same data of the previous week and the week before last, and its historical forecast deviation is:

$$e^{n-i,t}=P^{n-i,t}-\left(\frac{2}{3}P^{n-i-7,t}+\frac{1}{3}P^{n-i-14,t}\right) \tag{33}$$

where: $P^{n-i,t}$: actual load of the t-th interval on day $n-i$; The expression in parentheses represents the base forecast for day $n-i$; $e^{n-i,t}>0$: the historical forecast underestimates the actual load; $e^{n-i,t}<0$: the historical forecast overestimates the actual load.

Step3: Damping deviation correction. The average value of historical forecast deviations of the most recent m days is:

$$\overline{e}^{n,t}=\frac{1}{m}\sum_{i=1}^{m} e^{n-i,t} \tag{34}$$

To avoid misjudging short-term random fluctuations as long-term load trends, a damping coefficient η_f is introduced, and the final load forecast value is obtained:

$$P_{r}^{n,t}=P_{0,t}^{n}+\eta_f\overline{e}^{n,t} \tag{35}$$

Substitute Eq.(34)–Eq.(35) into Eq.(36) to obtain the complete forecasting formula:

$$P_{r}^{n,t}=\frac{2}{3}P^{n-7,t}+\frac{1}{3}P^{n-14,t}+\frac{\eta_f}{m}\sum_{i=1}^{m}\left[P^{n-i,t}-\left(\frac{2}{3}P^{n-i-7,t}+\frac{1}{3}P^{n-i-14,t}\right)\right] \tag{36}$$

The parameter settings in this paper are:

$$m=3,\eta_f=0.5 \tag{37}$$

where $m=3$ means the forecast deviation of the most recent 3 days before the target day is used for correction; $\eta_f=0.5$ means only partial correction is performed on the historical average deviation, to prevent short-term random fluctuations from being misidentified as long-term trends.

When the actual load of recent days is generally higher than the base forecast, Eq.(34) increases the load forecast of the target day; when the actual load is generally lower than the base forecast, Eq.(34) reduces the load forecast of the target day accordingly.

3.2 Conversion of Forecasted Load Power to Interval Electric Energy

The power forecast value obtained from Eq.(32) is in kW. Since purchased electricity and energy storage charge-discharge energy in the electricity purchase optimization model are measured in kWh, the forecasted load power is converted into electric energy within the 10-minute interval:

$$\hat{L}_{n,t}=P_{r}^{n,t}\Delta t,\Delta t=\frac{1}{6} \tag{38}$$

The photovoltaic power of the target day is directly read from Appendix 2 according to the model setting, denoted as $P_{pv}^{n,t}$. Its corresponding 10-minute photovoltaic energy is:

$$R_{n,t}=P_{pv}^{n,t}\Delta t \tag{39}$$

For symbol simplification, $\hat{L}_{n,t}$ and $R_{n,t}$ are used to represent the forecasted load energy and known photovoltaic energy input into the planning optimization model in the subsequent content.

3.3 Planned Electricity Purchase Optimization Model

Considering the risk of underestimation in load forecasting and the fact that emergency electricity price is 5 times the normal price, a 3% safety margin is added to the planned purchased electricity obtained by linear programming:

$$G_t^p=(1+\delta_G)G_t^* ,\delta_G=0.03 \tag{40}$$

where G_t^* is the original purchased electricity obtained by the planning optimization model, and G_t^p is the final implemented planned purchased electricity. This correction reduces the emergency power purchase risk when the actual load is higher than the forecast value. If the increased planned electricity is not actually consumed, it is regarded as wasted electricity without extra charge.

3.4 Solution of Model

Step1: Model solution workflow. In this paper, the rolling approach is adopted in MATLAB to solve Problem 2. For each target day within the result period, the following steps are executed repeatedly: Read the historical load data of the same weekday in the previous week and the week before last of the target day.
Calculate the load forecast values of 144 time periods on the target day according to Equation (32). Obtain the planned purchased electricity, energy storage charging power, discharging power and state of stored energy.
Raise the overall planned purchased electricity by 3%; substitute the actual load and photovoltaic data of the target day; calculate the actual power shortage in each time period; calculate the emergency electricity purchase cost at 5 times the electricity price for the power shortage; summarize the electricity purchase cost on the target day and within the result period.
Step2: Model solution. Table 4 shows the purchased electricity in specified time periods and the daily total purchased electricity and electricity purchase cost on four specified dates.

Table 4 Purchased Electricity in Specified Time Periods

Time period	2025.03.20	2025.06.21	2025.09.23	2025.12.21
10:00-10:10	0.00	0.00	0.00	0.00
12:00-12:10	497.64	0.00	374.44	917.69
14:00-14:10	0.00	0.00	0.00	0.00
16:00-16:10	555.29	147.71	561.09	840.29
18:00-18:10	718.64	0.00	803.50	727.20
20:00-20:10	0.00	0.00	0.00	0.00
Total purchased electricity /kWh	68467.98196	34462.50127	68691.92344	96853.63474
Total electricity purchase cost /CNY	41230.09885	19216.27851	42604.61389	61628.72448

Table 5 presents the charging and discharging electricity of the energy storage equipment in 6 time periods on the four specified dates. The stored energy at 00:00 and 24:00 of each day is 6000 kWh. Since actual data are adopted to formulate the plan in this problem, the power supply is always no less than the load, so the emergency purchased electricity of the four specified dates is 0 kWh.

Table 5 Charging, Discharging Electricity and Stored Energy on Specified Dates

Time period	2025.03.20		2025.06.21		2025.09.23		2025.12.21	
	Charging /kWh	Discharging /kWh	Charging /kWh	Discharging /kWh	Charging /kWh	Discharging /kWh	Charging /kWh	Discharging /kWh
00:00-4:00	4500.00	0.00	0.00	0.00	4500.00	0.00	4500.00	0.00
4:00-8:00	833.33	6004.40	0.00	0.00	4320.00	6805.37	1666.67	1508.33
8:00-12:00	6341.53	2635.60	464.33	0.00	5146.94	1838.70	5833.33	7806.67
12:00-16:00	4671.22	280.33	10202.33	0.00	6089.06	457.09	7675.64	2302.27
16:00-20:00	0.00	5744.01	0.00	6097.54	0.00	5687.31	0.00	5697.56
20:00-24:00	5333.33	2895.99	5333.33	2542.46	5333.33	2952.69	5333.33	2942.44
Stored energy at 00:00 /kWh	6000.00	—	6000.00	—	6000.00	—	6000.00	—
Stored energy at 24:00 /kWh	6000.00	—	6000.00	—	6000.00	—	6000.00	—

The annual solution results show that under this scheme, the total electricity purchase cost is 14218437.88 CNY, the planned purchased electricity is about 20830209.6 kWh, and the emergency purchased electricity is reduced to 377819.0 kWh. Compared with the scheme without energy storage, the cost saving rate is approximately 22.32%. Sensitivity analysis indicates that a higher adjustment ratio does not always yield better performance. When the ratio is set to 0%, the emergency purchased electricity is relatively high. The total cost reaches the minimum at the ratio of 3%. If the ratio continues to increase, the growth of planned electricity purchase cost will exceed the saved emergency purchase cost, leading to a rise in total expenditure.

4 CONCLUSIONS

This paper constructs intra-day deterministic and day-by-day rolling economic dispatching models for park microgrids with distributed photovoltaic and energy-storage devices. The intra-day linear-programming model takes the minimum daily electricity-purchase cost as the objective, and comprehensively considers energy balance, energy-storage capacity-power constraints and daily cyclic state constraints. Simulation results reveal that the energy-storage system realizes obvious “low-price charging and high-price discharging” operation characteristics and effectively cuts the microgrid electricity-purchase expenditure; among all parameters, charge-discharge efficiency exerts the most prominent influence on economic benefits. On this basis, a day-by-day rolling dispatching framework is established. Combined with same-week weighted load forecasting and deviation damping correction, a 3% safety margin for planned electricity purchase is introduced to balance planned cost and emergency power-purchase risk. The annual-scale calculation verifies that the proposed modelling framework can adapt to load fluctuation in practical scenarios, which possesses favourable feasibility for the engineering operation of park-type microgrids. The forecasting method only uses historical periodic data and ignores meteorological influence factors, and the model does not consider energy-storage life decay cost. Future work

will introduce meteorological information to raise prediction precision and further optimize the model for practical microgrid dispatching scenarios.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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