A power peak load shifting mixing with solar energy solution for hybrid energy system of the telecommunication base station

Weifeng Kong
Renewable energy research institute
ZTE Corporation
Shenzhen China
kong.weifeng@zte.com.cn

Lingqiao Teng
Renewable energy research institute
ZTE Corporation
Shenzhen China
teng.lingqiao@zte.com.cn

Shaomin Zhang
Renewable energy research institute
ZTE Corporation
Shenzhen China
zhang.shaomin@zte.com.cn

Dedi Zhang
Renewable energy research institute
ZTE Corporation
Shenzhen China
zhang.dedi@zte.com.cn

Xian Liu
Renewable energy research institute
ZTE Corporation
Shenzhen China
liu.xian1@zte.com.cn

Bin Shao
Renewable energy research institute
ZTE Corporation
Shenzhen China
shao.bin5@zte.com.cn

***Abstract*—Some areas have poor mains facilities and sufficient solar energy,but the hybrid energy system of telecommunication base station of those areas can not run well and the cost of operation and maintenance is very high.This paper introduce a power peak load shifting mixing with solar energy solution(SE-PPLS) for hybrid energy system of telecom base station. Comparing with traditional power supply solution,this solution can help telecom operators reduce investment and OPEX.**

Keywords*—*power peak load shifting,hybrid energy system,solar energy

I. Introduction

For hybrid energy system of telecom base station of some areas, like some countries in south Asia or Africa, are frequently cut off and short everyday due to poor mains facilities, or the expensive price of electricity.However,these areas have sufficient solar energy.Taking Pakistan as an example, most of Pakistan is suitable for the development of photovoltaic system,especially in Sindh, Balochistan and Punjab department, there are more than 3000 hours of light time in a year, and solar radiation is 2 thousand kwh / square meter.

The traditional power standby supply solution for these areas is always using diesel generator to provide standby power for telecom base station,so that the construction and operation cost of the telecom base station is very high.Also, for another scene with high price of electricity,the mains grid has different power consumption periods in one day,e.g.: peak power period,ordinary power period and valley power period.Generally,the price electricity of the peak power period is 4 times the price of valley power period,and two times the price of ordinary power period,or even more for some area.But sufficient solar energy of these areas has not been applied well.

II. SE-PPLS SOLUTION FOR HYBRID ENERGY SYSTEM

A. The design principles of this solution:

In the case of power supply, battery charging function of the centralized supervision unit (CSU) of hybrid energy system supports power peak load shifting(PPLS): CSU will adjust different battery charging coefficients that stetted at different time periods.At the same time, combined with the solar modules, if the output of these modules will reach a certain threshold at any time when the solar energy is sufficient.This shows that these modules have the ability to carry on the load and charge the battery, and the CSU can control to close the rectifiers in order to reduce the use of the mains grid.

The control logic diagram of SE-PPLS solution as follows:

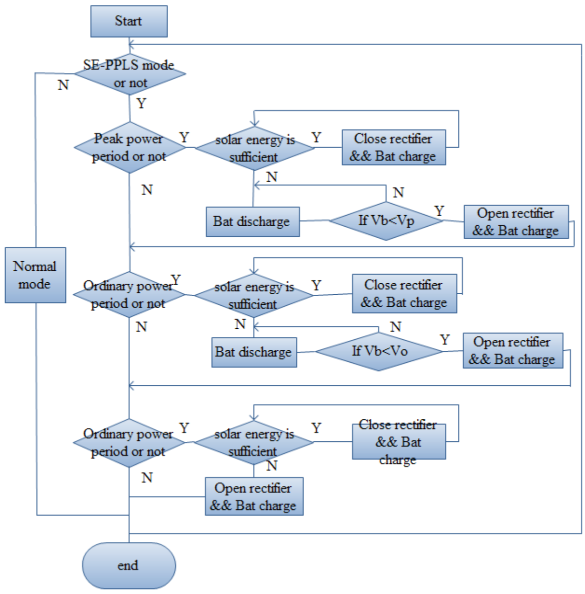

Fig.1. Control logic diagram

So that, by setting and adjusting parameters, solar energy resources can be used as much as possible to carry on the load and charge batteries at peak power period or ordinary power period during the daytime.And at valley power period of night, the battery can be charged by the mains electricity as much as possible to effectively reduce electricity charges.

B. Scenario analysis:

The following scenario of hybrid energy system with solar energy and mains supply:

First, for peak power period,due to sufficient solar energy at daytime,the centralized supervision unit (CSU) of hybrid energy system will control rectifiers sleep,try not to charge batteries or take load by using the mains grid.

1 Peak power period control strategy:

1) The CSU will control rectifiers to sleep,let batteries and photovoltaic module take load at the same time;

2) If solar energy is sufficient, solar module will carry on the load and charge batteries;

3) If solar energy is insufficient, batteries of site will carry on the load.In order to protect batteries,the CSU will waken rectifiers to control charging batteries by CC1 during the peak power period when the batteries voltage drop to the threshold voltage (Vp).

4) And mains can only take load due to the CC1 that can be set to zero default.

Second,for ordinary power period,this period is generally in the daytime,and also has sufficient solar energy.So,the control strategy of this period is similar to peak power period.They are different with battery charging coefficient and some threshold voltage,in order to adapt to different scenarios.

2 Ordinary power period control strategy:

1) The CSU will control rectifiers to sleep,let photovoltaic modules and batteries take load;

2) If solar energy is sufficient, solar module will carry on the load and charge batteries;

3) If solar energy is insufficient, batteries of site will carry on the load.In order to protect batteries,the CSU will waken rectifiers to control charging batteries by CC2 during the ordinary power period when the batteries voltage drop to the threshold voltage (Vo).

4) To avoid insufficient charge,the CC2 will be usually set less than normal charge coefficient.

Third,for Valley power period,because of insufficient solar energy,the CSU of hybrid energy system will take full advantage of the power of the mains grid to charge the batteries, especially at night.

3 valley power period control strategy:

The CSU will control charging the batteries by CC3;

Above all, for some scenarios that the mains grid is very scarce and short for one day, this solution can support take full advantage of the power of the Mains grid to charge the batteries by adjusting battery charging coefficient and some threshold voltage at any time.

Remarks:CC1:Battery charging coefficient 1 of Mains grid, as for CC2,CC3.

III. Effect of SE-PPLS Solution for Hybrid Energy System

This solution has been applied in some areas of South Asia and Africa. The following is the comparison of operation results between common solution and SE-PPLS solution for hybrid energy system in a certain area of Southeast Asia.

The configuration of hybrid energy system for those areas,as shown in Table1:

TABLE 1. SITE CONFIGURE

Load	Bat.Cap.[a]	Mains fail. Time/day[b]	Solar panel	Peak sun.time/day[c]
1KW	300AH	10 hours	4050wp	5KW/m2/day

[a] Bat.Cap.:Battery capacity;

[b] Mains fail. Time/day:Mains failure time per day;

[c] Peak sun.time/day:Peak sunshine time per day;

The following Fig.2 shows the distribution of energy import of hybrid energy system in some areas of South Asia in one day, and this areas used common solution to supply electricity.

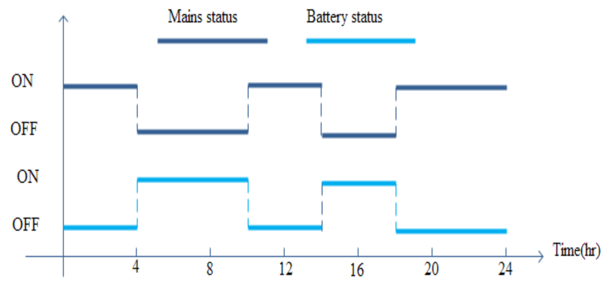

Fig.2. Distribution of energy in one day(common solution)

The following Fig.3 shows the distribution of energy import of hybrid energy system in one day that using the SE-PPLS solution in those areas of South Asia.The following table is a comparison between the two solutions of daily energy import of the hybrid energy system and electricity consumption.

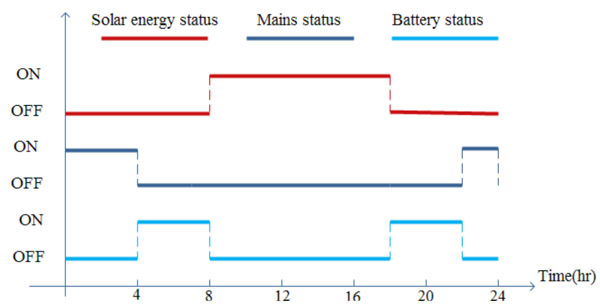

Fig.3. Distribution of energy in one day(SE-PPLS)

The following Fig.4 shows different charge coefficient under different power period by using SE-PPLS solution.

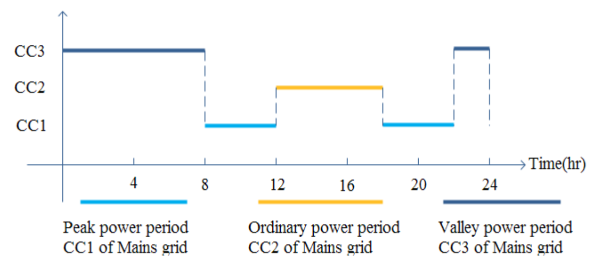

Fig.4. Charge coefficient in different period in one day

The following Table2. shows the electricity charge under different power period.

TABLE 2. ELECTRICITY CHARGES

	P.P.P.[e] (USD/KWH)	O.P.P.[f] (USD/KWH)	V.P.P.[g] (USD/KWH)
Elec.chg.[d]	0.26	0.17	0.13

d. Elec. chg.:Electricity charges ;

e. P.P.P.:peak power period;

f. O.P.P.:ordinary power period;

g. V.P.P.:valley power period;

TABLE 3. POWER GENERATION COMPARISON

Power supply solution	**Solar power gen./ day[h] (KWH)**	**Mains Con.in p.p.p./ day[i] (KWH)**	**Mains Con.in o.p.p./ day[j] (KWH)**	**Mains Con.in v.p.p./ day[k] (KWH)**	**Elec. chg. /day[l] (USD)**
SE-PPLS solution	15.5	0	0	9.1	1.2
Common solution	0	10	4	12	4.5

h. Solar power gen./day:Solar power generation per day;

i. Mains Con.in p.p.p./day:Mains consumption in peak power period per day;

j. Mains Con.in o.p.p./day:Mains consumption in ordinary power period per day;

k. Mains Con.in v.p.p./day:Mains consumption in valley power period per day;

l. Elec. chg. /day:Electricity charges per day;

Through the above Table3, under this configuration of the hybrid energy system in this areas, SE-PPLS solution not only can reduce the electricity charges by 4 times, but also reduce battery cycle and discharge time.It has a good effect in reducing OPEX.

IV. CONCLUSION

Through the above comparison,the power peak load shifting mixing with solar energy solution(SE-PPLS) can make the best of solar energy, cooperate with power peak load shifting of mains at the same time.It can reduce the dependence on Mains grid or DG by adding photovoltaic modules.From the long-term investment perspective,it can cut down CAPEX and OPEX for telecom operators.

REFERENCES

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