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Computer-Assisted Wiring Optimization Method for Photovoltaic Power Plant Area

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Abstract: At present, the system wiring method and construction in the photovoltaic power plant area are arbitrary and many design schemes reflect the designers' own habit. In addition, the economic benefit of different cable laying routes and method is not considered in the design stage. To solve these problems, the connection type, length proportion and cable specification of the primary system in the photovoltaic power plant area are scientifically optimized or selected and the expectation formulas of economic indicators for a variety of photovoltaic power stations are proposed on the basis of theoretical analysis; the mathematical and statistical calculation and enumeration method assisted with computer software are employed to obtain the recommended value of wiring lengths of various cables in this paper. Oriented to the three indicators in connection with cables, i.e. minimum installation cost, maximum total system revenue and minimum Levelized Cost of Energy (LCOE), and taking the selection specification, value and construction cost of cables as the input conditions, these expectation formulas can automatically generate the CAD wiring diagram and cable inventory according to the finally summarized computer operation logic diagram under the conditions where the corresponding computer software is obtained presumably, so that the technical data such as final output design drawing and cable inventory will be the most economic design scheme as expected by the formulas. Furthermore, in the process of theoretical analysis, some variables and principles present in the formulas are reasoned, calculated and demonstrated in a scientific way and the theoretical basis herein is improved accordingly. Introduction of theoretical formulas can guide the computer software developers to write programs for the schemes herein and finally work out cabling design software oriented for optimization of economic benefit for photovoltaic power plant areas.

Keywords: Photovoltaic Power Plant Area, Wiring Length, Installation Cost, Total System Revenue, LCOE, Computer-Assisted

1. Introduction

"Lowering the LCOE and realizing grid parity" is the target that has been assiduously sought by the people dedicated to photovoltaic (PV) power generation industry since its birth. [1] It can be seen from the calculation formula that lowering the LCOE can be realized by reducing the installation cost, increasing the power generation (i.e. system revenue), decreasing operation and maintenance (O&M) cost and lowering the financing cost. [2] The wiring of PV power plant area mentioned in this paper is related to the data and indicators of installation cost and power generation covered by the LCOE. Other indicators such as O&M cost and financing cost will not be studied and discussed herein. By saving the cables or adjusting the proportion of cables with different specifications, building mathematical calculation model, and using the enumeration and operation method assisted with computer technology, the cables with different specifications are compared and selected at the premise of three indicators, i.e. minimum installation cost, maximum total system revenue and minimum LCOE, so as to get the balance point (i.e. where the minimum LCOE is minimum) between reduction in installation cost and increase in generating capacity through calculation. Meanwhile, an independent formula is worked out for the installation cost and system total revenue, thereby the design can use the two indicators to independently generate CAD wiring diagram and cable inventory to meet the different investment demands in different perspectives. [3, 4]

2. Description to Computer-Assisted Wiring Optimization Method

For large ground PV power plant area, the mode of connection is divided into three types: serial, centralized and centralized-distributed [5]. Below the serial type PV power plant area is taken as an example to describe the wiring optimization method and then the optimization method for all types of PV power station. Under the computer-assisted condition, full play is given to the powerful drawing recognition, enumerative operation and automatic plotting capacity of computer. Then, the pre-plotted CAD drawing with landform background is input into the computer and the computer automatically recognizes the possible installation locations of inverter and combiner box. At the premise where the inverter-combiner unit is preset by the designer, the possible locations of all inverter and combiner box are subjected to enumerative operation to generate all possible wiring diagrams and all possible cable lengths, and automatically generate CAD wiring diagram and cable inventory according to the output result as required by the calculation formula. The schematic diagram is as follows:

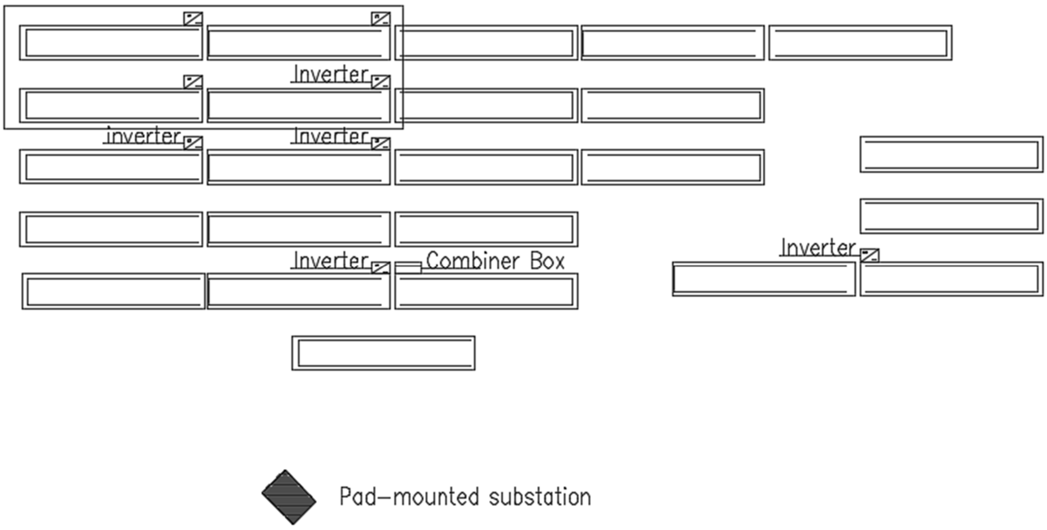

Figure 1. *Combiner Unit of Serial Type PV Power Station.*

Figure 1 indicates a combiner unit of a PV array in a serial type PV power station and the black part is where is located the Pad-mounted substation, which is arranged in the geometric center of PV array on the principle of minimizing the loss and cost; the green part is the combiner box containing 6 incoming lines and 1 combiner unit; the purple part is the inverter of 8 incoming lines and 8 outgoing lines; and the orange part is PV support group, of which the shape and size are predetermined by the designer. The PV support group is connected with the inverter via a DC cable, the inverter and the combiner box are connected via an AC incoming cable, and the combiner box is connected with the Pad-mounted substation via an AC outgoing cable.

For the inverter, the black frame is an inverter unit, namely the inverter can appear at the orange part only in the inverter unit; since in the mode of 6 incoming lines and 1 inverter, the maximum number of inverters in the above figure is 6; the combiner box may appear at the location possibly for all inverters, but it will be within the combiner unit as shown above; and the Pad-mounted substation is fixed in the geometric center of the array and its position is considered to remain unchanged.

After the computer automatically recognizes the drawing, the possible locations of all inverters and combiner boxes can be arranged in the serial type to automatically generate multiple arrangement diagrams, record the lengths of DC cable, AC incoming cable and AC outgoing cable and finally obtain a CAD drawing and output it for the designer and at the same time, calculate out the cable inventory according to the result from the algorithm expectation formula. The computer algorithm expectation formula will be introduced below. Meanwhile, the volume of new data employed by the formula will be explained or demonstrated to improve the argument for the algorithm formula.

3. Computerized Algorithm of Optimized Wiring of PV Power Station

For the large-scale ground PV power stations, three types of PV power station, i.e. serial, centralized, centralized-distributed, are introduced above. Below will be given the computerized algorithms of the optimized wiring for the three types and for each algorithm, there are three expectation formula for minimum installation cost, maximum system total revenue and minimum LCOE, respectively; in other words, there are 9 sets of algorithm formula to be compiled into the computer-assisted software to meet the investment demand in different perspectives.

3.1. Computerized Algorithm of Optimized Wiring of Serial Type PV Power Station

3.1.1. Expectation Formula for Minimum Installation Cost of Optimized Wiring of Serial PV Power Station

$$P = min\left[\frac{P_1*L_1+P_2*L_2+P_3*L_3}{W*10^6}\right] \quad (1)$$

P_is the installation cost of cables (computer output value, minimum value), yuan·W^{-1}

P_1 is the cost of combiner box AC incoming cables (price + construction & erection expense, user input value), yuan ·m^{-1}

P_2 is the cost of combiner box AC outgoing cables (price + construction & erection expense, user input value), yuan ·m^{-1}

P_3 is the cost of inverter DC incoming cables (price +construction & erection expense, user input value), yuan ·m^{-1}

L_1 is the length of combiner box AC incoming cables (computer output value), m

L_2 is the length of combiner box AC outgoing cables (computer output value), m

L_3 is the length of inverter DC incoming cables (computer output value), m

W is the installed capacity of PV array (user input value), MW

3.1.2. Expectation Formula for Maximum Total Revenue of Optimized Wiring of Serial PV Power Station

$$P' = min[P_1' * L_1 + P_2' * L_2 + P_3' * L_3] \quad (2)$$

Where,

$$P_1' = P_1 + \sum_{n=1}^{25}(1+i)^{-n} * M_n \quad (3)$$

$$P_2' = P_2 + \sum_{n=1}^{25}(1+i)^{-n} * M_n' \quad (4)$$

$$P_3' = P_3 + \sum_{n=1}^{25}(1+i)^{-n} * M_n'' \quad (5)$$

$$M_n = k * 3 * J * I_1^2 * R_1 * PR' * T_n \quad (6)$$

$$M_n' = k * 3 * J * I_2^2 * R_2 * PR' * T_n \quad (7)$$

$$M_n'' = k * J * RT * I_3^2 * R_3 * PR' * T_n \quad (8)$$

P' is the total expense of cables for 25 years (computer output value, minimum discounted value), yuan

P_1' is the total expense of combiner box AC incoming cables for 25 years (computer output value, discounted value), yuan·m^{-1}

P_2' is the total expense of combiner box AC outgoing cables for 25 years (computer output value, discounted value), yuan·m^{-1}

P_3' is the total expense of inverter DC incoming cables for 25 years (computer output value, discounted value), yuan·m^{-1}

P_1 is the cost of combiner box AC incoming cables (price + construction & erection expense, user input value), yuan ·m-1

P_2 is the cost of combiner box AC outgoing cables (price + construction & erection expense, user input value), yuan ·m- By Chen Min[1]

P_2 is the cost of inverter DC incoming cables (price + construction & erection expense, user input value), yuan ·m^{-1}

L_1 is the length of combiner box AC incoming cables (computer output value), m

L_2 is the length of combiner box AC outgoing cables (computer output value), m

L_3 is the length of inverter DC incoming cables (computer output value), m

M_n is the value of power generation loss of combiner box AC incoming cables in year n (computer output value), yuan·m^{-1}

M_n' is the value of power generation loss of combiner box AC outgoing cables in year n (computer output value), yuan·m^{-1}

M_n'' is the value of power generation loss of inverter DC incoming cables in year n (computer output value), yuan·m^{-1}

J is the grid purchase price (user input value), yuan ·kWh^{-1}

i is the discount rate (user input value),%

I_1 is the peak current of combiner box AC incoming cables (user input value), A

I_2 is the peak current of combiner box AC outgoing cables (user input value), A

I_3 is the peak current of inverter DC incoming cables (user input value), A

R_1 is the electrical resistivity of combiner box AC incoming cables (user input value), Ω·km^{-1}

R_2 is the electrical resistivity of combiner box AC outgoing cables (user input value), Ω·km^{-1}

R_3 is the electrical resistivity of inverter DC incoming cables (user input value), Ω·km^{-1}

RT is the efficiency of inverter (user input value),%

PR' is the efficiency of secondary system (user input value),%

T_n is the peak generation hours in year n (user input value), h

k is the conversion coefficient, defined as $T_n \cdot t^{-1}$, generally in the range of 0.55~0.65 (computer output value)

t is the local annual sunshine duration (user input value), h

3.1.3. Expectation Formula for Minimum LCOE of Optimized Wiring of Serial PV Power Station

$$P'' = min\left[\frac{(P_1*L_1+P_2*L_2+P_3*L_3)}{\sum_{n=1}^{25} W*PR*T_n*(1+i)^{-n}}\right] \quad (9)$$

Where,

$$PR = [(1000 * W * PR'' - 0.001 * k * I_3^2 * R_3 * L_3) * RT - 0.003 * k * (I_1^2 * R_1 * L_1 + I_2^2 * R_2 * L_2)] * \frac{PR'}{(1000*W)} \quad (10)$$

P'' is the LCOE of cables (computer output value, minimum discounted value), yuan [6]

P_1 is the cost of combiner box AC incoming cables (price + construction & erection expense, user input value), yuan ·m^{-1}

P_2 is the cost of combiner box AC outgoing cables (price + construction & erection expense, user input value), yuan ·m^{-1}

P_3 is the cost of inverter DC incoming cables (price + construction & erection expense, user input value), yuan ·m^{-1}

L_1 is the length of combiner box AC incoming cables (computer output value), m

L_2 is the length of combiner box AC outgoing cables (computer output value), m

L_3 is the length of inverter DC incoming cables (computer output value), m

W is the installed capacity of PV array (user input value), MW

PR is the efficiency of system (computer output value),%

T_n is the peak generation hours in year n (user input value), h

i is the discount rate (user input value),%

PR'' is the efficiency of primary system (user input value),%

I_1 is the peak current of combiner box AC incoming cables (user input value), A

I_2 is the peak current of combiner box AC outgoing cables (user input value), A

I_3 is the peak current of inverter DC incoming cables (user input value), A

R_1 is the electrical resistivity of combiner box AC incoming cables (user input value), $\Omega \cdot km^{-1}$

R_2 is the electrical resistivity of combiner box AC outgoing cables (user input value), $\Omega \cdot km^{-1}$

R_3 is the electrical resistivity of inverter DC incoming cables (user input value), $\Omega \cdot km^{-1}$

RT is the efficiency of inverter (user input value), %

k is the conversion coefficient, defined as $T_n \cdot t^{-1}$, generally in the range of 0.5~0.6 (computer output value)

t is the local annual sunshine duration (user input value), h

3.2. Computerized Algorithm of Optimized Wiring of Centralized Type PV Power Station

3.2.1. Expectation Formula for Minimum Installation Cost of Optimized Wiring of Centralized Type PV Power Station

$$P = min\left[\frac{P_3*L_3+P_4*L_4}{W*10^6}\right] \quad (11)$$

P is the installation cost of cables (computer output value, minimum value), yuan$\cdot W^{-1}$

P_3 is the cost of combiner box DC incoming cables (price + construction & erection expense, user input value), yuan $\cdot m^{-1}$

P_4 is the cost of combiner box DC outgoing cables (price + construction & erection expense, user input value), yuan $\cdot m^{-1}$

L_3 is the length of combiner box DC incoming cables (computer output value), m

L_4 is the length of combiner box DC outgoing cables (computer output value), m

W is the installed capacity of PV array (user input value), MW

3.2.2. Expectation Formula for Maximum Total Revenue of Optimized Wiring of Centralized Type PV Power Station

$$P' = min[P_3' * L_3 + P_4' * L_4] \quad (12)$$

Where,

$$P_3' = P_3 + \sum_{n=1}^{25}(1+i)^{-n} * M_n'' \quad (13)$$

$$P_4' = P_4 + \sum_{n=1}^{25}(1+i)^{-n} * M_n''' \quad (14)$$

$$M_n'' = k * J * RT * I_3^2 * R_3 * PR' * T_n \quad (15)$$

$$M_n''' = k * J * RT * I_4^2 * R_4 * PR' * T_n \quad (16)$$

P' is the total expense of cables for 25 years (computer output value, minimum discounted value), yuan

P_3' is the total expense of combiner box DC incoming cables for 25 years (computer output value, discounted value), yuan$\cdot m^{-1}$

P_4' is the total expense of combiner box DC outgoing cables for 25 years (computer output value, discounted value), yuan$\cdot m^{-1}$

P_3 is the cost of combiner box DC incoming cables (price + construction & erection expense, user input value), yuan $\cdot m^{-1}$

P_4 is the cost of combiner box DC outgoing cables (price + construction & erection expense, user input value), yuan $\cdot m^{-1}$

L_3 is the length of DC combiner box DC incoming cables (computer output value), m

L_4 is the length of DC combiner box DC outgoing cables (computer output value), m

M_n'' is the value of power generation loss of combiner box DC incoming cables in year n (computer output value), yuan$\cdot m^{-1}$

M_n''' is the value of power generation loss of combiner box DC outgoing cables in year n (computer output value), yuan$\cdot m^{-1}$

J is the grid purchase price (user input value), yuan $\cdot kWh^{-1}$

i is the discount rate (user input value),%

I_3 is the peak current of combiner box DC incoming cables (user input value), A

I_4 is the peak current of combiner box DC outgoing cables (user input value), A

R_3 is the electrical resistivity of combiner box DC incoming cables (user input value), $\Omega \cdot km^{-1}$

R_4 is the electrical resistivity of combiner box DC outgoing cables (user input value), $\Omega \cdot km^{-1}$

RT is the efficiency of inverter (user input value), %

PR' is the efficiency of secondary system (user input value),%

T_n is the peak generation hours in year n (user input value), h

k is the conversion coefficient, defined as $T_n \cdot t^{-1}$, generally in the range of 0.5~0.6 (computer output value)

T is the local annual sunshine duration (user input value), h

3.2.3. Expectation Formula for Minimum LCOE of Optimized Wiring of Centralized Type PV Power Station

$$P'' = min\left[\frac{(P_3*L_3+P_4*L_4)}{\sum_{n=1}^{25} W*PR*T_n*(1+i)^{-n}}\right] \quad (17)$$

$$\text{Where, } PR = [1000 * W * PR'' - 0.001 * k * (I_3^2 * R_3 * L_3 + I_4^2 * R_4 * L_4)] * \frac{RT*PR'}{(1000*W)} \quad (18)$$

P'' is the LCOE of cables (computer output value, minimum discounted value), yuan

P_3 is the cost of combiner box DC incoming cables (price + construction & erection expense, user input value), yuan $\cdot m^{-1}$

P_4 is the cost of combiner box DC outgoing cables (price + construction & erection expense, user input value), yuan $\cdot m^{-1}$

L_3 is the length of DC combiner box DC incoming cables (computer output value), m

L_4 is the length of DC combiner box DC outgoing cables (computer output value), m

W is the installed capacity of PV array (user input value), MW

PR is the efficiency of system (computer output value), %

T_n is the peak generation hours in year n (user input value), h

i is the discount rate (user input value), %

PR'' is the efficiency of primary system (user input value), %

I_3 is the peak current of combiner box DC incoming cables (user input value), A

I_4 is the peak current of combiner box DC outgoing cables (user input value), A

R_3 is the electrical resistivity of combiner box DC incoming cables (user input value), $\Omega\cdot km^{-1}$

R_4 is the electrical resistivity of combiner box DC outgoing cables (user input value), $\Omega\cdot km^{-1}$

RT is the efficiency of inverter (user input value), %

PR' is the efficiency of secondary system (user input value),%

k is the conversion coefficient, defined as $T_n \cdot t^{-1}$, generally in the range of 0.5~0.6 (computer output value)

t is the local annual sunshine duration (user input value), h

3.3. Computerized Algorithm of Optimized Wiring of Centralized-Distributed Type PV Power Station

The calculation formula of centralized-distributed type PV power station is identical to that of the centralized type PV power station, which may be completely referred to the formula and calculation methods in Section 2.2 herein.

4. Demonstration on the Definitions of Several Variables in the Computerized Algorithm Formula for Optimized Wiring

4.1. Demonstration on PR' Efficiency of Secondary System Used in the Expectation Formula for System Total Revenue

Take the formula (7) $M_n' = k * 3 * J * I_2^2 * R_2 * PR' * T_n$ as an example, it means the value of power generation loss of the combiner box AC outgoing cable in year n in the serial type PV power plant area. The model showed below is employed to demonstrate the accuracy of efficiency secondary system that is used in the formula:

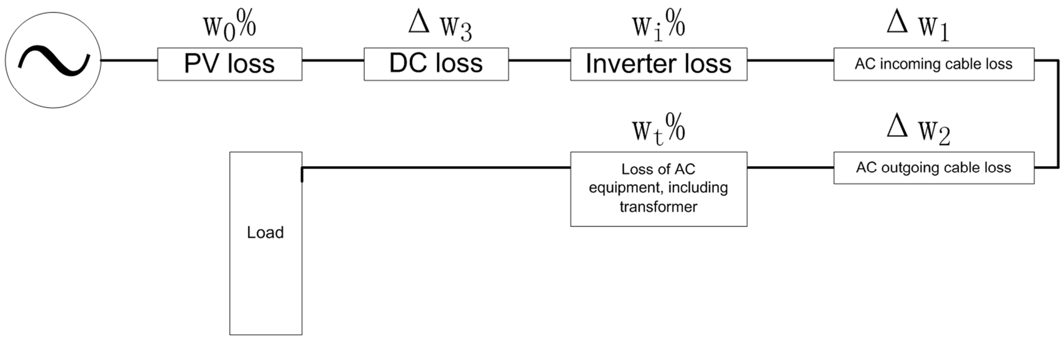

Figure 2. *Schematic Diagram of Electricity Loss of Serial Type PV Power Station.*

The loss obtained from formula (7) is ΔW_2, the definition of efficiency of secondary system can be determined by comparing the power gain obtained at the load before and after completely omitting the loss - the total loss of the equipment between the cable and the load - whether the requirement of system total revenue formula is met [7]. Before ΔW_2 is completely omitted, the formula of total power at the load is:

$$W_{before} = [(W_{total} * W_0\% - \Delta W_3) * W_i\% - \Delta W_1 - \Delta W_2] * W_t\% \quad (19)$$

After ΔW_2 is completely omitted, the equivalent diagram is as follows:

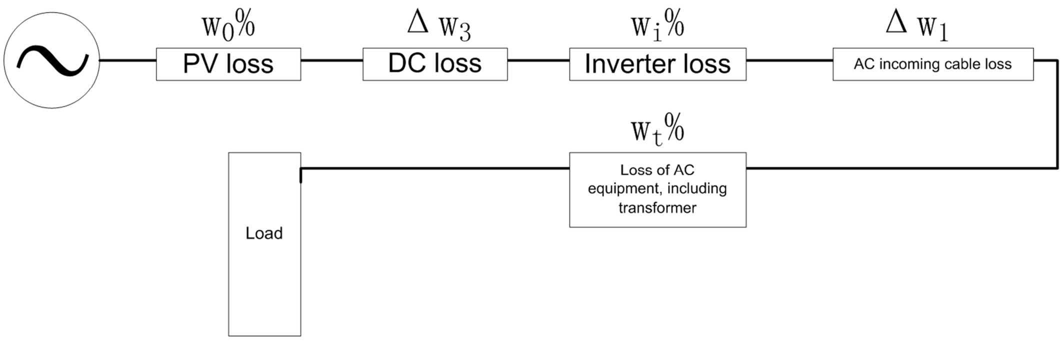

Figure 3. *Schematic Diagram of Electricity Loss Comparison of Serial Type PV Power Station.*

The formula of total power at the load is:

$$W_{\text{after}} = [(W_{total} * W_0\% - \Delta W_3) * W_i\% - \Delta W_1] * W_t\% \quad (20)$$

After formula (19) is deducted by formula (20), a difference of system total revenue after completely omitting the AC outgoing cables:

$$W_{after} - W_{before} = [(W_{total} * W_0\% - \Delta W_3) * W_i\% - \Delta W_1] * W_t\% - [(W_{total} * W_0\% - \Delta W_3) * W_i\% - \Delta W_1 - \Delta W_2] * W_t\% = \Delta W_2 * W_t\% \quad (21)$$

Where, $\Delta W_2 = k * 3 * I_2^2 * R_2$, after comparing formula (21) and (7), it is known that *J* and *Tn* is the grid purchase price and the effective generation time, both being known constants, and the efficiency $PR^{'}$ of secondary is the percentage *Wt%* of losses of AC transformer and other AC equipment between *ΔW2* and the load. Therefore, the definition of efficiency of secondary system can completely meet the requirement of expected value for calculating the system total revenue. When calculating the loss value, the efficiency $PR^{'}$ of secondary system other than the efficiency *PR* of system is to be multiplied by.

4.2. Demonstration on Definition of Conversion Coefficient K in the Line Loss Formula

Take the sub-formula (8) $M_n^{''} = k * J * RT * I_3^2 * R_3 * PR^{'} * T_n$ of the expectation formula of system total revenue for the serial type PV power station as an example, its physical meaning lies in the value of power generation loss of DC cables in the serial type PV power plant area in year n, wherein J is grid purchase price, T_n is the peak power generating hours in year n, is the efficiency of secondary system demonstrated above, and the conversion coefficient k is defined as $k = T_n \cdot t^{-1}$, of which the accuracy is now demonstrated.

As is known to all, the output current of PV module is shown in an extremely irregular curve and it is impossible to determine a unified real-time value technically; therefore, a set of scientific algorithm is required to avoid this technical difficulty. Considering the experience in converting AC to effective value and the concept peak generation hours of PV power station, it can be assumed the PV power station would generate power at the peak power, namely Wp in the peak generation hours; in this case, there is a current effective value to guarantee the power generating system to maintain the power generation condition at its peak; however, according to the past experience in operating the PV power station, the voltage at the DC output end of PV modules could reach the maximum value in a short time of weak irradiation in the morning and remain a high stable level in the power generation process in all day long [8]. Therefore, the power/time curve of a PV power station is nearly consistent with its current/time curve; in other words, the real-time power is in direct proportion to its real-time current, wherein the proportional constant, namely peak voltage is calculated as follows:

$$p(t) = U * i(t) \quad (22)$$

$p(t), i(t)$are realt-time value and power, and the current curve is as shown below:

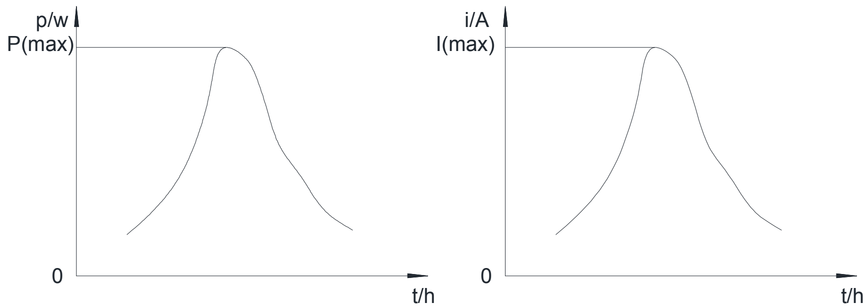

Figure 4. *Schematic Diagram of Real-Time Power/Current of PV Power Station.*

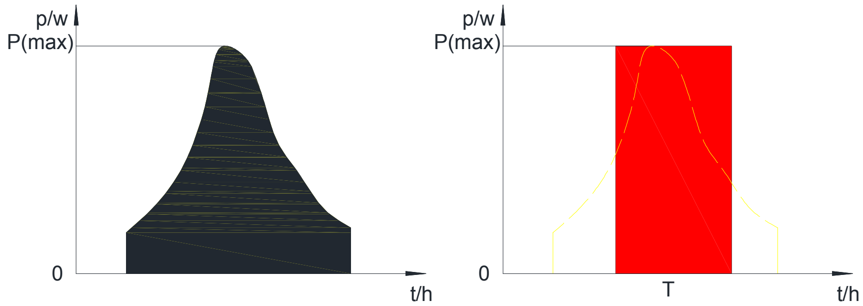

Figure 5. *Schematic Diagram of Power Generation of PV Power Station.*

As shown in the left hand side of Figure 5, the total power generation in a fixed time is the area covered by the power curve (area of black part); it converted to the power generation in peak generation hours, it is the area of red part covered by the rectangular block and the width T of rectangle is the peak generation hours.

According to the definition of current effective value, the following formula can be derived in combination with formula (23):

$$I^2Rt = R\int_0^t i^2(t)dt = \frac{R}{U^2}\int_0^t p^2\,(t)d(t) \qquad (23)$$

According to the definition of peak generation hours in Figure 5, a formula can be obtained as follows: $\int_0^t p\,(t)d(t) = P_{max} * T$,

It can be obtained

$$p(t) = \frac{P_{max}*T}{t} \qquad (24)$$

of which the physical meaning is as shown below:

Figure 6 indicates the physical meaning that the total power generation can be converted to integral value of effective power in the local annual irradiation duration as the integral width, namely the power in formula (24) can be the height coordinates of blue block and the blue area is equal to the black or red area in Figure 5, both representing the power generation; after substitution into formula (23), we can obtain

$$I^2Rt = \frac{R*P_{max}^2*T^2}{U^2*t} = I_{max}^2 * R * T^2/t = I_{max}^2 * R * T * T/t = k * I_{max}^2 * R * T \qquad (25)$$

I is current effective value, A

R is the electrical resistivity of conductor, Ω·km^{-1}

t is the local annual sunshine duration, h

P_{max} is the peak power, W

U is the peak voltage, V

I_{max} is the peak current, A

T is the peak generation hours, h

k is the conversion coefficient, defined as $T_n \cdot t^{-1}$, generally in the range of 0.5~0.6

It is can be seen from formula (25), when the peak generation hours is used to calculate the conductor heat value, a conversion coefficient is required, namely the conversion coefficient k=T/t, defined as the ratio between the annual peak generation hours and annual sunshine hours, generally in the range of 0.5~0.6, which depends on the local annual sunshine duration and the annual peak generation hours of PV power station, which will decrease progressively year by year [9] [10].

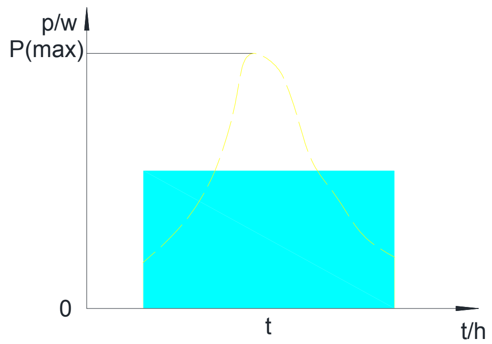

Figure 6. *Schematic Diagram of Comparison of Power Generation of PV Power Station.*

It can be demonstrated that the definition of conversion coefficient k is reliable and necessary.

4.3. Description of Efficiency PR'' of Primary System for the Expectation Formula of Minimum LCOE

It can be defined from the power supply position at W_0% in Figure 2 that the efficiency of primary system is $PR'' = W_0$%. This definition can be understood easily, namely the loss arising from PV modules before conversion to electric energy from these modules, including their serial matching, temperature and dust. This definition is mainly introduced for the convenience of formula writing and calculation.

At this point, all variables in the formula for optimized wiring of PV power plant area are defined clearly and the computer software can be used to calculate according to the above formula. It can be predicted that the final result would progress to the most economically optimal direction.

5. Operation Flow Chart of Optimized Wiring Computer Software

The operation process of optimized wiring computer software is as follows: first, the computer automatically recognizes the CAD PV array arrangement plan with landform background image, then the design selects the model and specification of PV power plant area equipment such as cable, inverter, combiner box, Pad-mounted substation, module and support; after calling the database, the computer makes it available to the designer for division of each inverter and combiner unit; then the computer begins to enumerate the possible installation position of inverter and combiner box, and according to the principle of permutation and combination, automatically plots a set of wiring diagram and count up the cable length for each case; when the enumerative operation is finished for all cases, the length of various cables used in the expectation algorithm formula, the CAD wiring diagram is generated automatically and the cable inventory is counted up at the same time.

The flow chart of software operation is as follows:

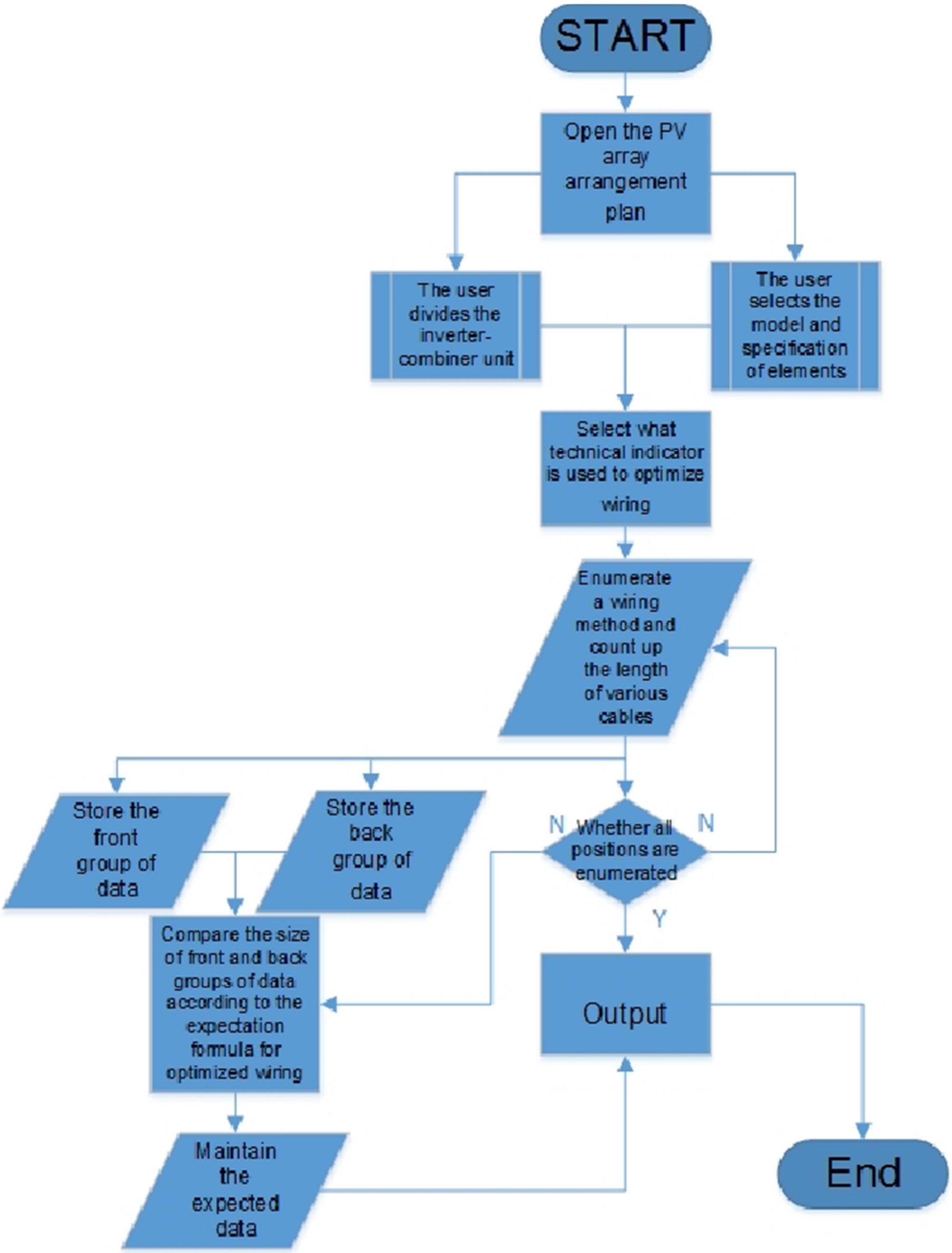

Figure 7. *Operation Flow Chart of Optimized Wiring Computer Software of PV Power Station.*

6. Conclusion

The computer-assisted optimized wiring and its core content lie in computerized algorithm. Focusing on the wiring characteristics of PV power plant area, the inverter and combiner box are regarded as mobile equipment in this paper. By means of the powerful enumerative operation capacity of computer, thousands of drawings are automatically plotted to generate the optimal result through comparison. Furthermore, the computer software can automatically distinguish the topographic map of PV array in the region, which the computer-assisted means is undoubtedly the optimal choice suitable for optimized wiring in various complex terrains. Not only can the computer-assisted optimized wiring software realize the wiring of PV power plant area in most economically manner, but also the CAD wiring diagram and cable inventory can be generated automatically and the workload in design is saved. The software can reduce both the construction cost and the design cost. Therefore, the software application can completely meet the actual demand and definitely provide help in refined design of PV power station, so that it is a necessary choice to enhance economic benefit of the system and provide vigorous support to lower the LCOE for large-scale ground PV power station design.

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