Survey on the Proposal of High-rise Building Embedded Pumped Storage as a New Dispersed Energy Storage and Water Conservation for Building Micro-grid and Large Cities

Jianmin Zhang¹, Qianzhang Zhang², Yijun Zhao³, Yubin Fang⁴

1 Hangzhou Dianzhi University, Hangzhou, China; 2. National Energy Distr. Energy Tech. R&D Center, Hangzhou, China

Introduction
Since the proposal of High-rise Building (HB) Embedded Pumped Storage (HBEPS) being proposed in 2013, an economic viability and optimal sizing study has been completed which assumes HBEPS as a building owner electricity payment saving tool to take full advantage of utility TOU tariff structure. The developed daily optimal operation model can use MILP to achieve the global optimum solution. The cost/pump/turbine main machines are made based on market investigation and the available initial investment range is estimated to check whether it can cover the pump/turbo/civil works in 8-10% annual interest rate and 10-12 return years based on the maximum daily saving; conventional design has been made including the quantity calculation and transition process simulation; further survey has been made to investigate the similar thought from patents, dissertation and papers, available reports or talks of great experts from state grid, and conventional Pumped Storage Hydroelectricity (PSH) design institute, building design institute, machine factory, university, etc. are invited or visited to query, argue or suggest this proposal. A few fundamental techniques are gradually focused, and the roles of HBEPS for building dispersed resources (BDR) and building micro-grid (BMG), and smart city (SC) are more and more clarified. In Mwh scale, HBEPS is very attractive for BDR/BMG/SC/SS. With its particular and unique utilization of height potential energy concurrent with the man-made high-rise building, HBEPS could never be taken to compare or compete with electrochemical storage techniques theoretically.

HB Resources and Potential in the World
From the statistical data, total number of building with height above 90m has reached more than 17383, 1/3 of them is located in China, USA has more than 2000. It is estimated that China has the HBES potential of 7.2GMWh, and USA 2.4GWh, respectively.

Existed Water Supply System and Three Proposed Multi-tank HBEPS Topo-connection

A concept of “High-rise Energy Storage Core (HESC)” with “High-rise Construction Tube (HCT)” by an architecture MSc thesis of DUT, Holland

Two similar proposals by DUT, Holland and AHEC, USA

AHEC USA holds a patent of 70 storey buildings with two 1514 m penstock, 40 Francis turbine generators up to 28,000MW.

HB Resources and Potential in the World

Roles in BDR/BMG/SC/SS

The energy storage capacity of HBEPS with roof tank volume and height of building

The height of building vs. roof tank volume to achieve 1 MW*h capacity of HBEPS

HB Resources and Potential in the World

Roles in BDR/BMG/SC/SS

The energy storage capacity of HBEPS with roof tank volume and height of building

The height of building vs. roof tank volume to achieve 1 MW*h capacity of HBEPS

HB Resources and Potential in the World

Roles in BDR/BMG/SC/SS

The energy storage capacity of HBEPS with roof tank volume and height of building

The height of building vs. roof tank volume to achieve 1 MW*h capacity of HBEPS

HB Resources and Potential in the World

Roles in BDR/BMG/SC/SS

The energy storage capacity of HBEPS with roof tank volume and height of building

The height of building vs. roof tank volume to achieve 1 MW*h capacity of HBEPS

HB Resources and Potential in the World

Roles in BDR/BMG/SC/SS

The energy storage capacity of HBEPS with roof tank volume and height of building

The height of building vs. roof tank volume to achieve 1 MW*h capacity of HBEPS


Generative purposes: 2.57 kWh/m²

Pumped storage purposes: 5.73 kWh/m²

China Standard: GB 50050-2012 Load code for the design of building structures

Generative purposes: 3.6 kWh/m²

Pumped storage purposes: 7.3 kWh/m²

New MILP for optimal daily operation of Jinmao Tower

Economic Evaluation

Hydro capacity: 17000kW, pump capacity: 2200 kW

Total machine investment: 117.00 (10k ¥)

Daily revenue: 3600 ¥, Annual 108.9 (10k ¥)

A very good investment.

Comparison Shanghai & Beijing TOU with Jinmao Tower

Study on economic viability of HBEPS in different Roof Weight Rate

Study on economic viability of HBEPS in different RWR

Study on economic viability of HBEPS in different RWR