Cost Estimates of MJ Class HTS Superconducting Magnetic Energy Storage Magnet

Xiao Zhou, Yuejin Tang, Chi Zhang and Kang Gong

State Key Laboratory of Advanced Electromagnetic Engineering and Technology, Huazhong University of Science & Technology, Wuhan, China

Abstract **Various theorems and papers are written about cost estimation of Low Temperature Superconducting (LTS) magnets. Compared to LTS magnets, High Temperature Superconducting (HTS) Magnets have received more attention and research in recent years. Thus, High Temperature Superconducting (HTS) Magnet-ic Energy Storage System experiences a high-speed development. This paper focused on estimating the budgetary cost of High Temperature Superconducting Magnetic Energy Storage System (SMES), which using YBCO as the superconductor. The cost of SMES includes magnet cost, refrigeration system cost, power conditioning system cost and others. Through cost estimation, the optimal economic capacity allocation of SMES is discussed under different scenarios.**

I. Introduction

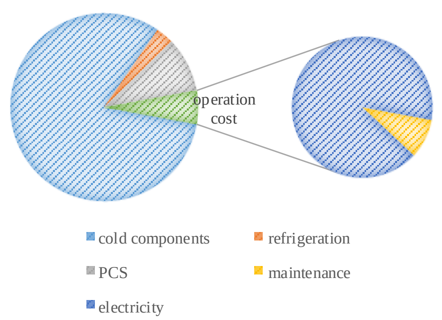
With the development of high-temperature superconducting technology, HTS SMES applications have received a lot of attention. Several 0.1-100 MJ SMES are developed and pre-researched. When designing the capacity and power of SMES, application scenarios and costare the basis considerations. In several specify scenarios, D-SMES is taken into consideration to reach a better control results, this requires the optimization of the SMES capacity and quantity configuration. Therefore, the economic analysis of SMES is one of the main analytical issues for SMES applications. Therefore, this article focused on evaluating the cost of HTS-SMES. First of all, a cost model has been established to estimate the construction costs and operating costs of SMES with the capacity ranging from 0.1 to 500MJ. Then, the optimal economic capacity-power allocation is analysed for serveral typical application scenarios. Finally, we make cost estimation based on present cost and analyse the cost changes from technological improvement and labor cost increase.

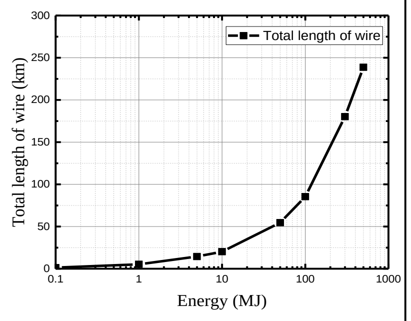
Ⅱ. Cost Modeling and Estimate Results

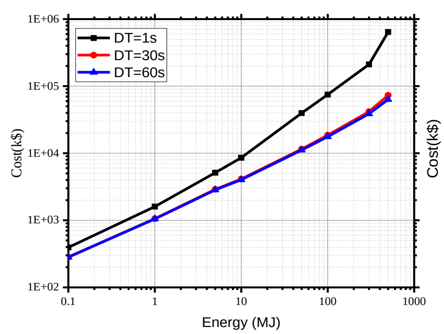
The cost consisted of equipment cost and operating cost, while equipment cost includes three major subsystems: 1) cold components 2) refrigeration and 3) power conditioning system (PCS). Operating cost mainly comes from maintenance and electricity usage.

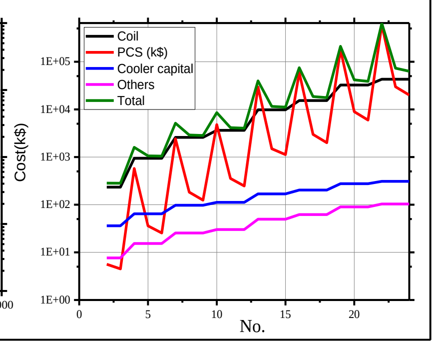
III. Estimate Results

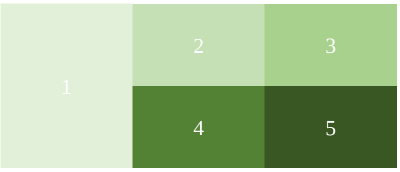
No.	ENERGY (MJ)	Power (kW)	Discharge Time(s)	Cooling power (RW)
1		155	1	27
2	0.1	5	30	27
3		3	60	27
4		854	1	110
5	1	32	30	110
6		17	60	110
7		4024	1	300
8	5	163	30	300
9		83	60	300
10		7995	1	420
11	10	316	30	420
12		165	60	420
13		49501	1	1140
14	50	1662	30	1140
15		833	60	1140
16		98921	1	1780
17	100	3320	30	1780
18		1667	60	1780
19		297380	1	3750
20	300	9950	30	3750
21		4988	60	3750
22		997035	1	4970
23	500	33277	30	4970
24		16653	60	4970









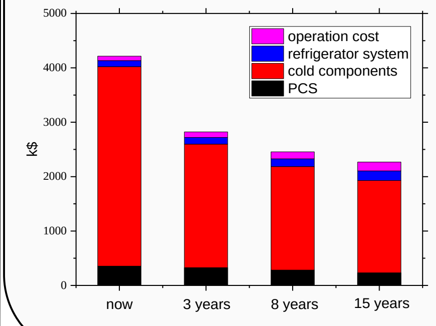


1. SMES number and parameter; 2. Cost composition pie chart; 3. Total length of wire with different energy;
4. Total costs with different energy (Dt=1s,Dt=30s.Dt=60s); 5. Cost composion of SMES

The capacity of SMES varies from 0.1MJ to 500MJ. And with three discharge time schemes (1s, 30s and 60s), the output power of this SMES varies from 3kW to nearly 1000MW. Ta-ble 2 shows the annual operating costs and annual costs of this series SMES

IV. Potential Cost Change

- ***Wire cost reduction from increasing production***
- ***Refrigeration system and PCS cost reduction***
- ***Labor costs increase***



Cost trend of SMES (10MJ/300kW)

V. Conclusions

This study introduced the cost composition of SMES, then estimated the cost of SMES with different capacities. Based on the estimated results, the optimal economic capacity allocation of SMES in some typical application scenarios were analyzed. Then, costs reductions from volume production and competition and costs increase from increased labor costs was analyzed, results show that costs are expected to improve over the next 15 years. It's worth mentioning that the optimal converter system collocation of different capacity SMES is also a worthy project, and further work will be carried out in the future.

EUCAS17-3LP4-05

zxywlwx@126.com