

High-rise Building Micro-hydro Pumped-storage and PV Micro-grid Proposal with Shanghai Jinmao Tower as a Case Study

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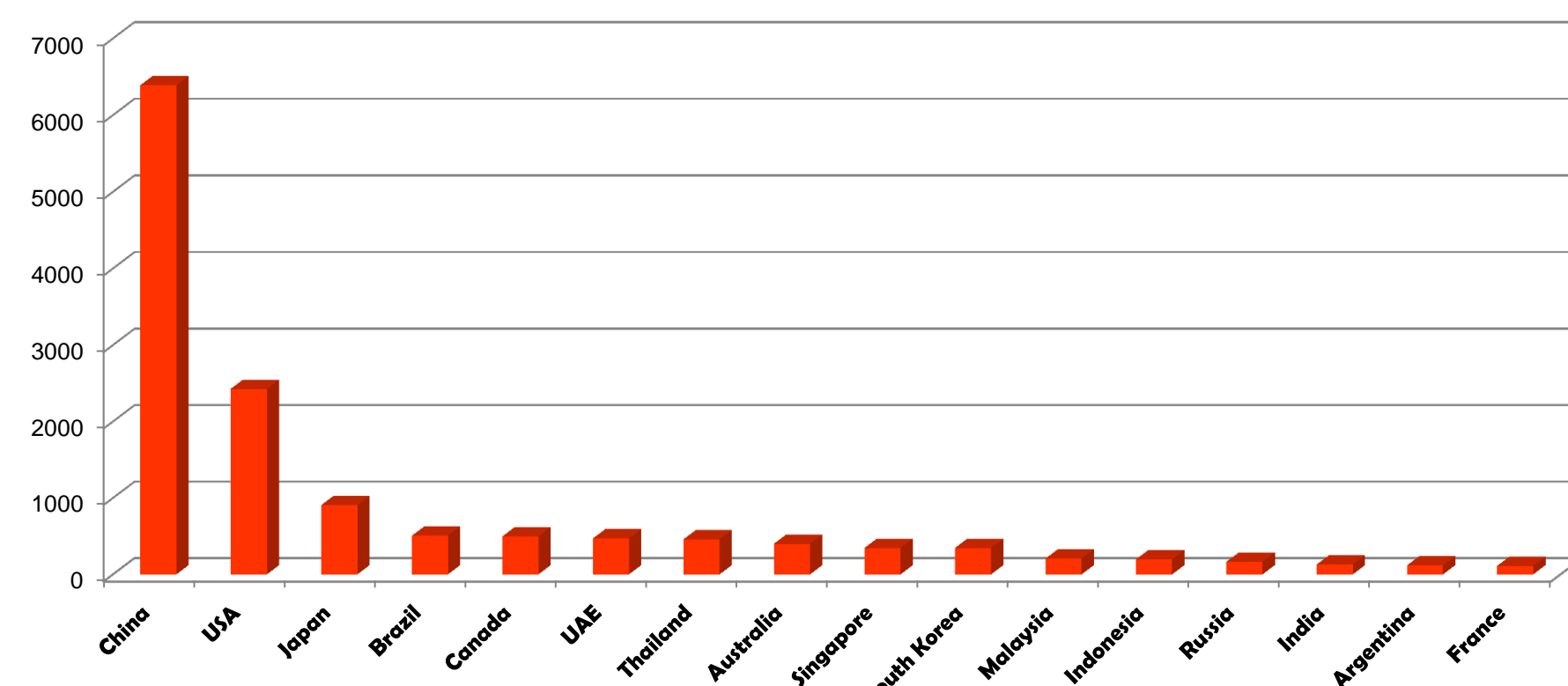
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Introduction

Electrical load is centralized in city, especial in high-rise building which not only has PV or Wind generation resource but also has a ignored **great gravity potential**. The building above 50 meters are everywhere in city, there are 17383 buildings above 90 meters in the world. Water is also a necessary resource that city should have; water storages in the roof, or water bodies in waist, and water tanks underground of a building or a building group, are not difficult to build them, in fact, water systems including pump system have already been implemented in those buildings for water drink, sanitation, swim pool, fire control, water drain, etc. The hydro pumping storage will only add some new spaces, weight-bearings, new mini hydro pumping systems, etc. A micro-grid development scheme of mini-hydro pumping with PV or others is surveyed and it seems feasible from technical as well as economic point of view.

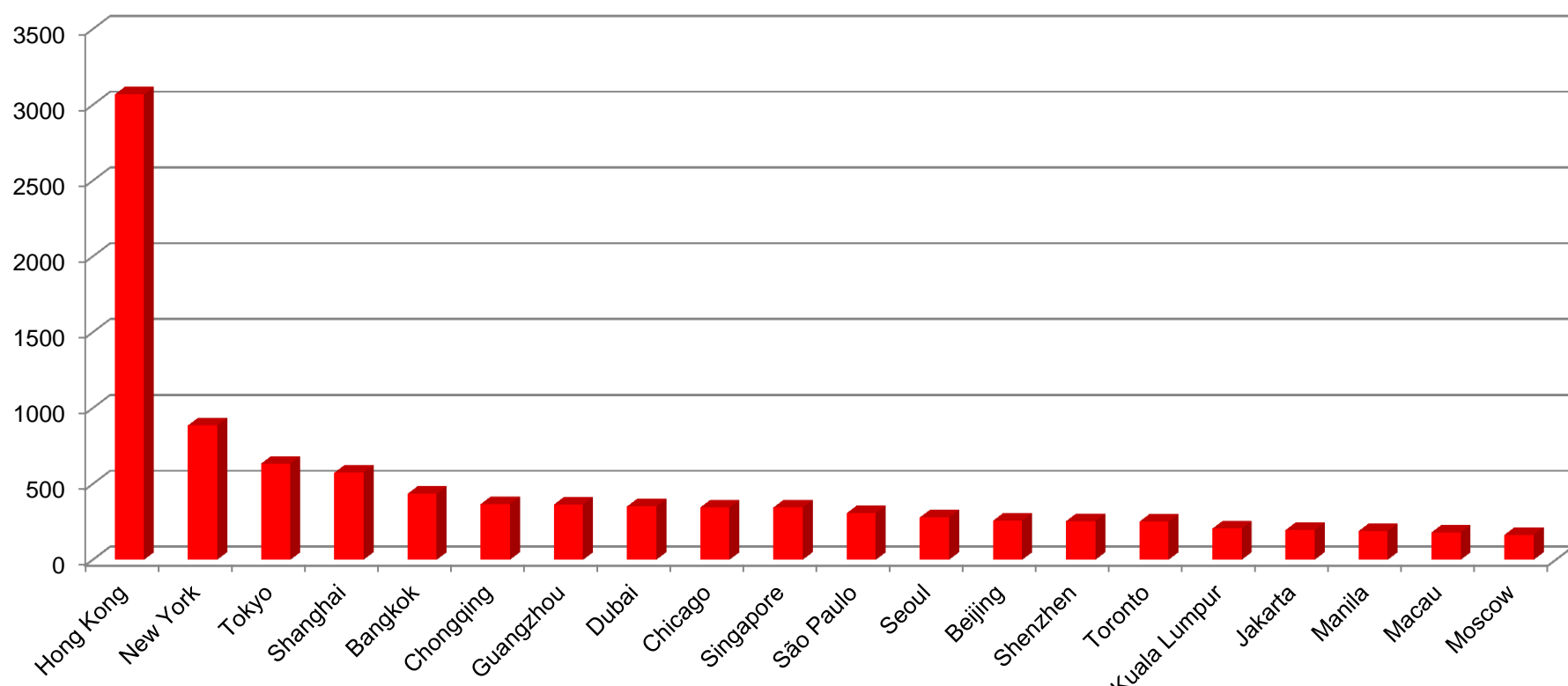
High Rise Building Resources in the World

Numbers of Blvd above 90m of Country over 100 Blvds (World total 17383)



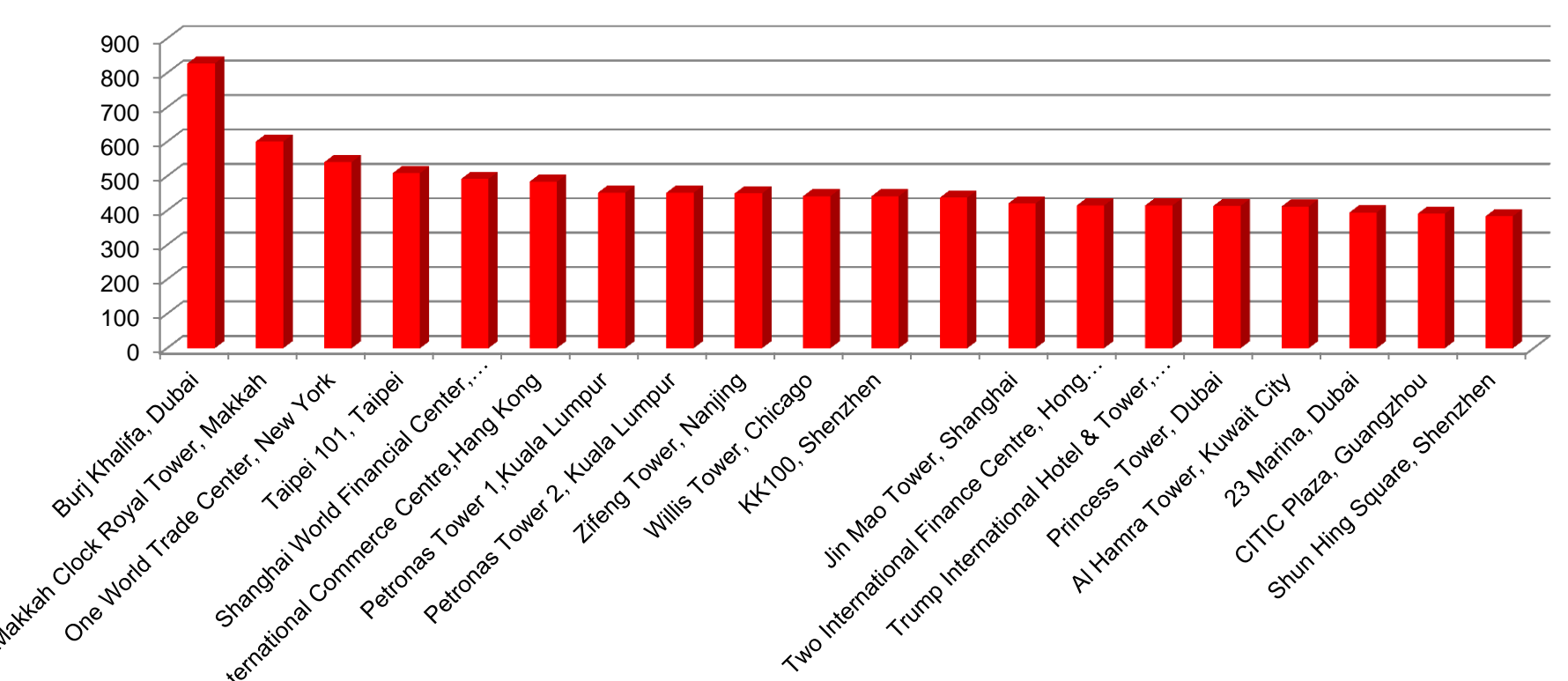
Top 20 City Rank of Number of Building over 90 m

Numbers of Blvd above 90m of top 20 Cities

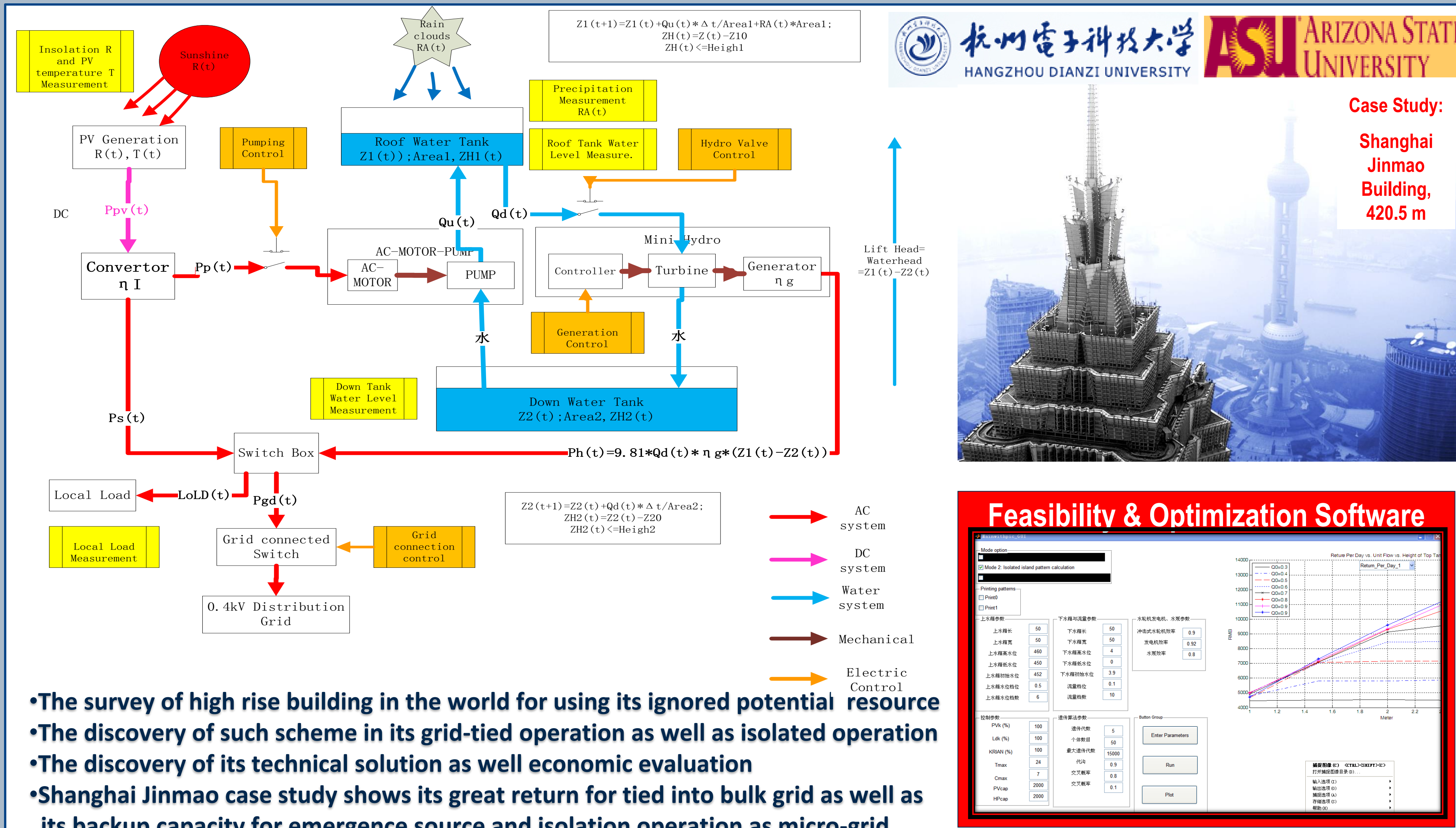


Top 20 High Rise Building in the World

Height, No.1: 828m, No.20: 385m

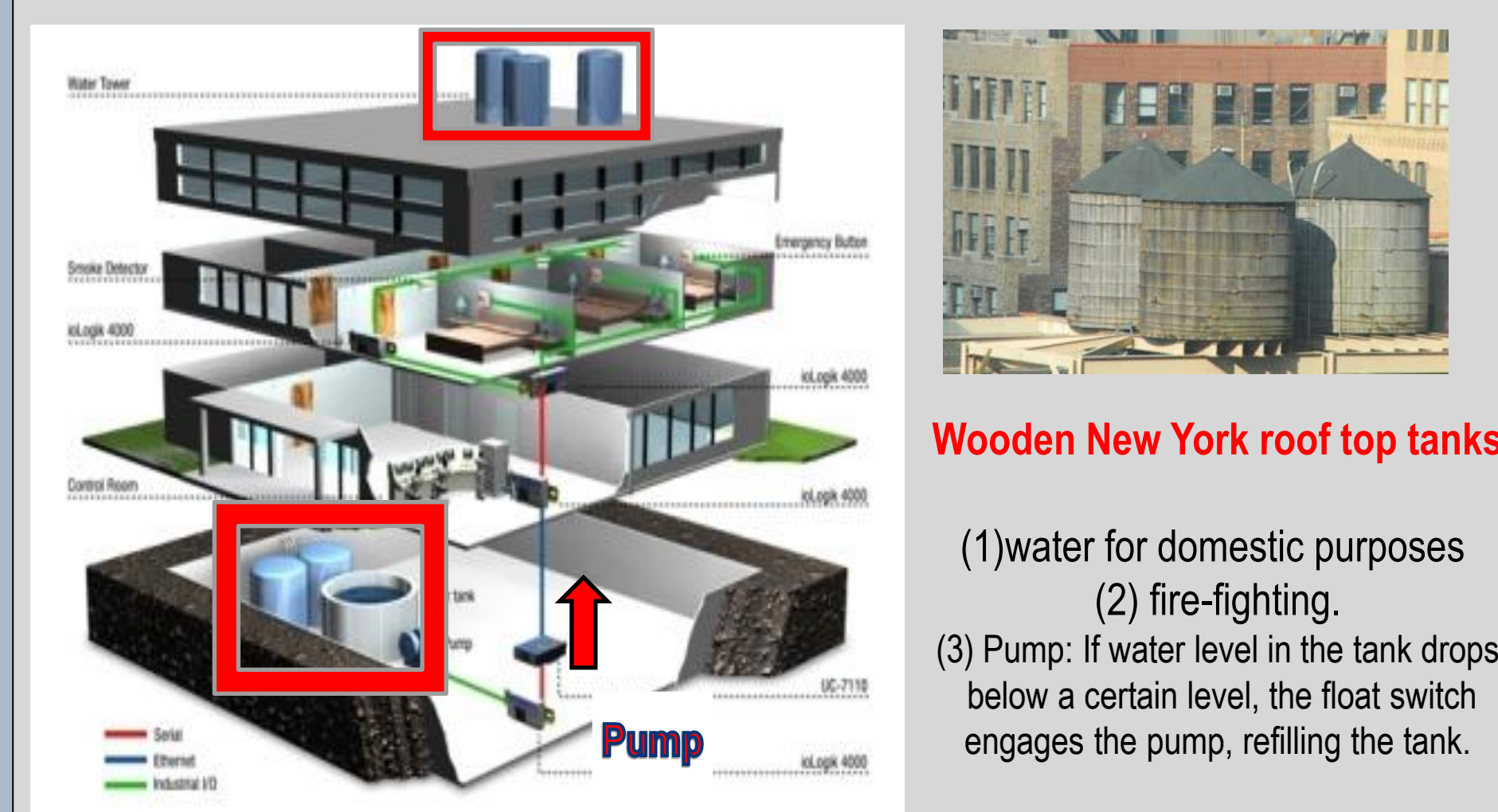


New York City



- The survey of high rise building in the world for using its ignored potential resource
- The discovery of such scheme in its grid-tied operation as well as isolated operation
- The discovery of its technical solution as well economic evaluation
- Shanghai Jinmao case study shows its great return for tied into bulk grid as well as its backup capacity for emergence source and isolation operation as micro-grid

Top Water Tank & Bottom Water Tank & Pumping for General High Rise Buildings



Wooden New York roof top tanks

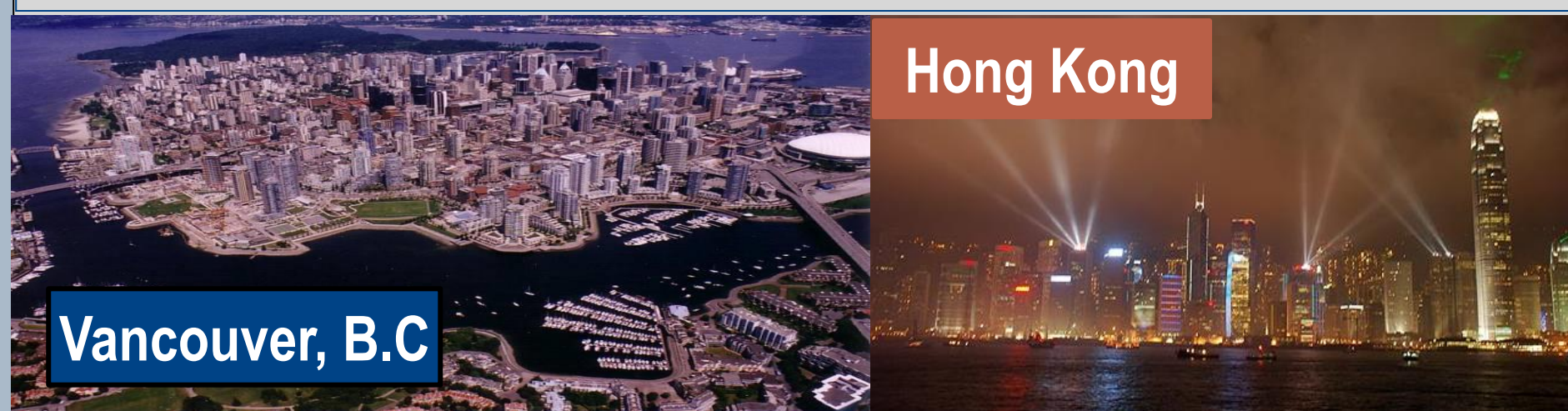
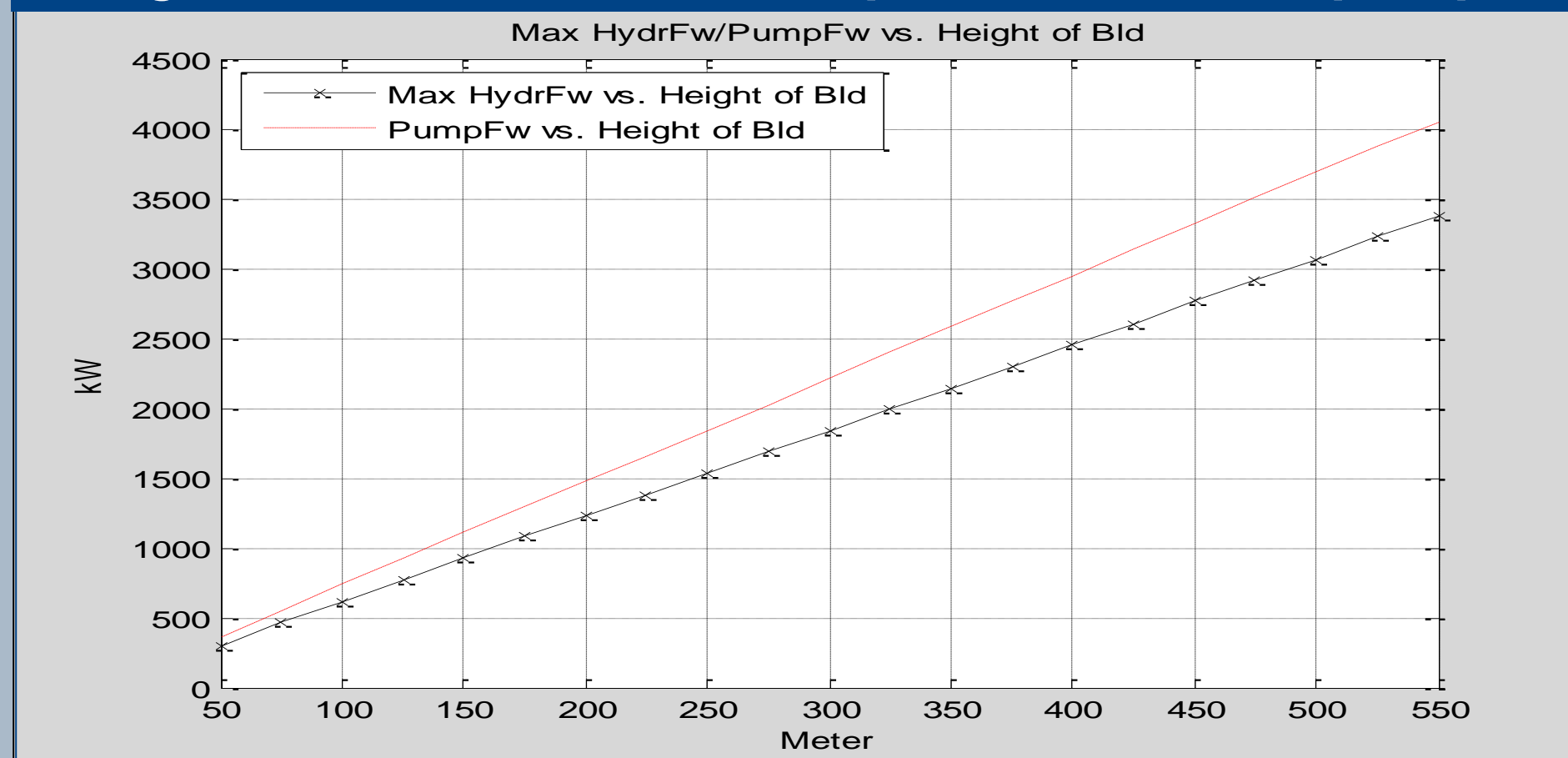
- (1) water for domestic purposes
- (2) fire-fighting.
- (3) Pump: If water level in the tank drops below a certain level, the float switch engages the pump, refilling the tank.

Roof Live Loads Standard (USA, China)

US Standard: ASCE-2005 Minimum Design Loads for Buildings and Other Structures

China Standard: GB 50009-2012 Load code for the design of building structures

A 50m*50m*3m Water Tank on Roof, how much power can generated and how much power needs for pump?



Parameters of Shanghai Jinmao Building

Bld Parameters:
Height:420.5m
Section Area:
100m*100m

Electrical Parameters (Top Reliability):
Volt: 35kV/6.3kV/380/220V
Incoming: 2*35kV Independent Lines
Main Transformers: 4*10MVA
Static Load:10MVA, so 3 Transf backup
Emer.Standby Gen: 6*1094 kW Oil

Present Shanghai Electricity Price Table

Valley 22pm – 5am : 0.273;
Ave 6-7, 11-12am/15-17, 21pm : 0.719;
Peak 8-10 am/13-14, 18-20pm : 1.202,

Turbine/Pipe/Generator/Pump Efficiency

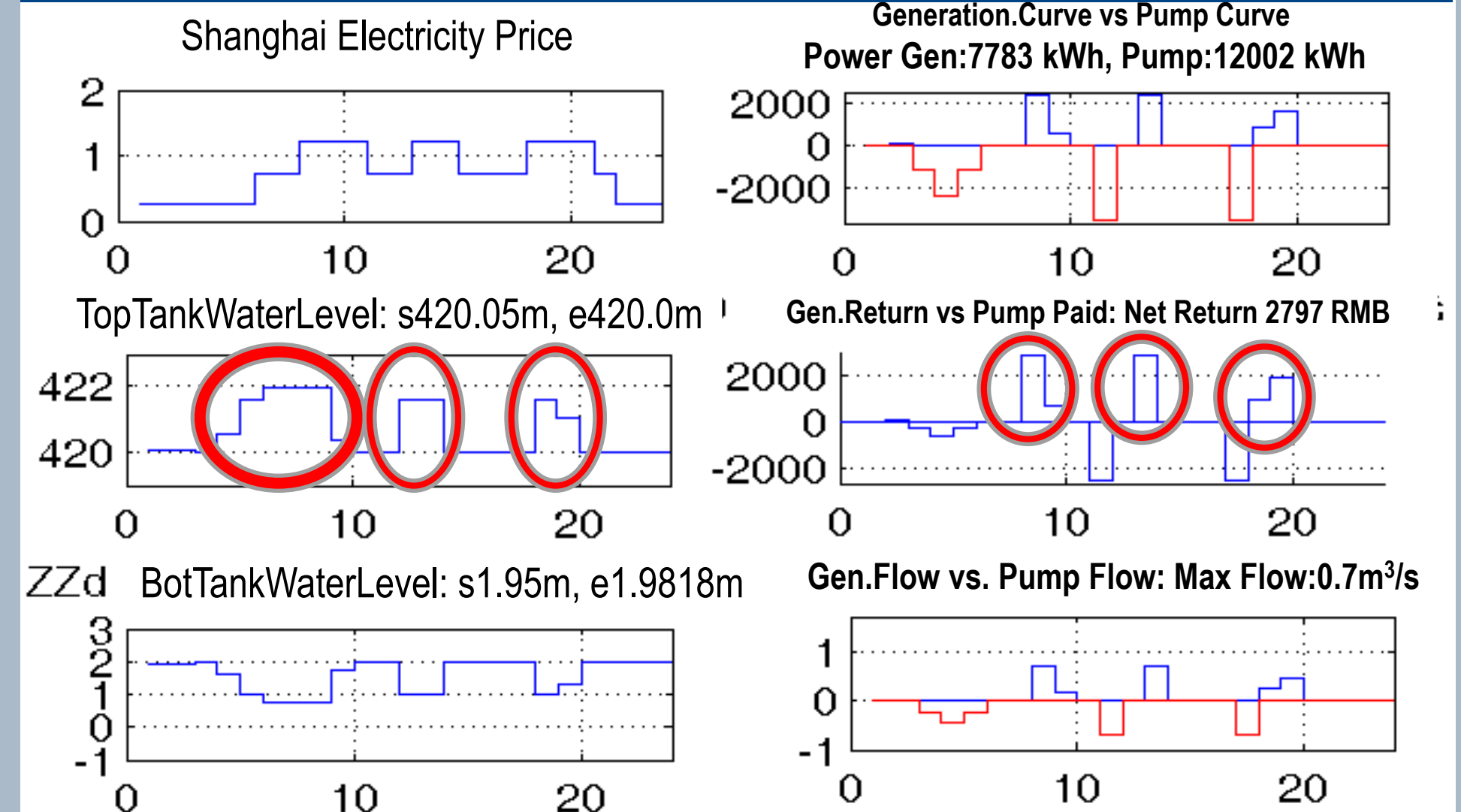
Turbine efficiency : 0.9; Generator efficiency : 0.92
Pump efficiency : 0.8; Global Efficiency : 0.6624.

Hydro-Pump Parameters Optimal Selection for grid-tied operation under weight bearing of roof garden standard

Table 1 The revenue return for different top-tank design under the garden standard of burden

Button	square meter(m ²) Surface area of Tank(m ²)	The height of Top Tank (m)	Maximum Generation Power Pump power (kW)	Generation Energy Pump Energy (kWh)	Ratio of Energy Generated over Pump used (%)	Daily revenue (RMB)
1.	100/10124/124.	0.31.	2930/3595.	8163/11983.	68.12.	2896.
2.	80/654/154.	0.48.	2382/3597.	7966/11982.	66.57.	2818.
3.	60/3806/206.	0.86.	2384/3599.	7860/11987.	65.57.	2811.
4.	50/2748/248.	1.24.	2932/3597.	7815/11992.	65.17.	2802.
5.	40/1910/310.	1.94.	2388/3599.	7763/12002.	64.84.	2797.
6.	20/1020/620.	7.75.	2407/3637.	7770/12077.	64.34.	2796.

Roof Garden Burden: Typical Operation Mode , 3 turns of pump-generating (40*40*2 TopTank)

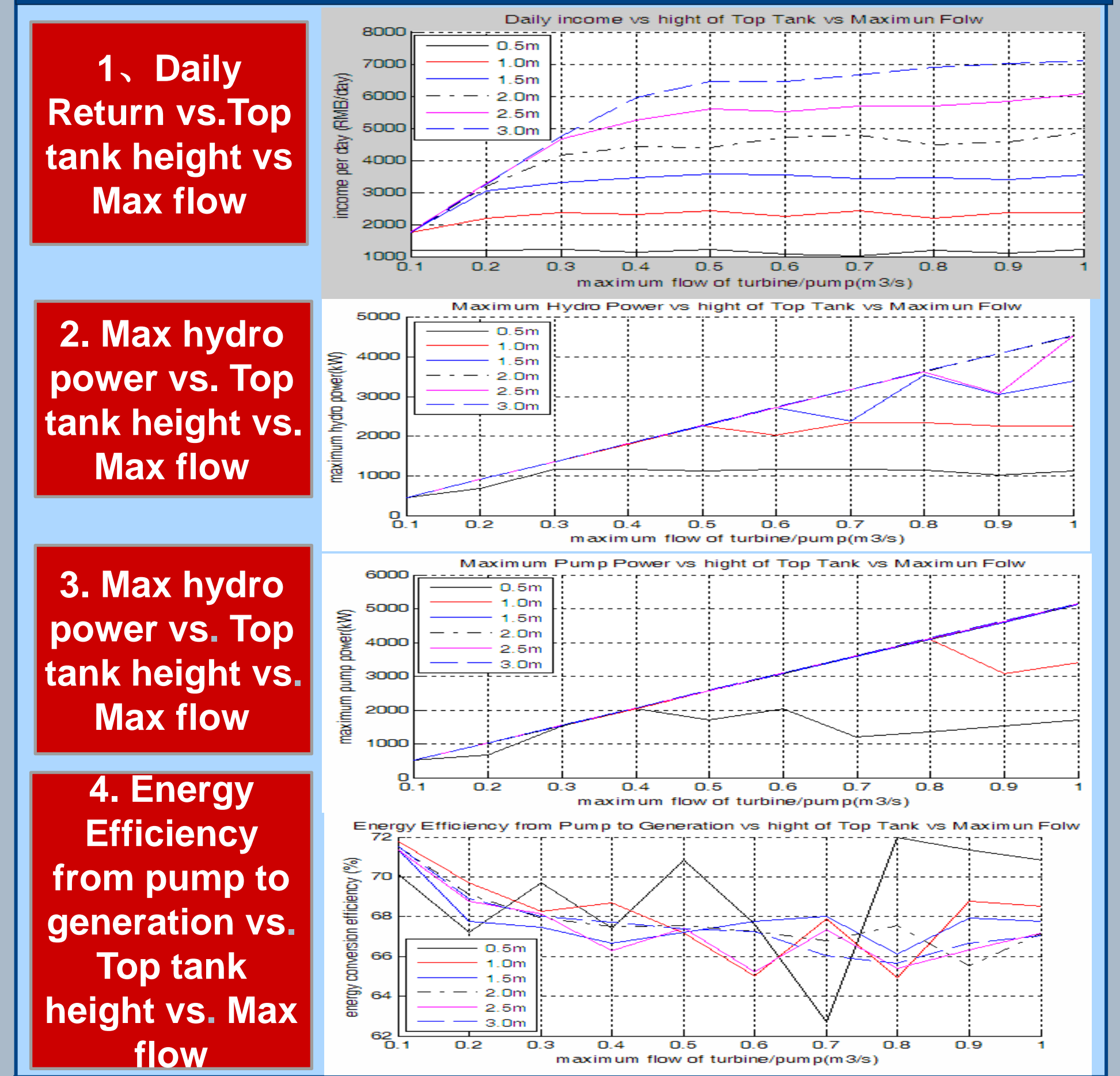


Economic Evaluation for Roof Garden Burden (40*40*2 TopTank)

Hydro capacity:2400kW, 37% of the standby oil gen.sets;
Pump capacity:3600 kW. Total investment: 40.00k ¥
Daily return: 2800 ¥, Annual 10.22k ¥, 4 Years return.

a very good investment.

Results for weight bearing over the garden standard under Top Water Tank bottom section in 50m*50m



Photovoltaic+ Pumped-hydro Storage + Sensitive Load Isolated Operation Mode

