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分布式光伏发电在智能电网中的作用分析

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Role of Distributed Photovoltaic Generation in Smart Grid

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ABSTRACT This paper introduces the principle of distributed photovoltaic and discusses the feasibility of distributed grid-connected photovoltaic pv in the smart grid from perspectives of peak sharpening effect impacts on the low voltage distribution network node voltage and line voltage drop and impacts on the system load factor. Through theoretical analysis and example analysis the paper has obtained following conclusion: the distributed photovoltaic power generation system integrated into the smart grid can cut the load peak cut and plays an important role on the safe operation of the power grid and full use of the energy. For the low voltage distribution network it can boost the voltage slow the effects of reduced pressure drop and reduce the load rate of the overloaded lines in the system. In addition this system poses no threat to the voltage stability of the system.

KEY WORDS distributed photovoltaic power generation smart grid peak load shifting line voltage drop load rate

[1–7] 2

LV [8]

PV

[9–15]

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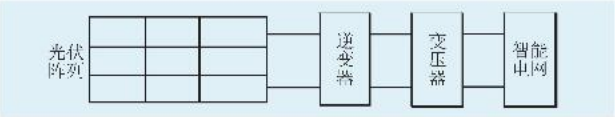

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Fig. 1 Photovoltaic grid-connected structure diagram

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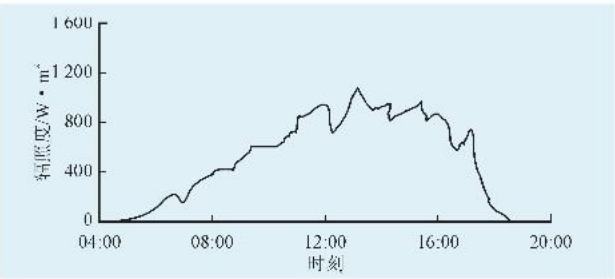

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Fig. 2 The light curve

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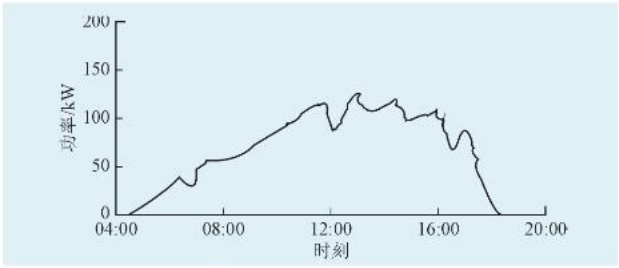

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Fig. 3 Output power of photovoltaic array

$$F_{3n}=\frac{P_n+\Delta P_{1n}}{P_{\max}+\Delta P_{2n}} \quad n\in \boldsymbol{T}$$

$\boldsymbol{T}$= 1 2 3 24 T

P_n $P_{\max}$

ΔP_{1n}

ΔP_{2n}

4

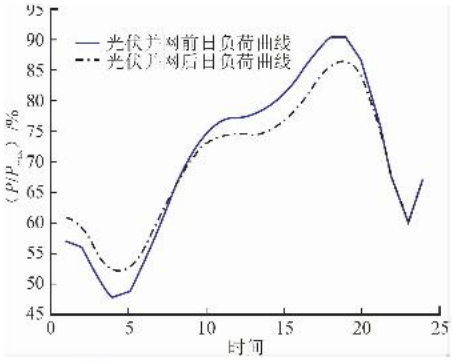

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Fig. 4 The daily load curve before and after photovoltaic grid-connected

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3.1

5 380 V

4N 4 4

n P_n+jQ_n n=1 2

N U_0=380 n

U_n n=1 2 N n n-1

l_n n=1 2 N

r x n

P_{Vn} n=1 2 N

m

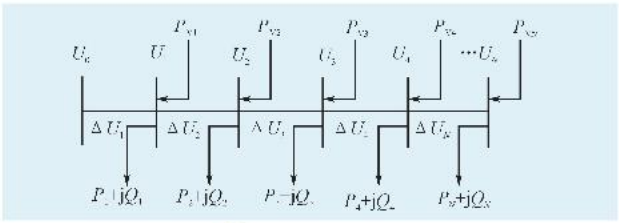

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Fig. 5 Low voltage transmission line

$$U_m=U_0-\sum_{k=1}^{m}\frac{\sum_{n=k}^{N}P_n-P_{Vn}\ rl_k+\sum_{n=k}^{N}Q_nxl_k}{U_{k-1}}\quad m\in \boldsymbol{W}$$

$\boldsymbol{W}$= 1 2 3 N T

m $m-1$

$$\Delta U_m=U_m-U_{m-1}=-\frac{\sum_{n=m}^{N}P_n-P_{Vn}\ rl_m+\sum_{n=m}^{N}Q_nxl_m}{U_{m-1}}$$

$m\in \boldsymbol{W}$ $\boldsymbol{W}$= 1 2 3 N T

$\sum_{n=m}^{N}P_n>\sum_{n=m}^{N}P_{Vn}$ $U_m-U_{m-1}<0$ $\sum_{n=m}^{N}P_n<\sum_{n=m}^{N}P_{Vn}$ $U_m-U_{m-1}>0$

$\sum_{n=m}^{N}P_n>\sum_{n=m}^{N}P_{Vn}$ $U_m-U_{m-1}<0$

3.2

5 20 4

5 LGJ-25 mm^2 $r+jx$= 1.131+j0.393 Ω/km 0.05 km

4 10 kW

PJF2-100/1.80/0.75-VE-A1 1.5 kW

2 1

4 1

2

2

1

1

1 3

6 7

1

Tab. 1 The contrast between voltage and pressure drop before and after photovoltaic grid-connected

接入点	光伏并网前		按方案1并网		按方案2并网	
编号	电压/V	压降/V	电压/V	压降/V	电压/V	压降/V
1	372.56	7.44	373.67	6.33	377.02	2.98
2	366.49	6.07	368.52	5.15	374.62	2.40
3	361.86	4.63	364.61	3.91	372.81	1.81
4	358.73	3.13	361.97	2.64	371.60	1.21
5	357.15	1.58	360.64	1.33	370.99	0.61

注:压降一栏对应的接入点编号表示此点与前一点间的压降

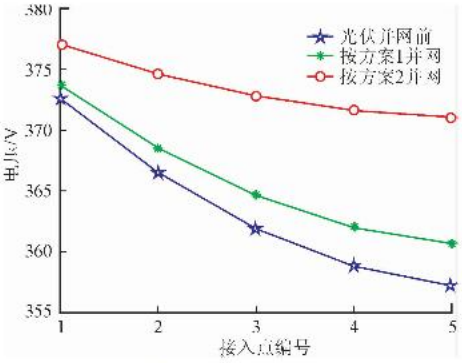

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Fig. 6 Voltage at each access point

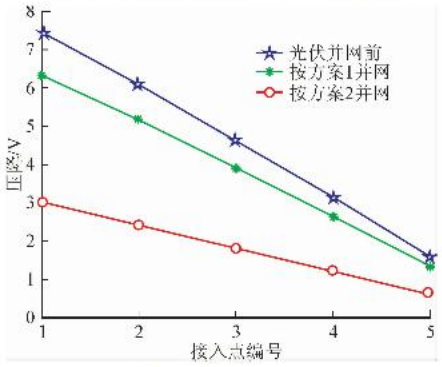

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Fig. 7 Pressure drop at each access point

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IEEE9

15%

2

3

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Tab. 2 Grid-connected photovoltaic capacity of each load node

节点编号	负荷有功/MW	光伏并网量/MW
5	12.5	18.75
6	90	13.5
7	35	5.25
8	100	15

3

Tab. 3 Node voltage and line loading rate before and after photovoltaic grid-connected

节点	节点电压/pu		线路	线路有功负载率/%	
编号	光伏并网前	光伏并网后	编号	光伏并网前	光伏并网后
1	1.038 59	1.038 42	4-1	57.1	33.6
2	1.042 79	1.044 09	7-5	32.4	37.7
3	1.053 26	1.054 43	7-2	83.8	73.5
4	1.005 93	1.007 06	7-8	32.2	29.4
5	1.022 00	1.023 48	9-3	43.4	43.2
6	1.031 75	1.034 00	9-6	24.9	29.0
7	1.010 00	1.010 00	5-4	35.5	24.8
8	1.010 00	1.010 03	6-4	22.4	13.0
9	1.010 00	1.010 02	8-9	21.5	17.8

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