The 2010 Shanghai World Expo: The Challenge for Distributed Energy

WEIJUN GAO PhD

Associate Professor, Faculty of Environmental Engineering
The University of Kitakyushu, Japan

Professor, Department of Architecture
Xi'an JiaoTong University, China

Visiting Professor, The Energy Analysis Department
Ernest Orlando Lawrence Berkeley National Laboratory, USA

Brief Introduction of My Laboratory

http://gao.env.kitakyu-u.ac.jp/

- Distributed Energy Resource and Network
- Environmental Evaluation
- China Energy
- Building Recycle

2006

Ph.D candidates: Four
Master Candidates: Three
Bachalor: Four
Reasearch: Four
Visiting Professor: Five

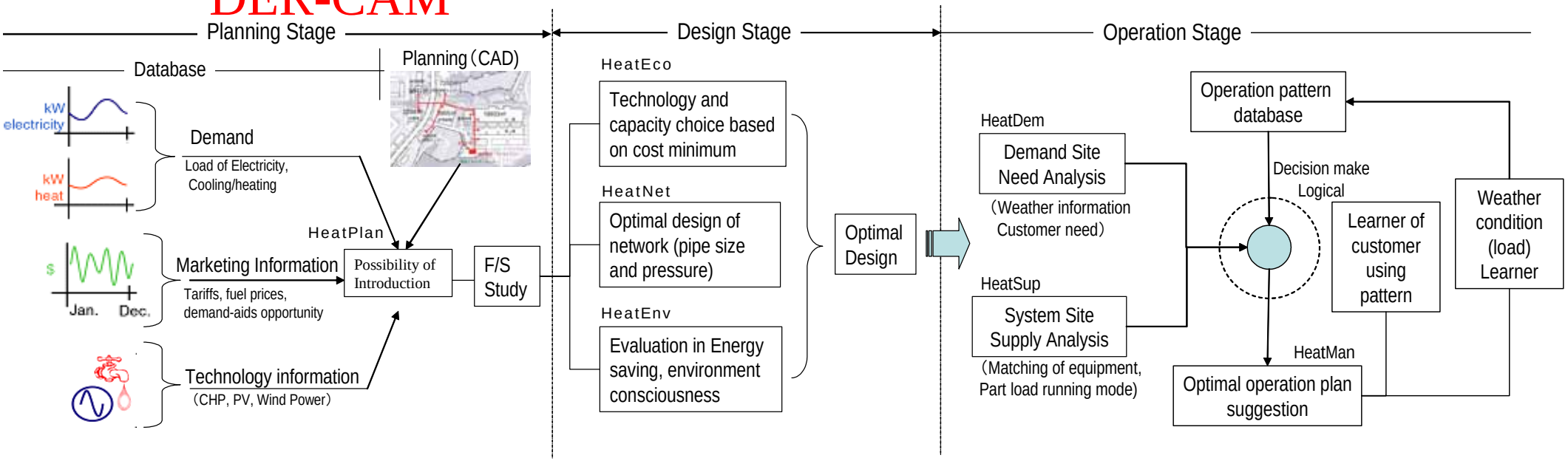
Distributed Energy Resource and Network

Design and Management Support System for Promoting the Local Distributed Energy Resources (2005-2007)

It is time from an era of making products to an era how to manager them. The long social value with a life cycle evaluation has been added in the present economical value. We need a “soft” technology to support the “hard” technology in order to realize this value.

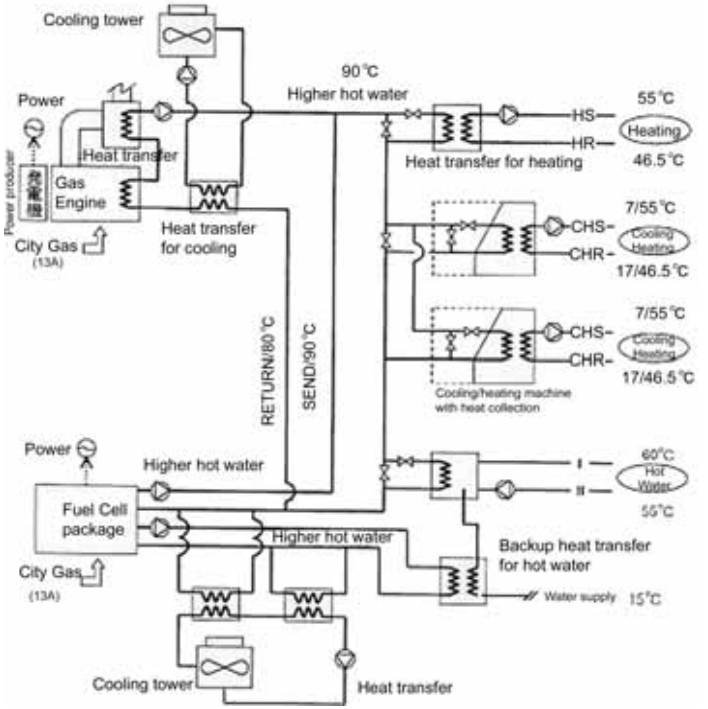
In this study, we have developed a comprehensive computerized simulation tool to give an optimal decision making in using the distributed energy resources as well as to help the operation to reach its better mode in energy, money saving and environmental concern

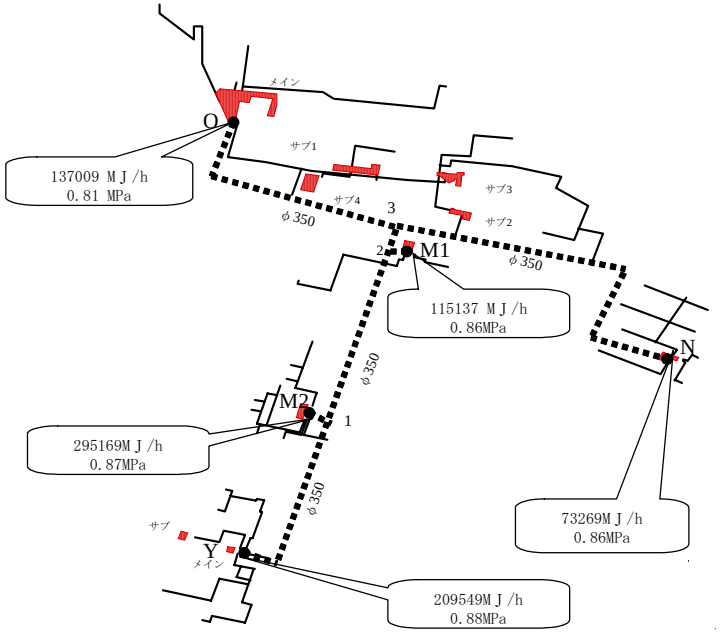
DER-CAM



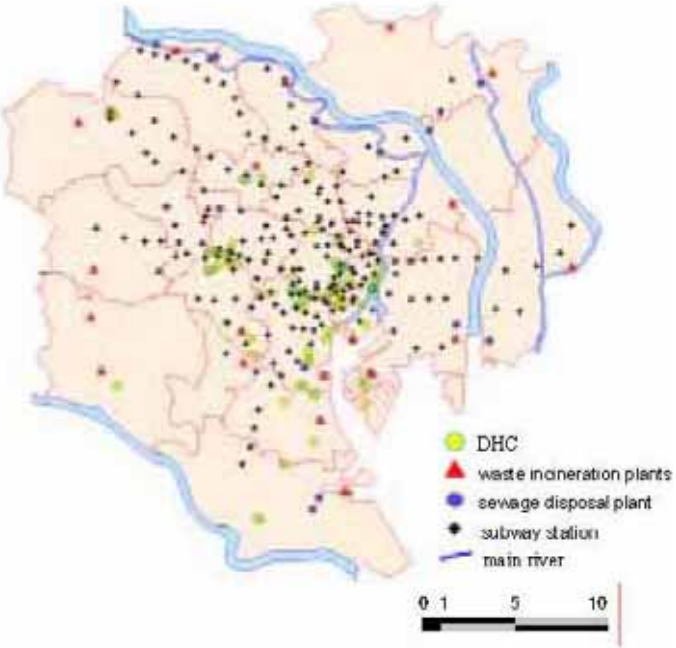
Planning, design and management tool for distributed energy resources

Field study on the effects of introducing a distributed district energy system (2002-2004)





Research on safety and backup of heat supply by networking heat resources (2003)



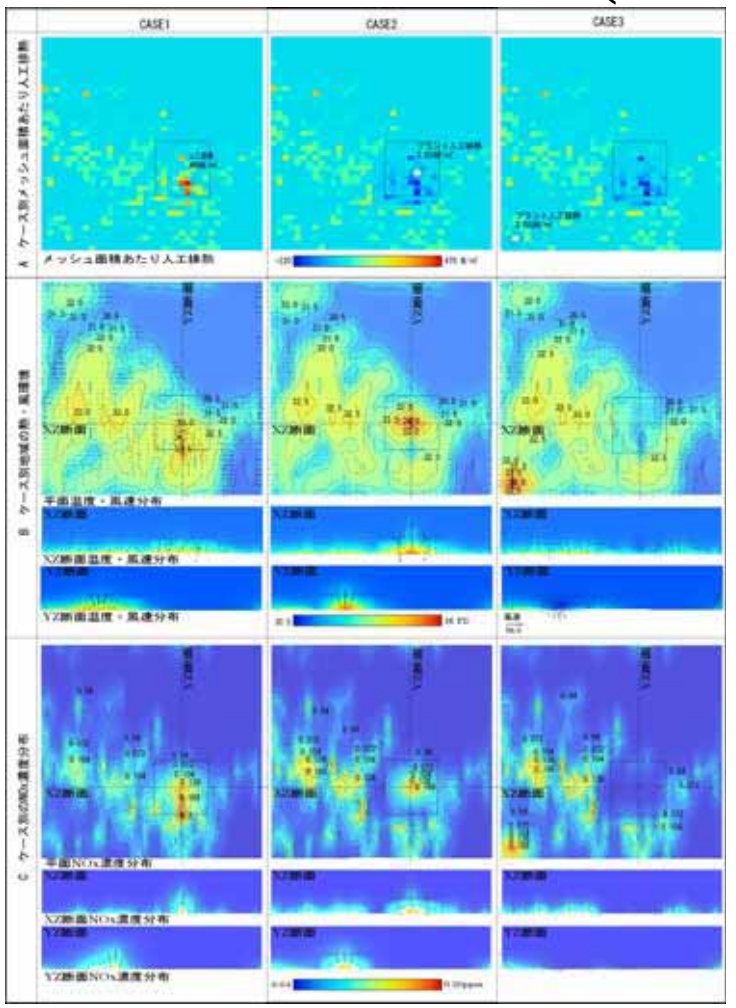
Study on heat supply enterprise network by distributed generator arrangement (2000-2003)

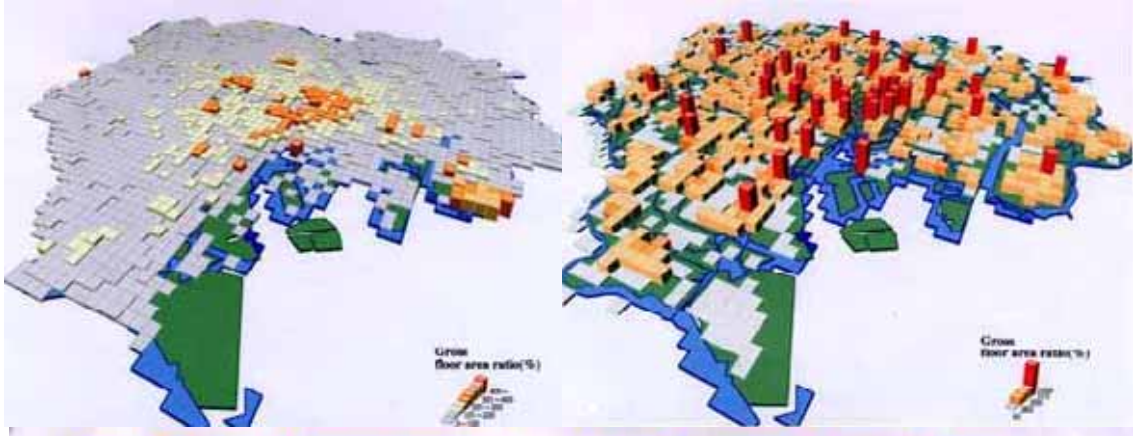
China Energy

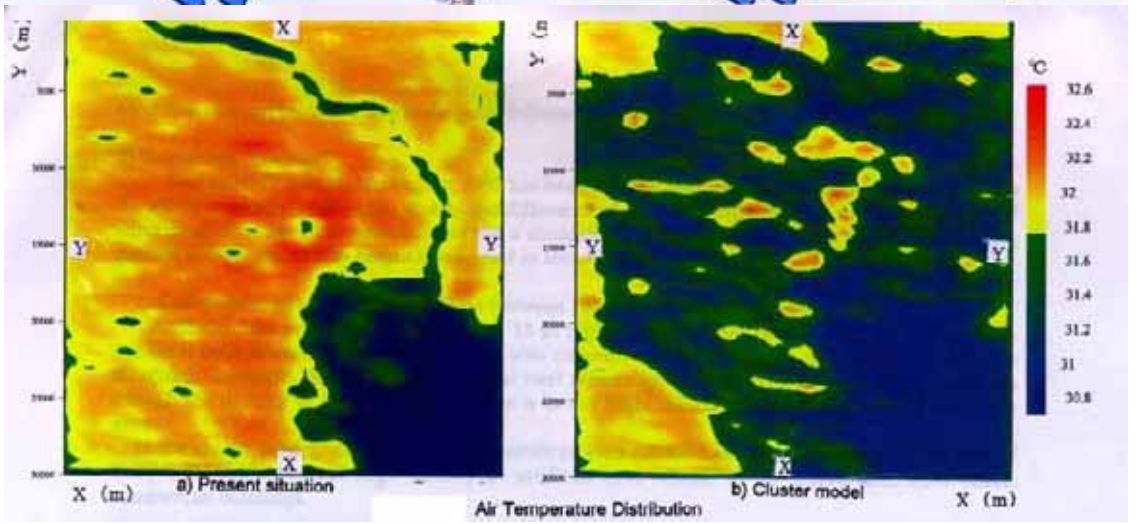
- Planning an Energy Infrastructure with a low environmental load in Shanghai World Expo(2004-2005)
- Shanghai Energy Saving Situation and the Entry Possibility of ESCO enterprise into Shanghai Market (2005)
- Feasibility Study In relation to Methane Gas CDM Project In China (2005-2007)
- Research on district heat supply system with a low environment load in North-east area of China (Changchun) (2002)
- Investigation on Energy Consumption in Dalian, China (2001)
- Energy Consumption and its Impacts on Environment in Shanghai, China (2000)
- Investigation of City Environment and Energy Consumption in Yangtze Delta Area (1999)

Environmental Evaluation

Mitigating the heat island in Tokyo Metropolitan area with a Numerical Simulation(1999)







Effects of introducing distributed energy system on the local environment(1997)

LBNL-43955 Mitigation of urban heat islands: meteorology, energy, and air quality impacts 09/30/1999 Taha, Haider;Meier, Alan;Gao, Weijun;Ojima, Toshio

Research on Building Recycle

Recycle process of building materials in the detached houses (2005)

- Lifecycle resource and energy consumption evaluation in residential house with steel construction (2005)
- Lifecycle resource evaluation system for building material Recycle (2004-2005)
- Evaluation on decreasing the resource and energy consumption in environmental residential buildings (2003-2004)
- Research on disassemble and recycling energy consumption in collective residential buildings of Kitakyushu (2003)
- Lifecycle energy consumption for building material recycles in residential buildings (2002)
- Investigation on energy consumption of building material recycles in residential buildings (2002)
- Sociological Experimental Study of Low Environmental Impact and Resource Circulation Habitation System (1997-2004)

LBNL-46020 Energy impacts of recycling disassembly material in residential buildings.02/01/2000, Gao, Weijun;Ariyama, Takahiro;Ojima, Toshio;Meier, Alan

Design and Planning Works

Dalian Port Eastern Coastal Park Planning (2005) with Nikken Sekkei

Comprehensive planning and design of Guiming garden houses (2002)

International Consultancy for the Urban Design of Shenzhen City Center and Comprehensive Planning of the Underground Spaces (2000)

International Consultation for Integrated Planning Proposal of Luohu Land Port/Railway Station Area, Shenzhen(2000)

Why do we need the *Distributed Energy* ?

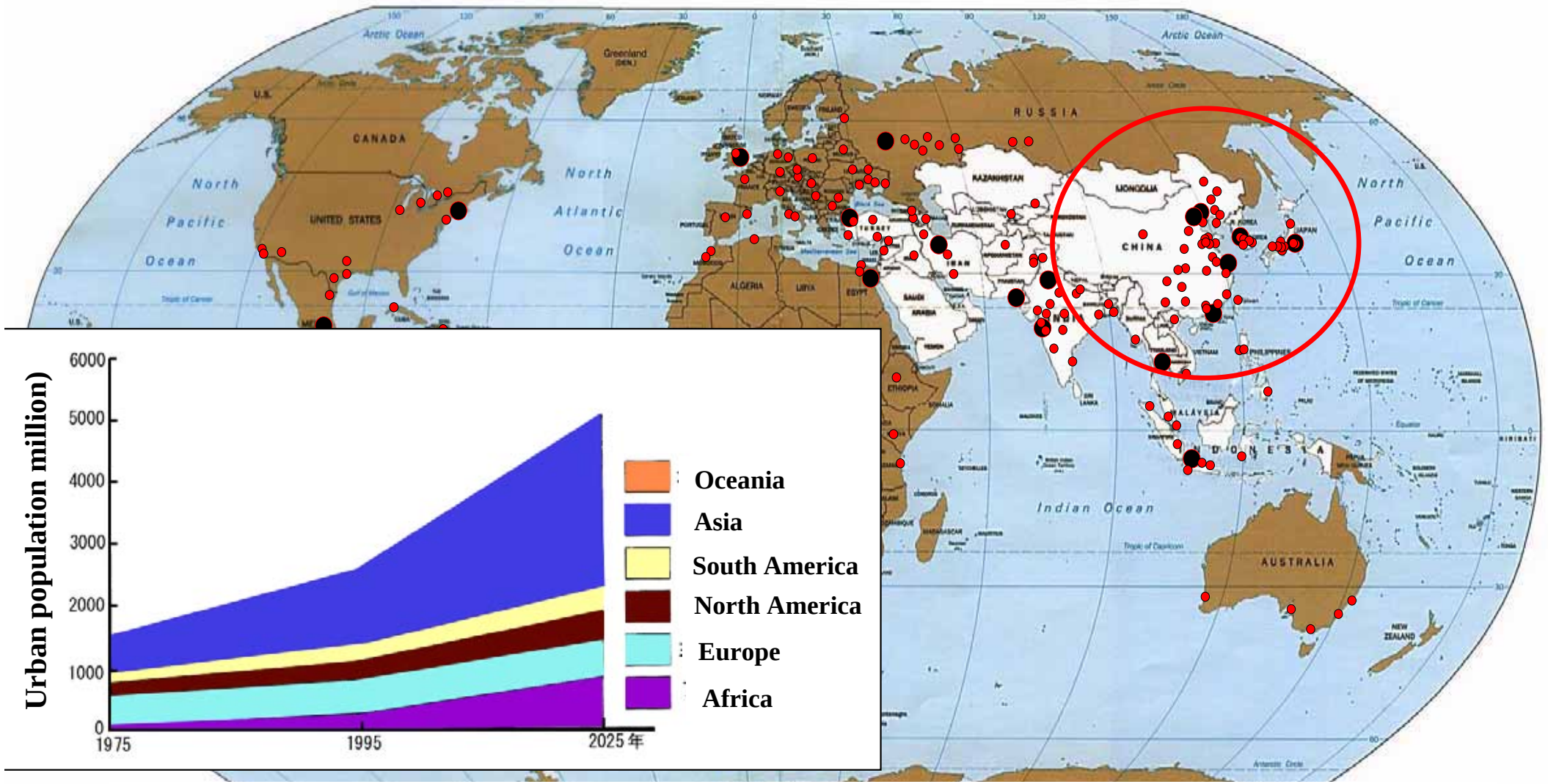
In China

In Japan

In USA

In the World

Asia Urbanization and Distribution of Population



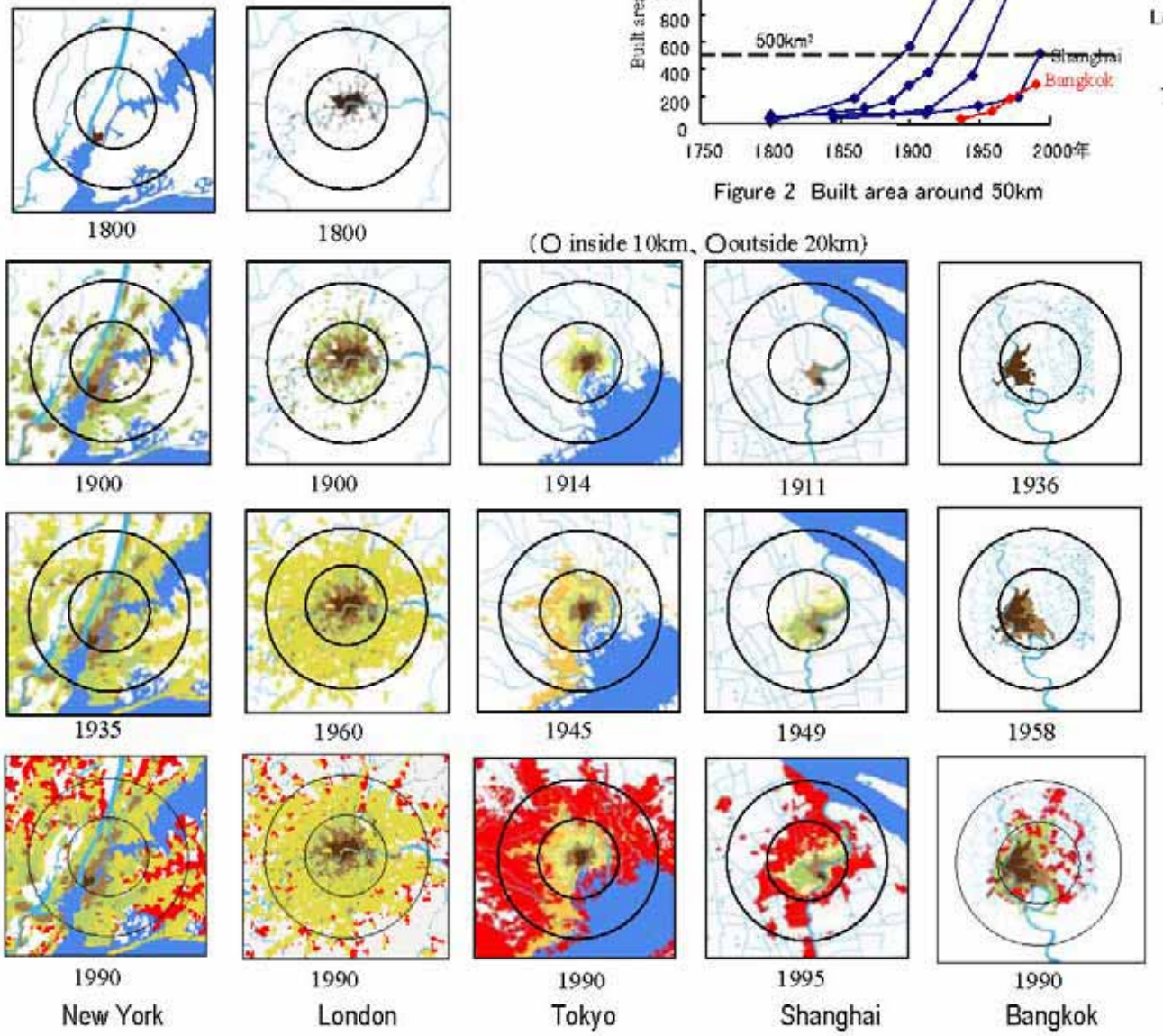
The urbanization will be speeded in Asia in the next twenty years

1990年代の世界都市人口分布（人口100万人以上）

参考文献：UN「Demographic Yearbook」

● 人口100～500万人
● 人口500万人以上

Monitoring in World Cities



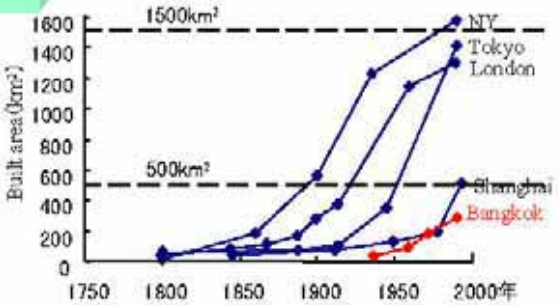


Figure 2 Built area around 50km

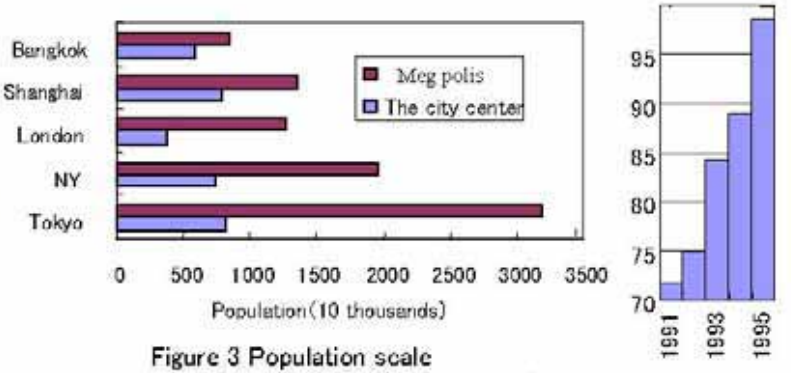


Figure 3 Population scale

Figure 4CO2 recharge in Shanghai

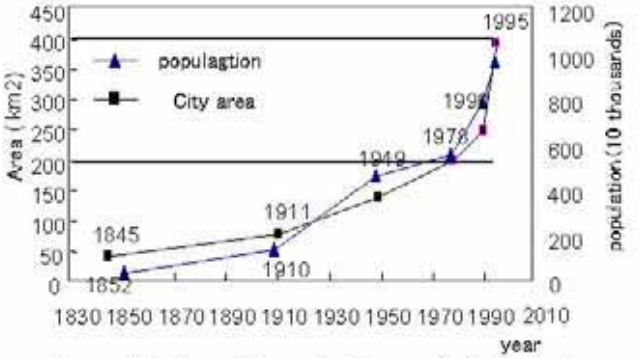


Figure 5 Population and city area in Shanghai

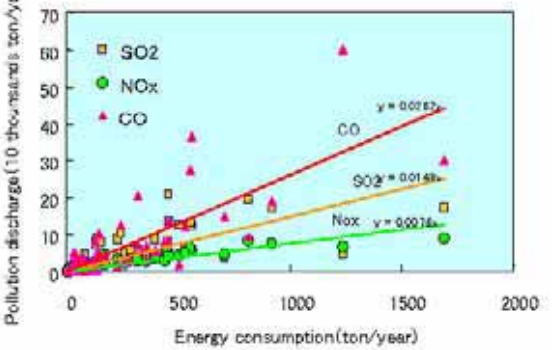
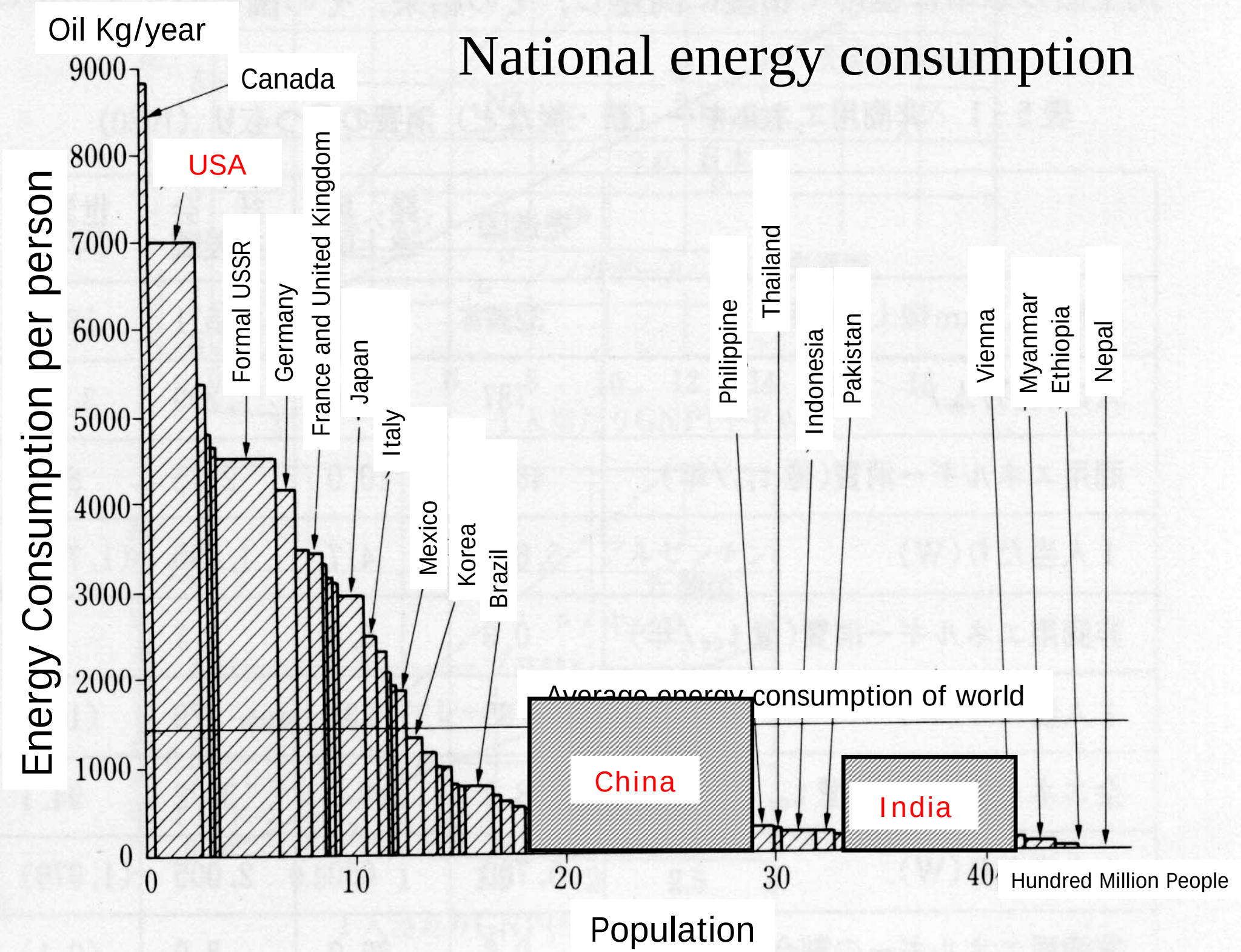
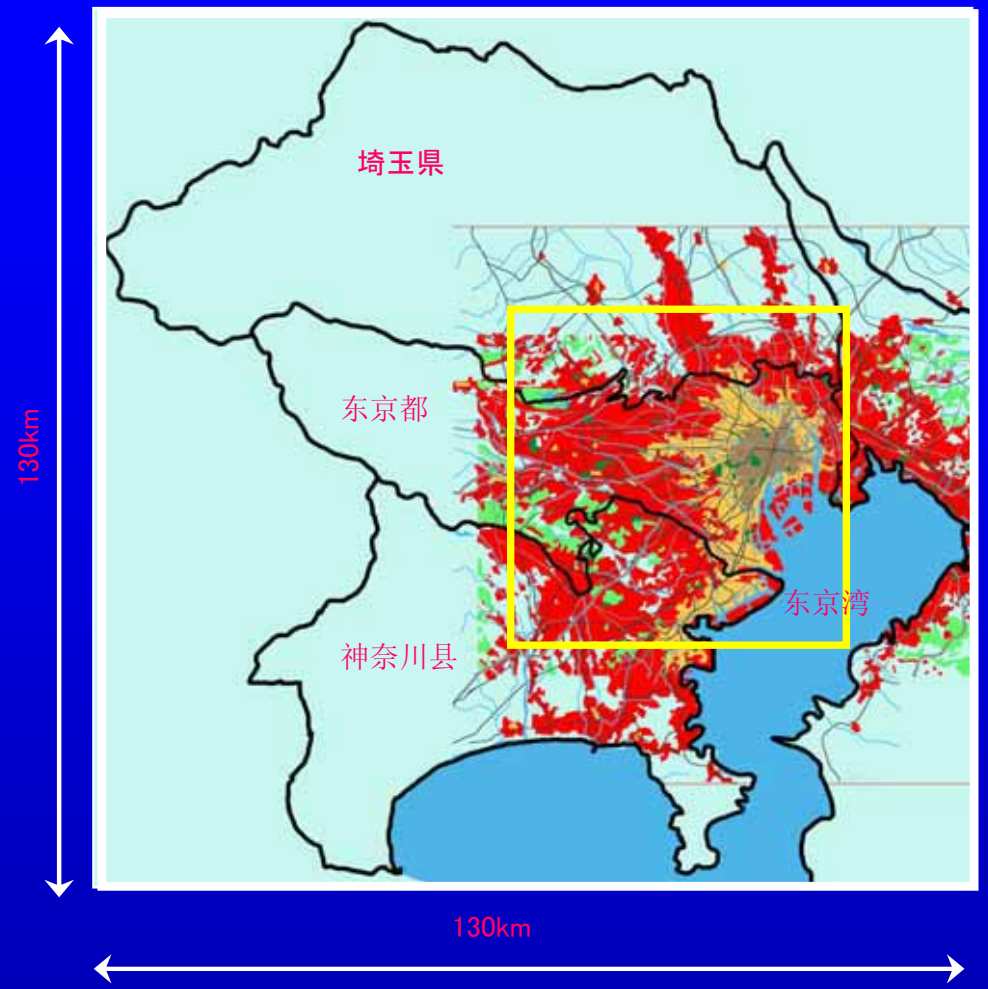


Figure 6 Energy consumption and sir pollution

National energy consumption



Comparison of area between Tokyo and Shanghai



Tokyo

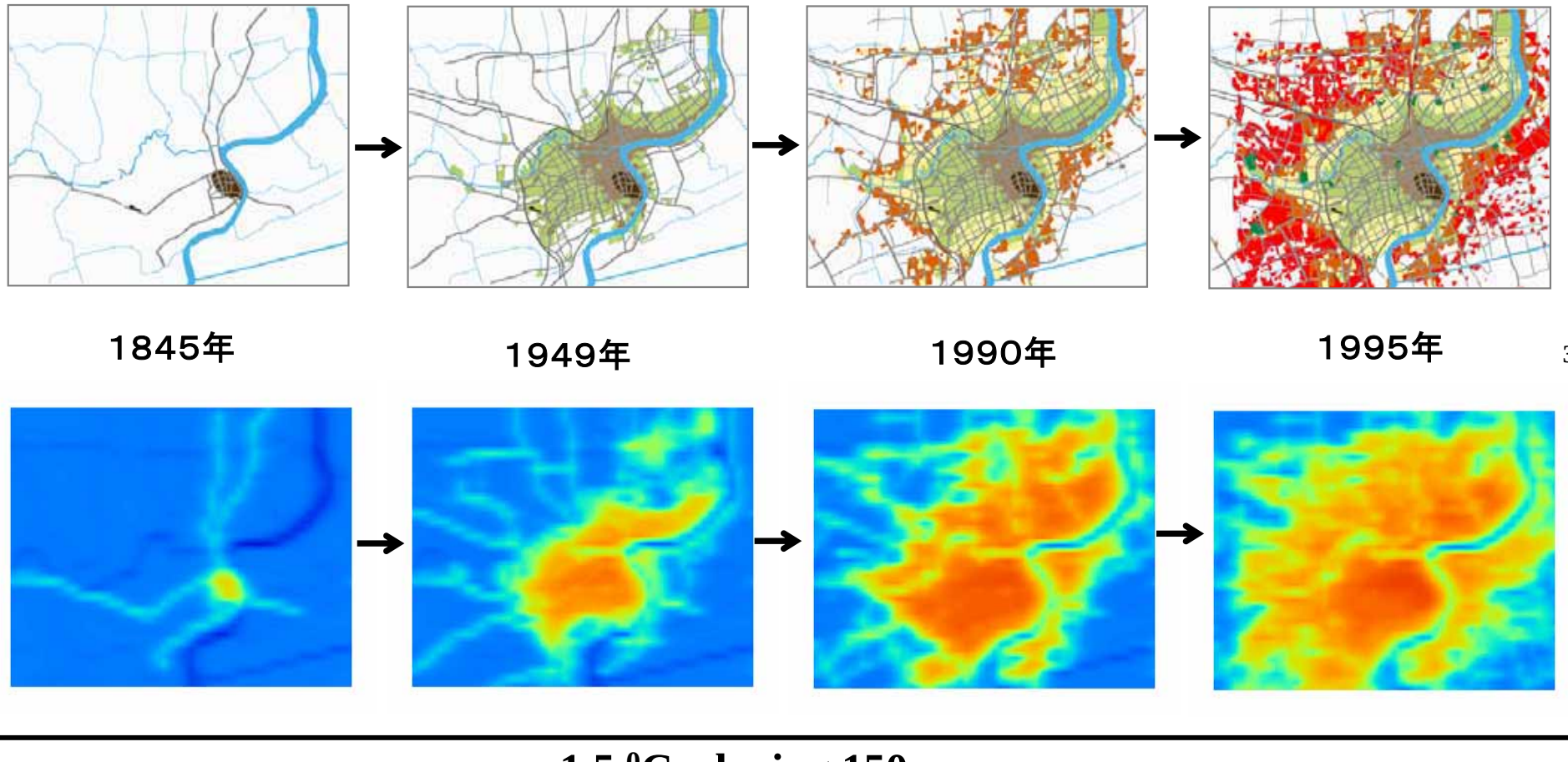
Shanghai

凡例

上海市和东京首都圈（一市两县）130km²的比较
（内区为50km²）

The city warming phenomenon due to sudden urbanization

Urbanization of Shanghai（25km×19km)

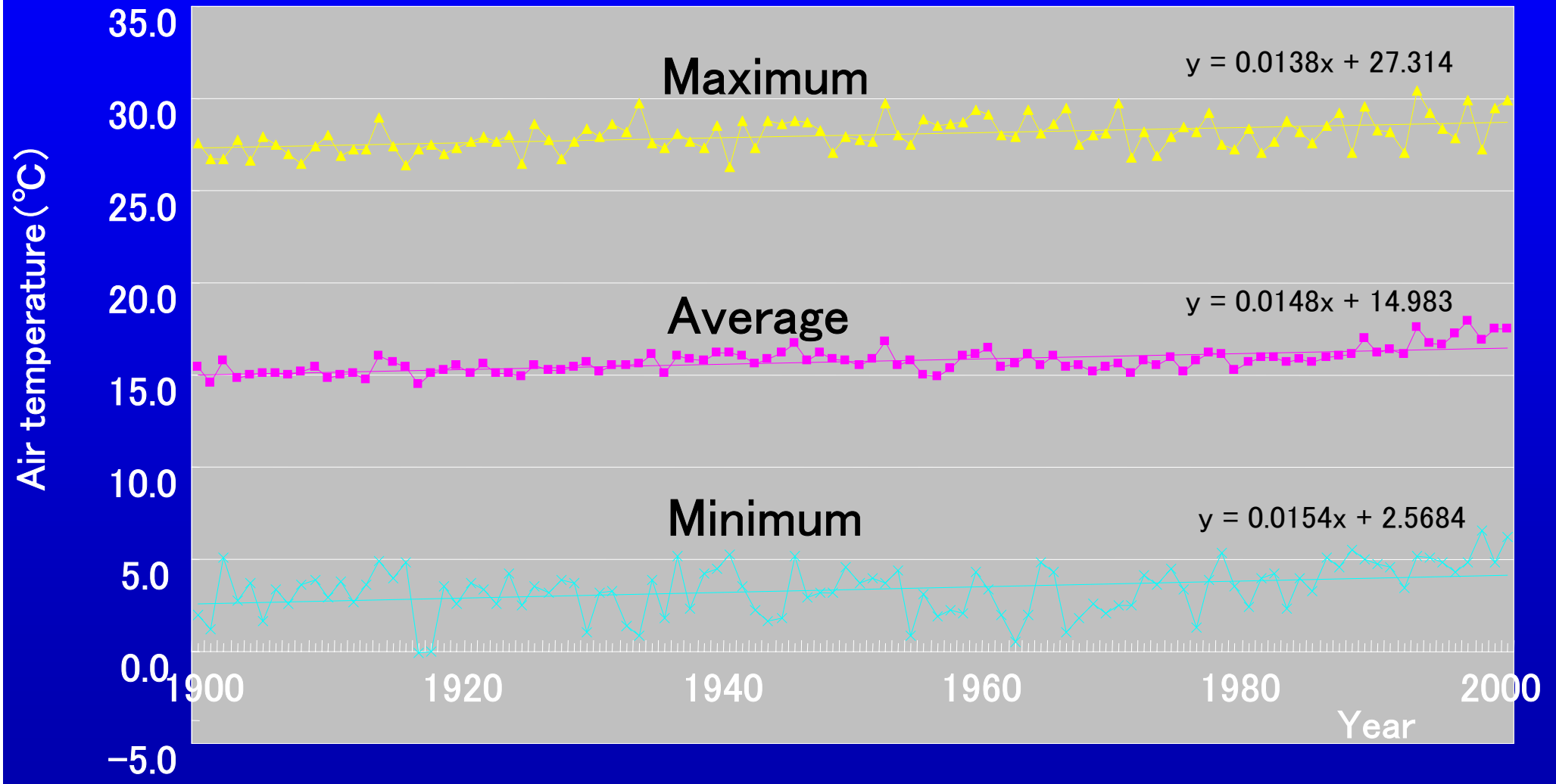


1.5 ^{0}C during 150 years

Increase of urban air temperature due to urbanization in Shanghai (height at 1.5m)

Simulation by Weijun GAO, Haifeng LI and Toshio OJIMA

Over the past century, the average temperature in Shanghai has increased by 1.5°C/year, more than three times of the global average. The temperature increase in recent ten years is at a rate of 0.11°C/yea



Climate change of Shanghai in recent 100 years

Television tower and 88 floor building of Shanghai

People Square

City traffic of Shanghai

City night scene

ai

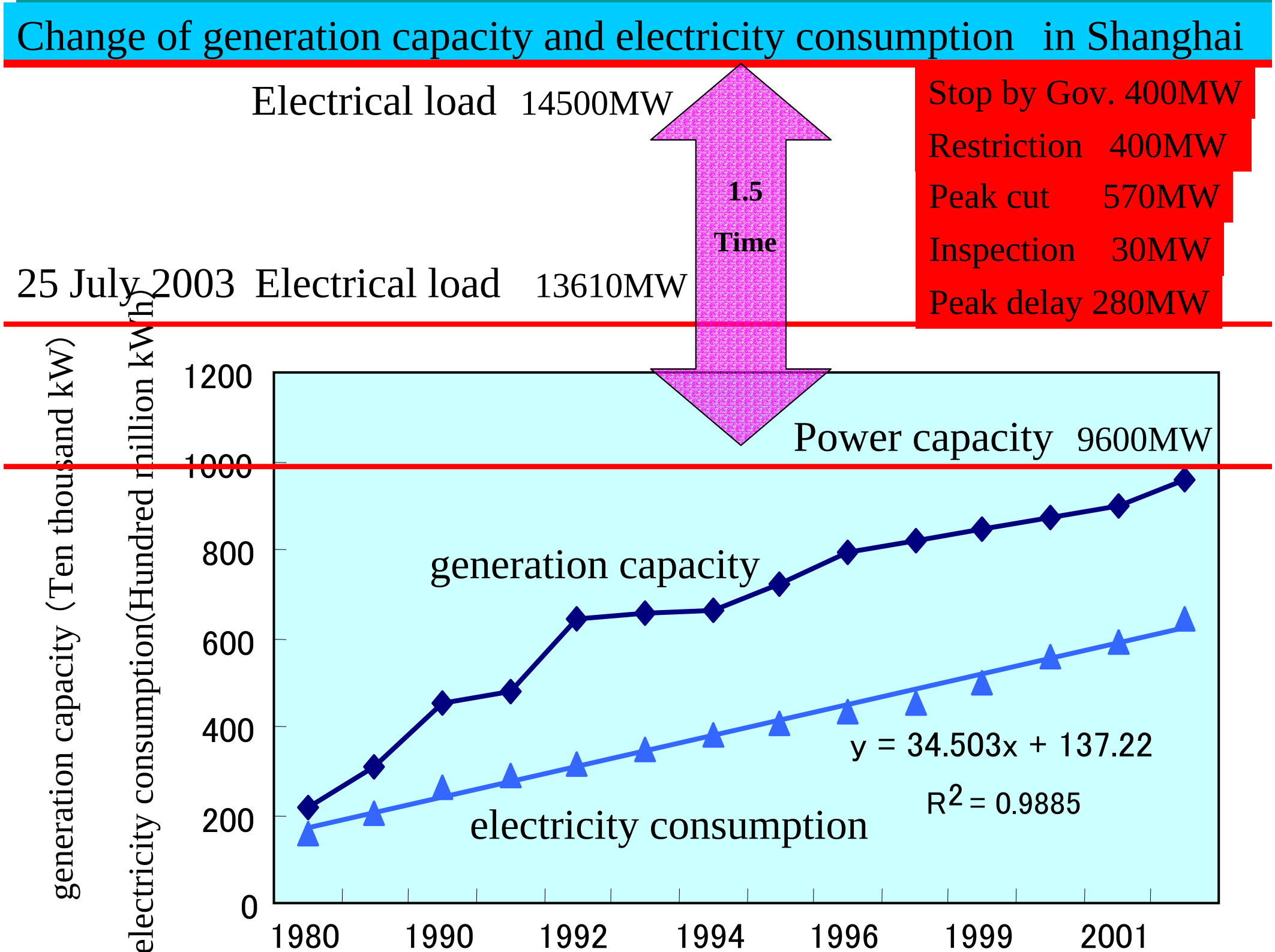
Huangpu River Bridge

Three-dimensional traffic system of Shanghai

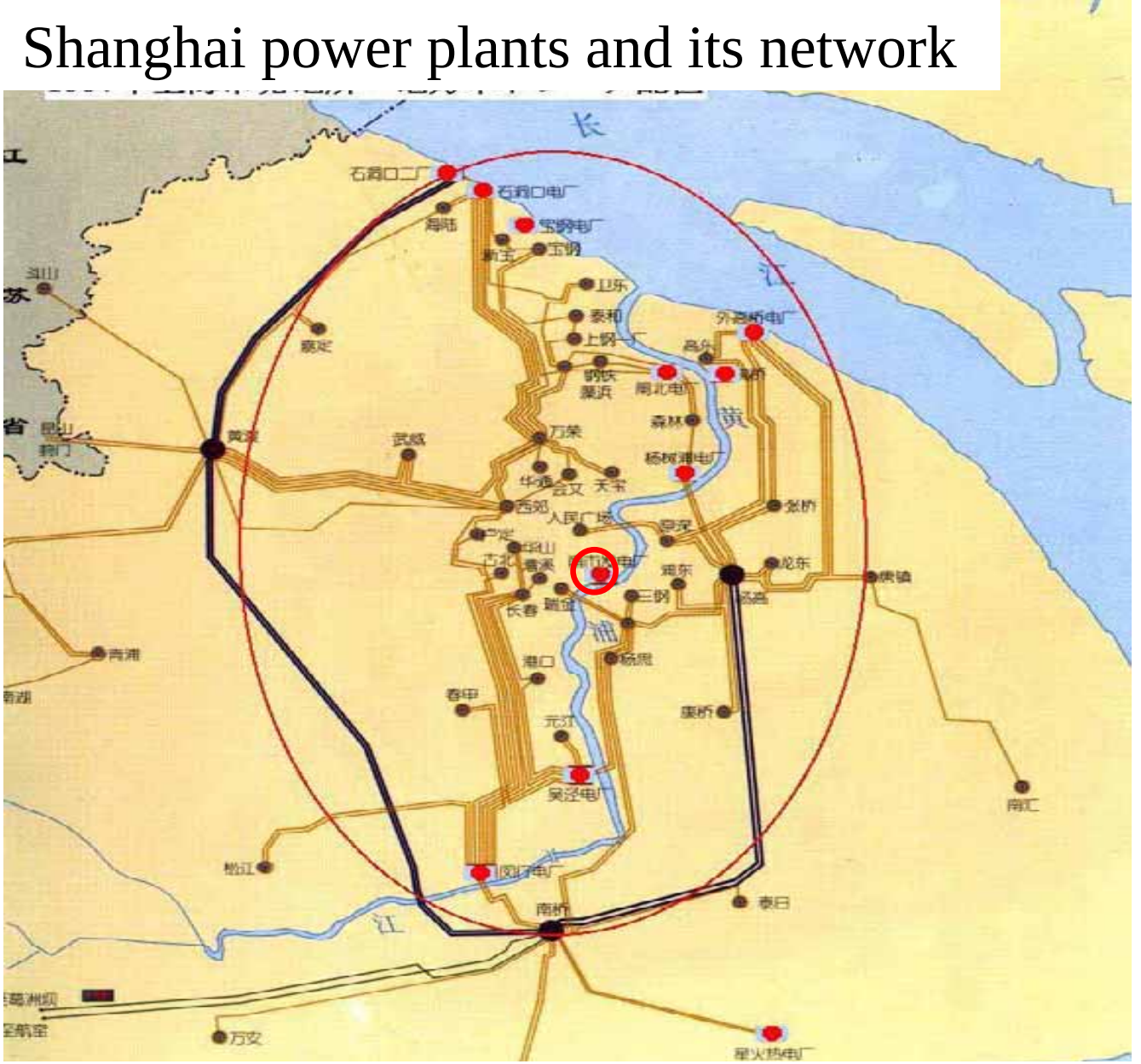
linear motor car

Subway of Shanghai

Change of generation capacity and electricity consumption in Shanghai



Shanghai power plants and its network



Grid Power can not catch up the increase of demand

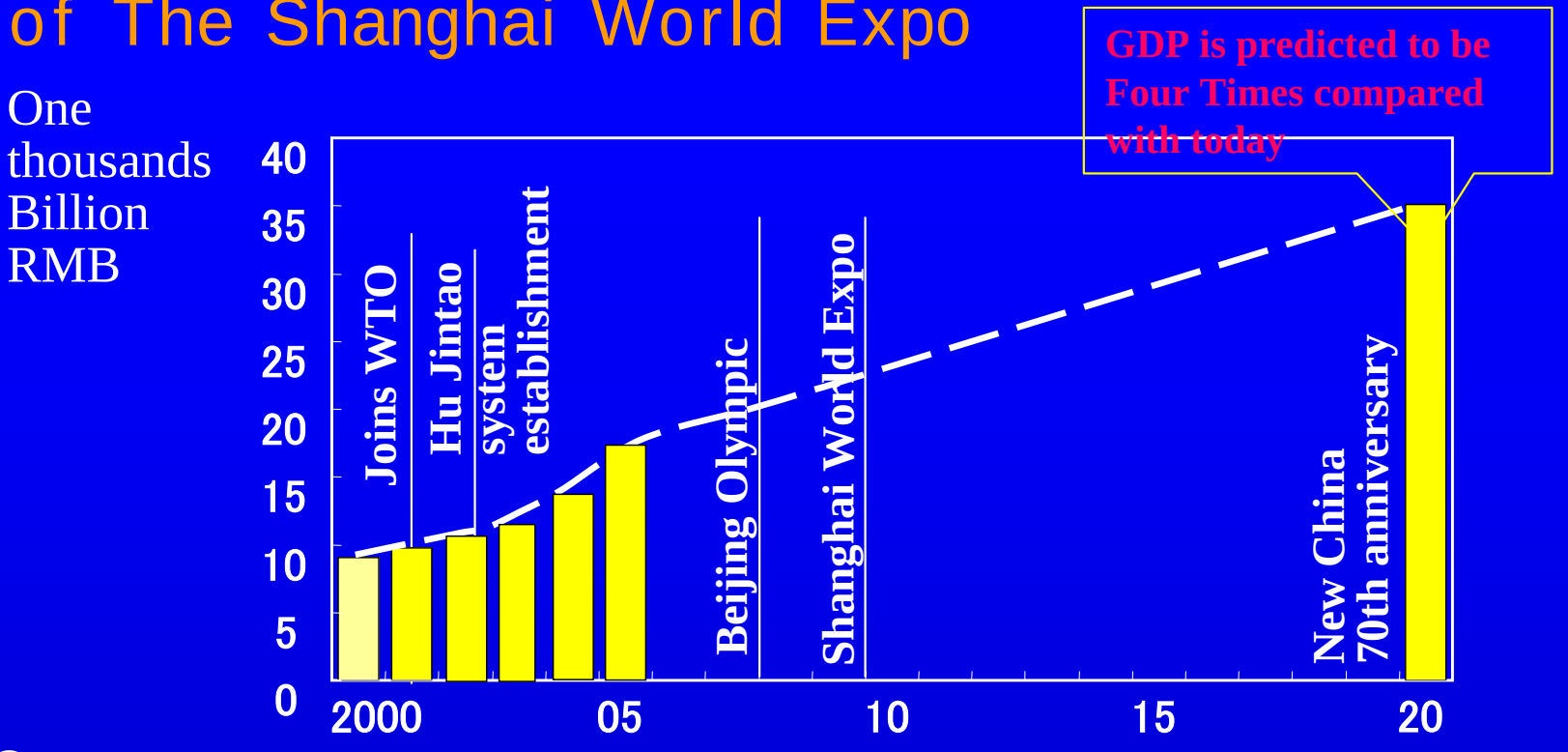
China have “million(many)” reasons to develop the distributed energy resource

Necessity or Purpose	USA	EU	JAPAN	CHINA
Reliability of power Supply	○			○
Reduction of investment in plant and equipment Reduction of erection period	○			○
Reduction of energy cost	○	○		○
To keep environmental condition (ex. Reduction of Co2)		○	○	○
To ensure diversity of energy supply			○	○
Power supply to island and/or remote place		○	○	○

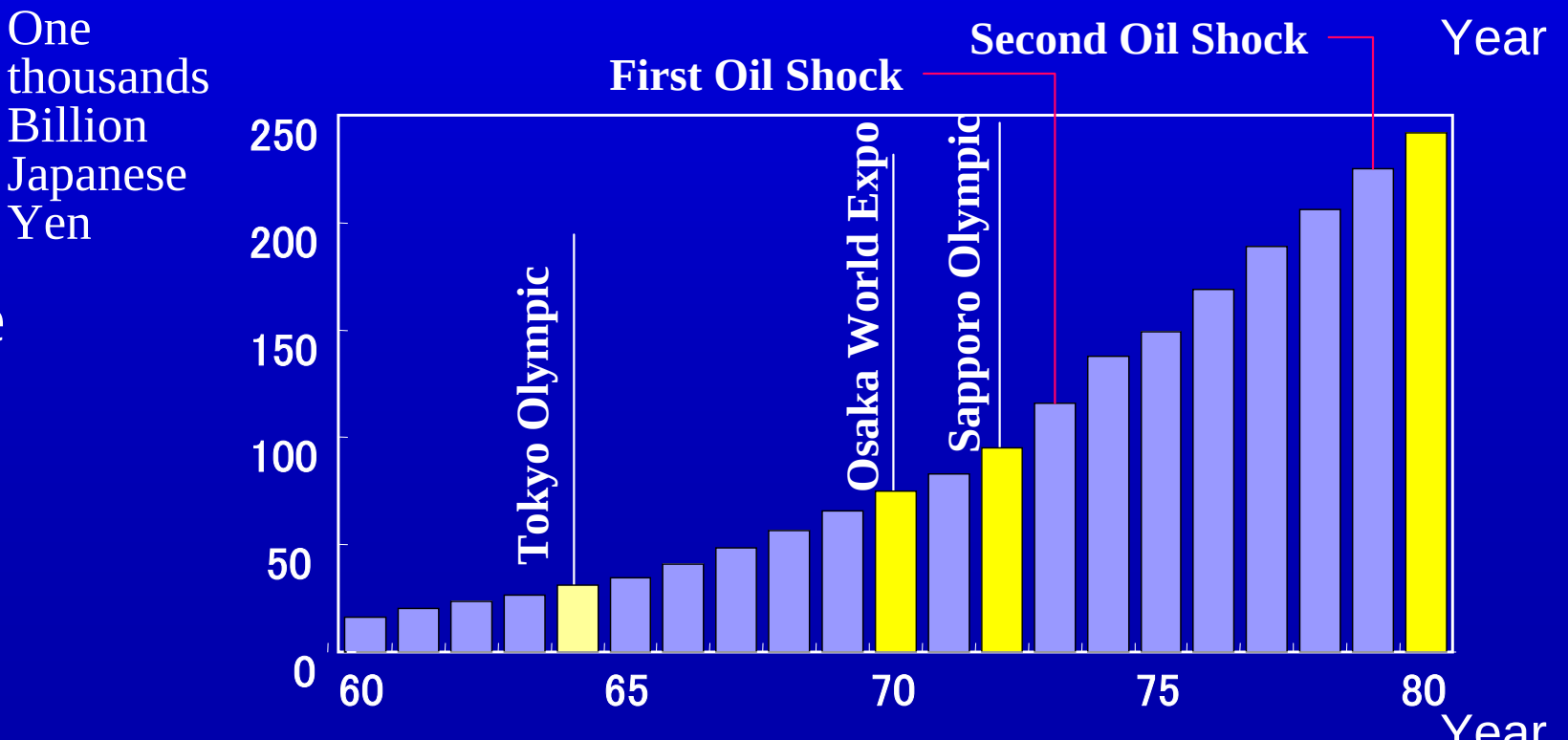
The 2010 Shanghai World Expo
Planning an Energy Infrastructure with a Low Environmental Load

The Effects of The Shanghai World Expo

The Surge of GDP in China



The Surge of GDP in Japan



Project Teams

the Ministry of Economy, Trade and Industry

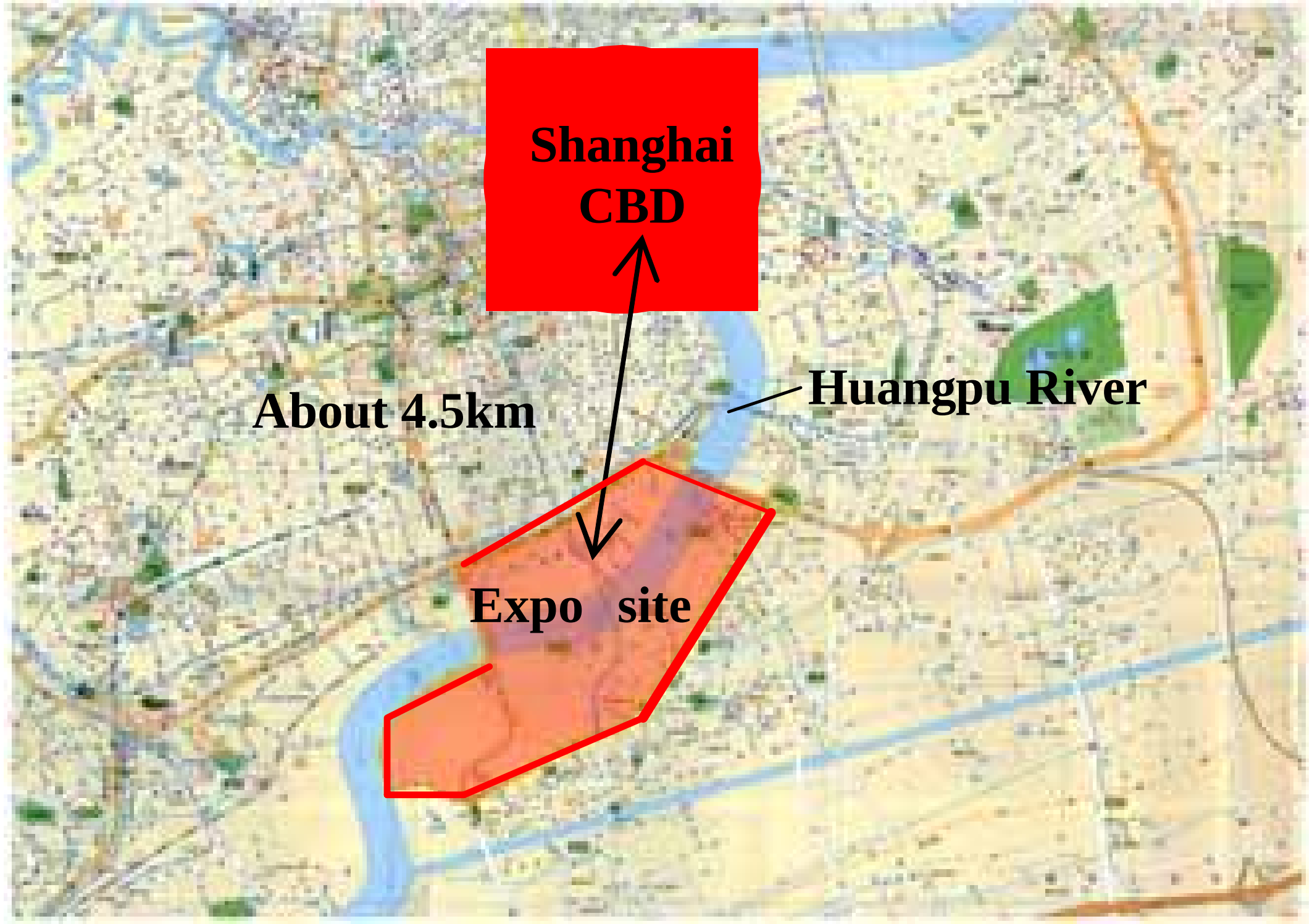
J-Power
Electric Power Development Co.,Ltd

JES
Japan Environment Systems CO.,LTD

Waseda University
Toshio Ojima LAB

Tongji University
Research Center of World Expo 2010

Shanghai Construction committee



Location of the Site and CBD of Shanghai

Outline

Background

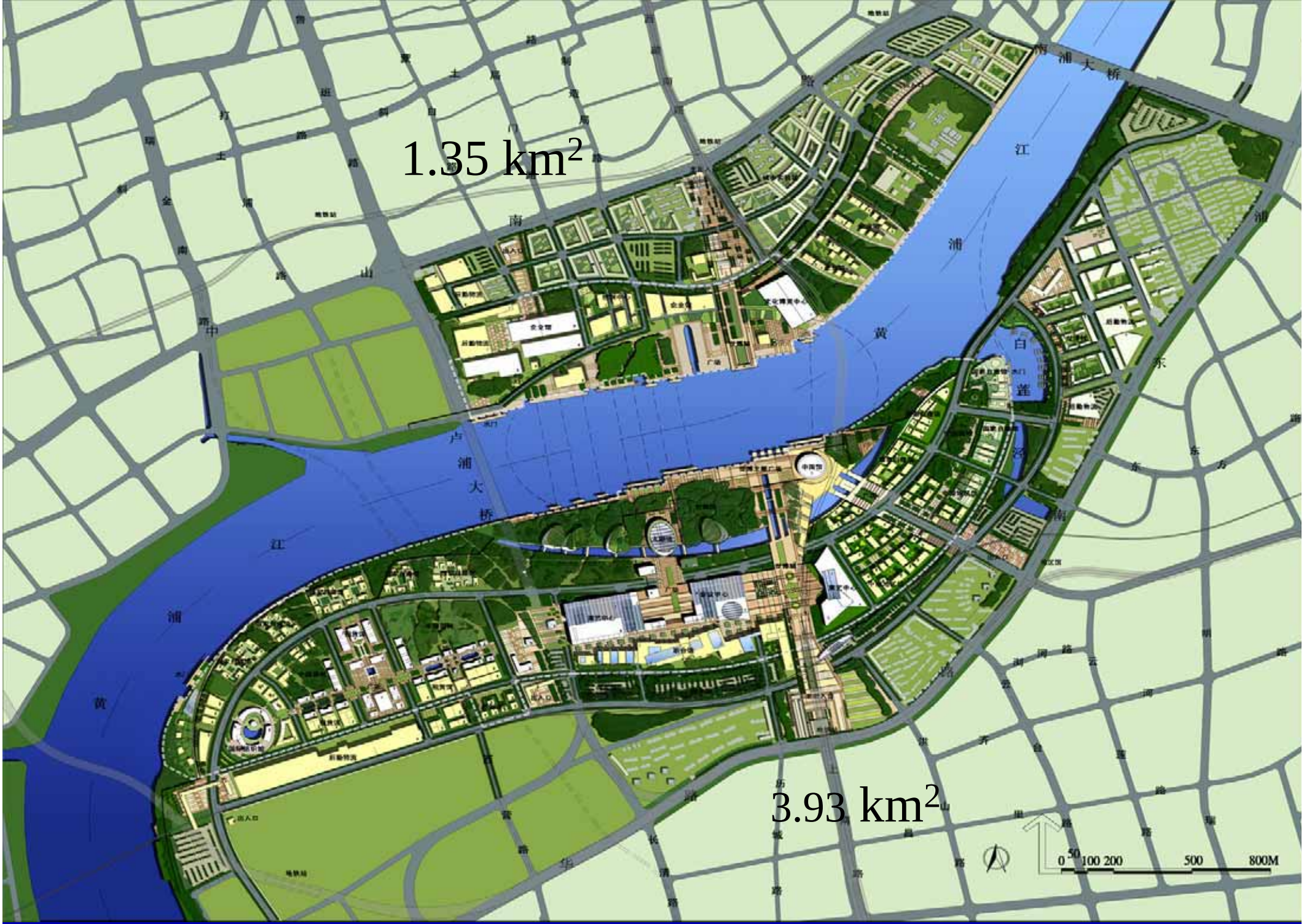
- Better City, Better Life
- After the EXPO, re-development as a world trade city

Basic Consideration

As an example of the east Asian big city, energy infrastructure with a lower environmental load should be built

Plan

- Introduce a district heating/cooling system with distributed generation and unused energy (the river water)
- Introduce the underground multi-purpose utility tunnel which aims toward the improvement of city environment



Master plan of 2010 Shanghai World Expo

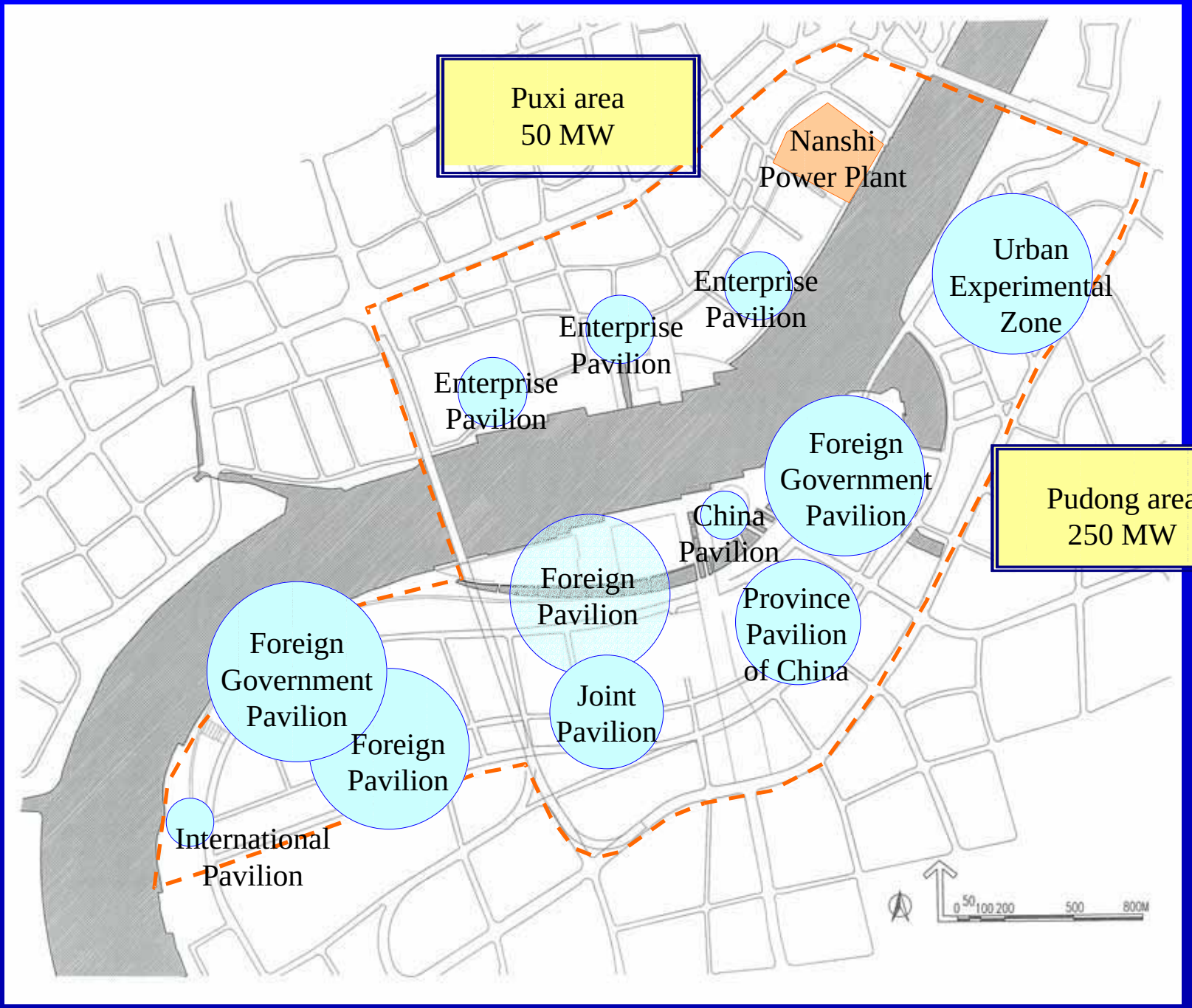
万博サイト

The Scale of Shanghai Expo (comparison with Osaka and Aichi

	Osaka Expo (1970)	Aichi Expo (2005)	Shanghai Expo (2010)
Theme	Progress and Harmony for Mankind	Nature's Wisdom	Better City, Better Life
Area(ha)	350	170	670
The number of attendance(Million)	64	15	70
After Expo	EXPO Park	Park, Village (restoration)	The International Trade Center
Cooling Area (ten thousand m^2)	28.5	10	About 120
Cooling Capacity(kW)	105,000 （30,000RT）	35,000 （10,000RT）	307,900 (88000RT)
Other		Forest	Huangpu River Near Nanshi City power plant

Prediction of maximum cooling load during exposition in 2010

Zone		Floor area	Air conditioning area	Cooling load
Theme pavilion		800,000m^2	703,000m^2	307,900 kW (88,000USRT)
Government pavilions	Foreign government			
	Foreign			
	Joint pavilions			
	China pavilion			
International Pavilions				
Pavilions for Chinese province				
Pavilions for enterprises				
Urban experimental zones		500,000m^2	100,000m^2	
Auxiliary Facilities		700,000m^2	400,000m^2	
Total		2,000,000m^2	1,203,000m^2	307,900 kW

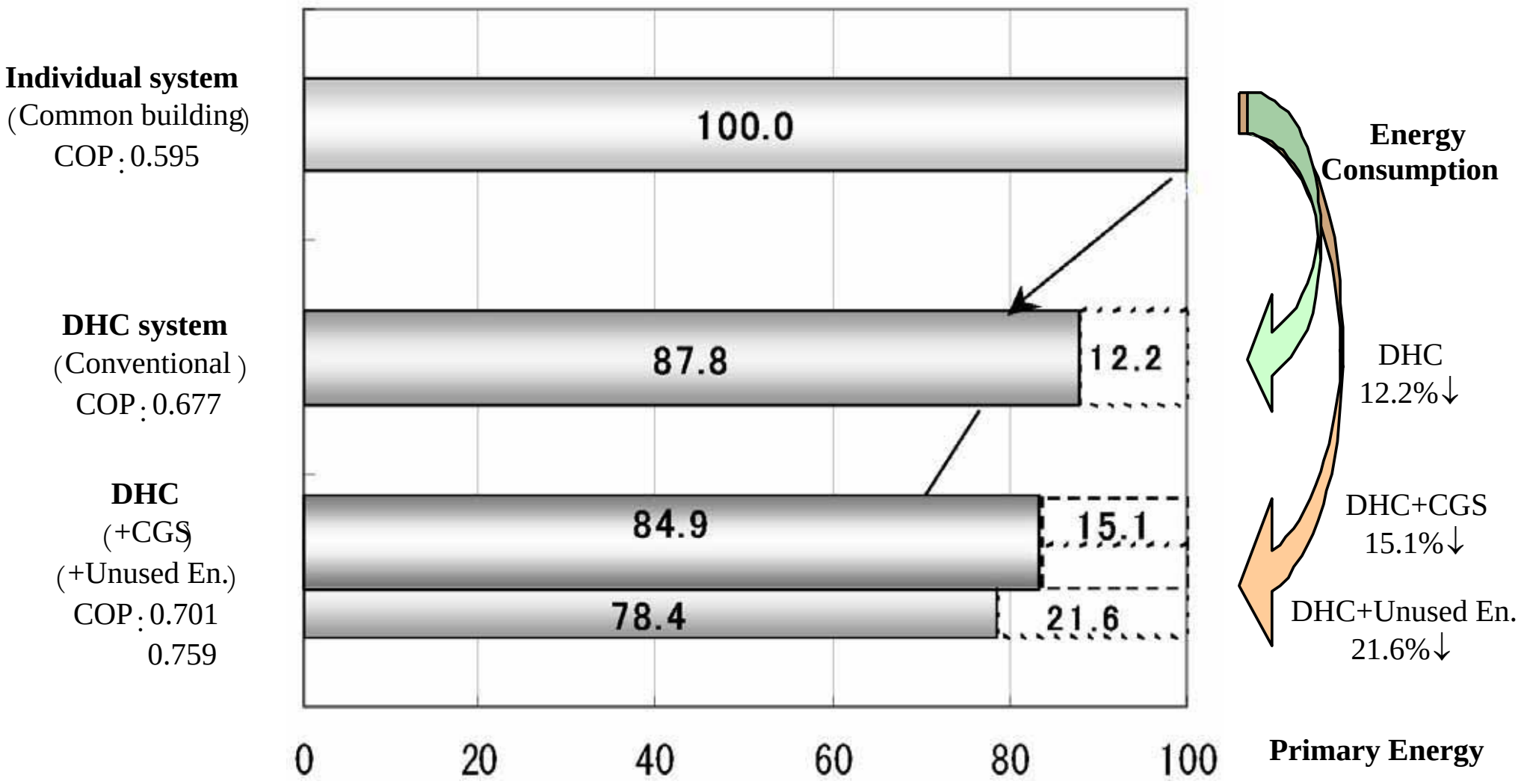


Distribution of cooling load during Expo

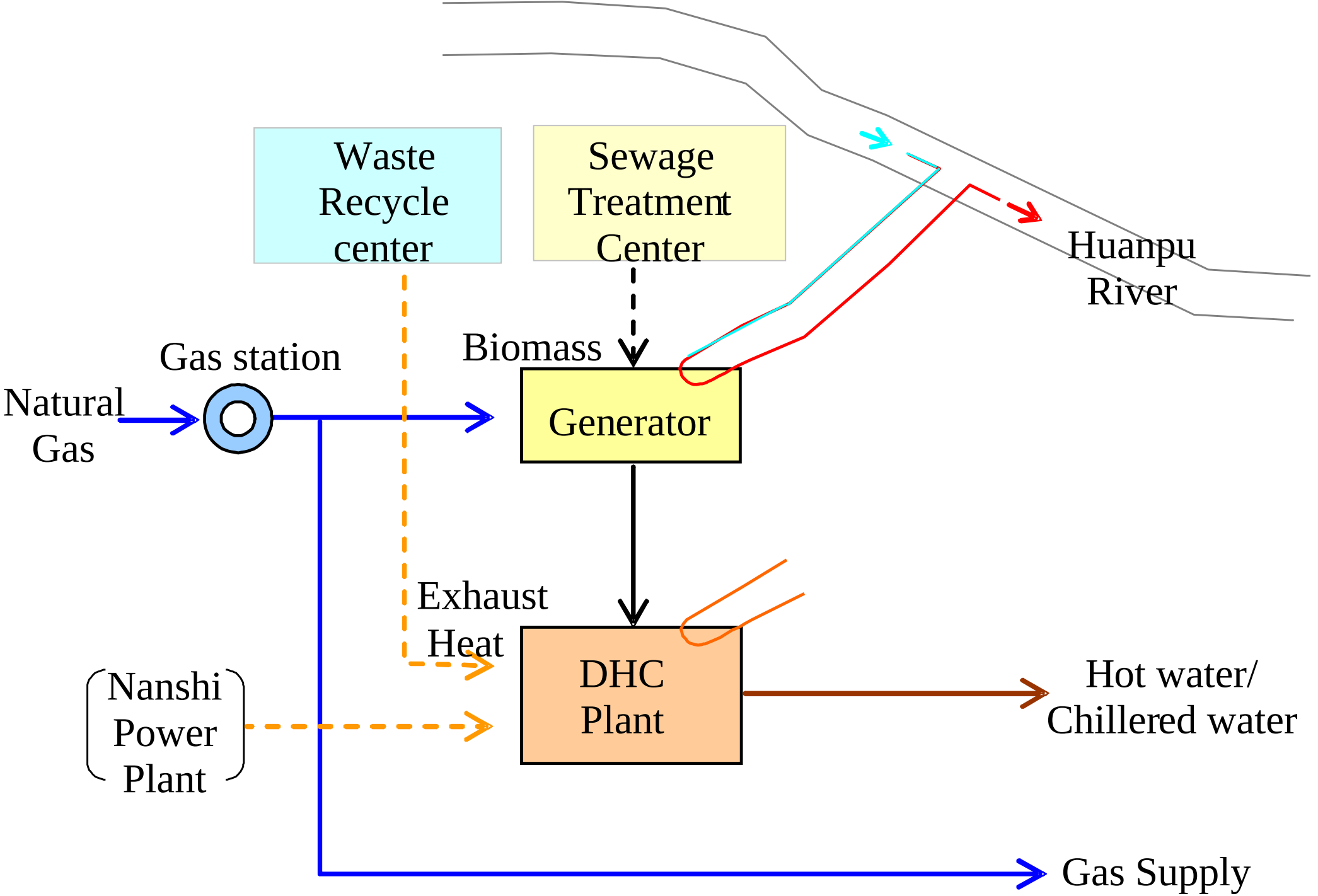
River width 400m,
the depth of water 6m- 8m
flow 200-300m^3/s
Average water temperature in August 29.3 ℃.

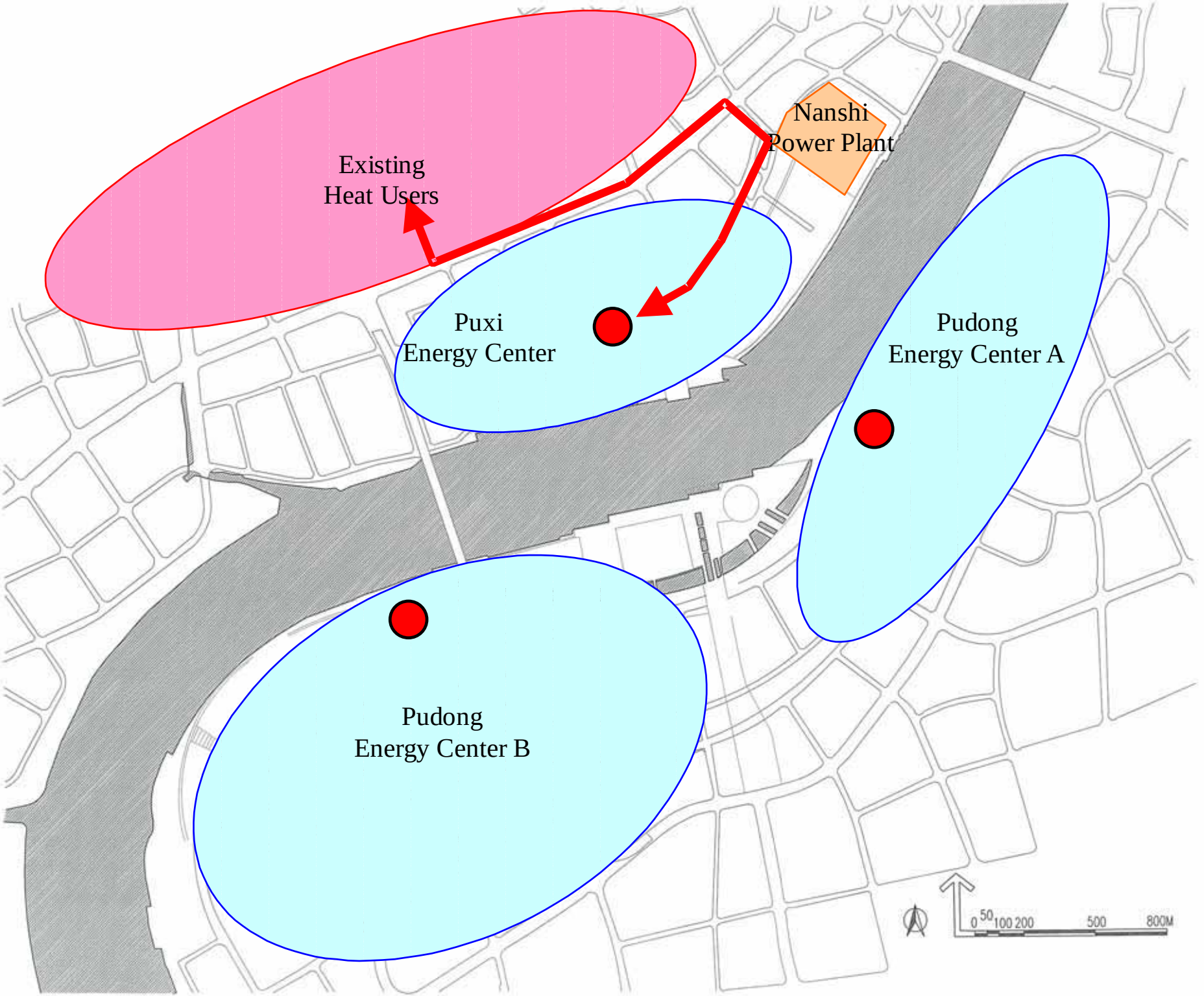
data
boiler: 220t/h×4
generator (air bleeding system): 60MW×2
generator (back air system): 25MW×1
thermal supply area: 8.1km^2

Nanshi city power plant



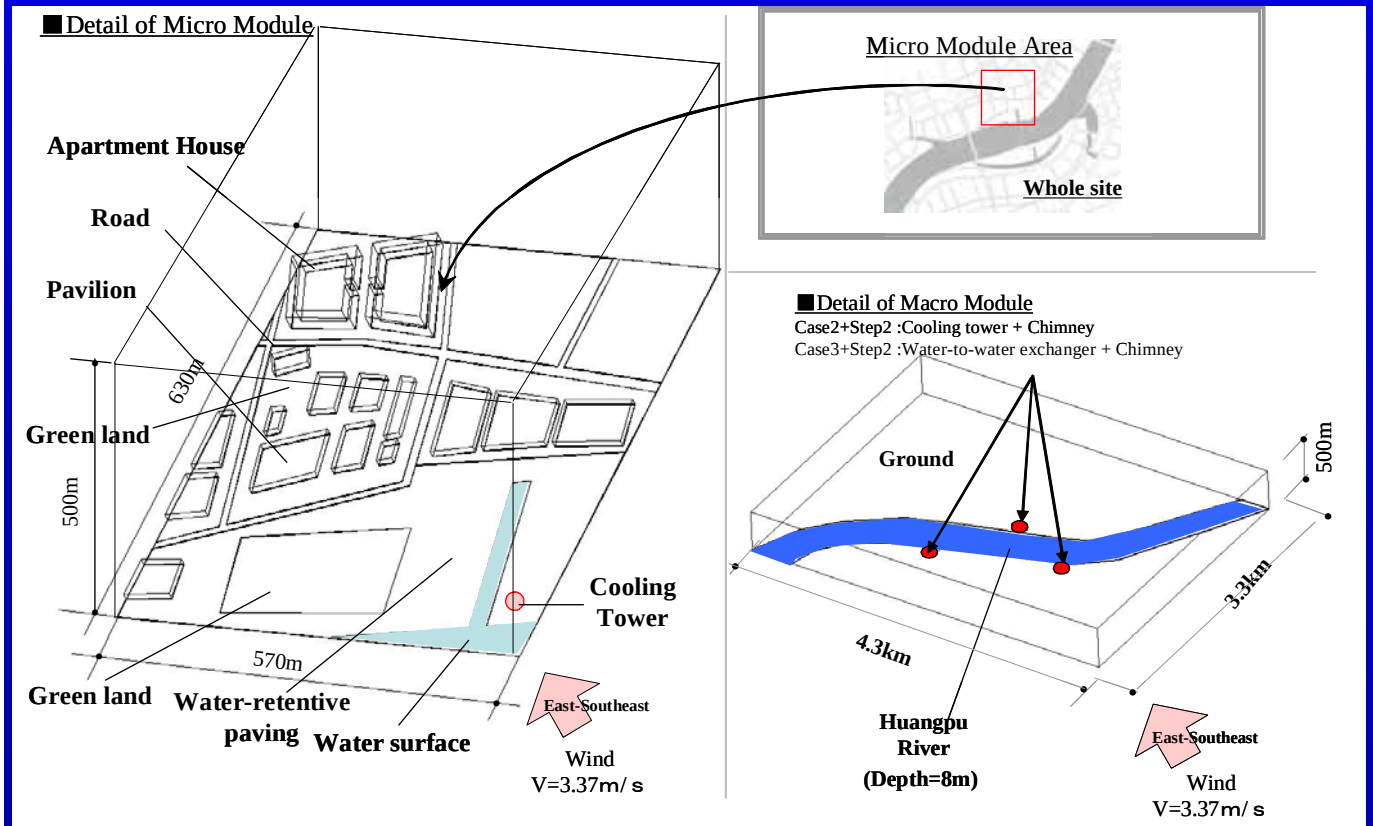
Actual energy savings for DHC systems in Japan

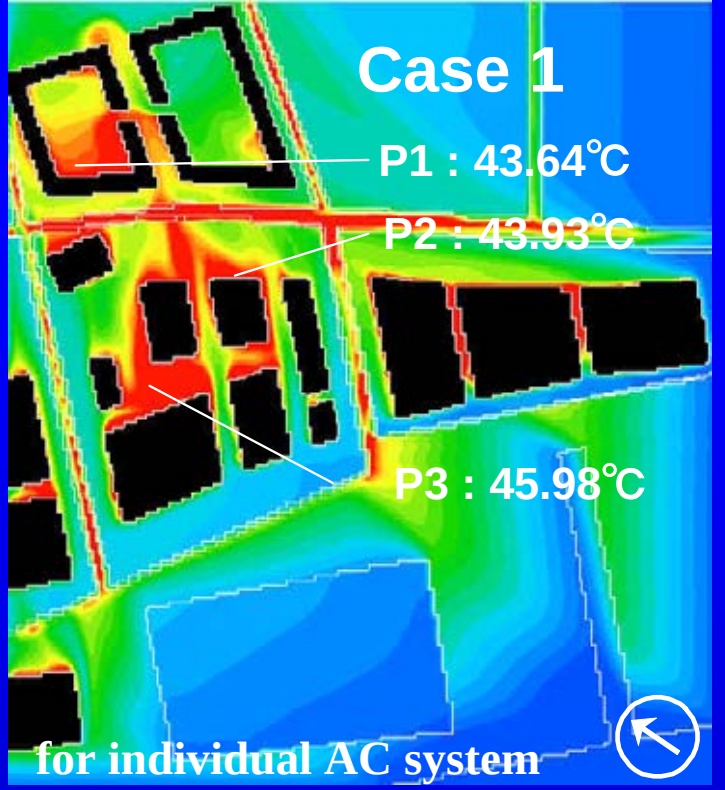

Waste
Recycle
center
Sewage
Treatment
Center
Huanpu
River
Biomass
Gas station
Natural
Gas
Generator
Exhaust
Heat
Nanshi
Power
Plant
DHC
Plant
Hot water/
Chillered water
Gas Supply

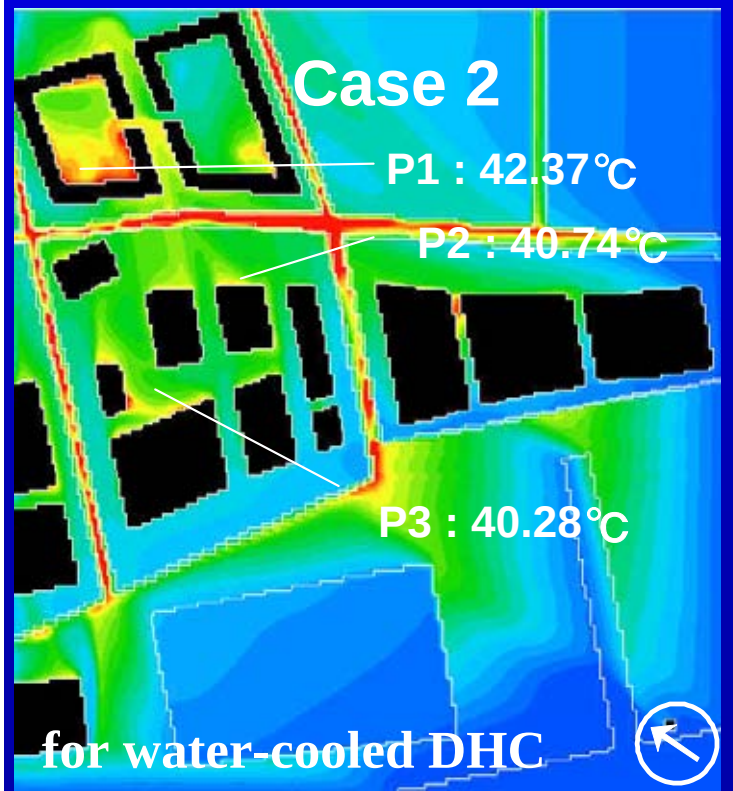

Existing
Heat Users
Nanshi
Power Plant
Puxi
Energy Center
Pudong
Energy Center A
Pudong
Energy Center B
0 50 100 200 500 800M

Thermal Environmental Evaluation

The average air temperature in the Case2 is 0.16°C lower than that in Case1, which shows that the DHC system with water cooling has less heat island effect. Especially at the places surrounded by buildings, such as Point 3, the air temperature in Case1 is about 5°C higher than in Case2.

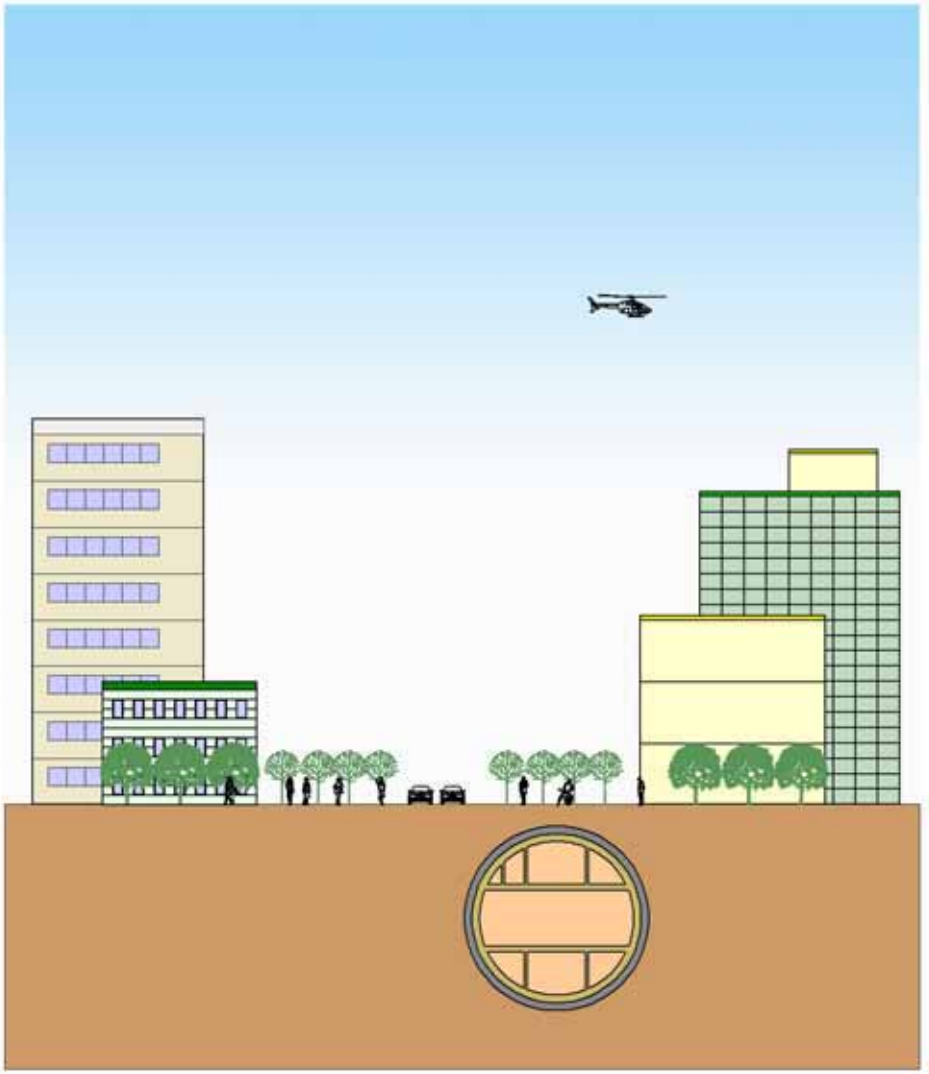




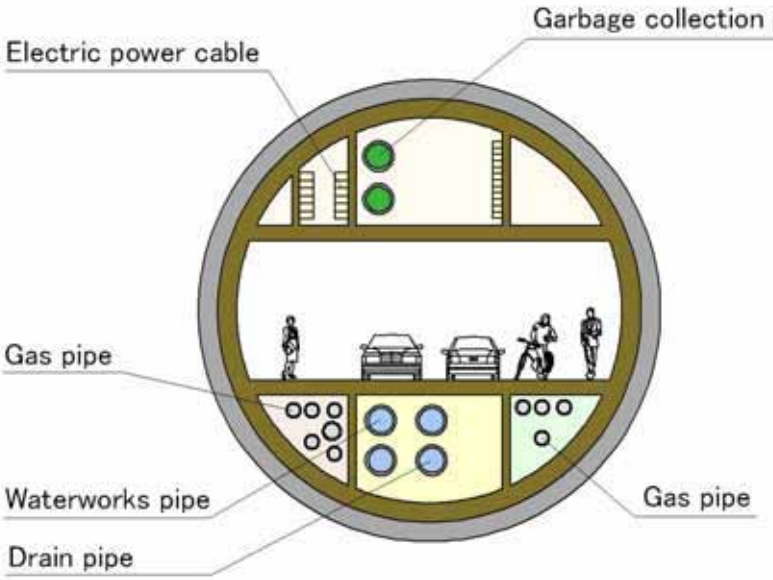


Suggestion for Shanghai EXPO 2010

Underground Life Line (U.L.L)



断面詳細図



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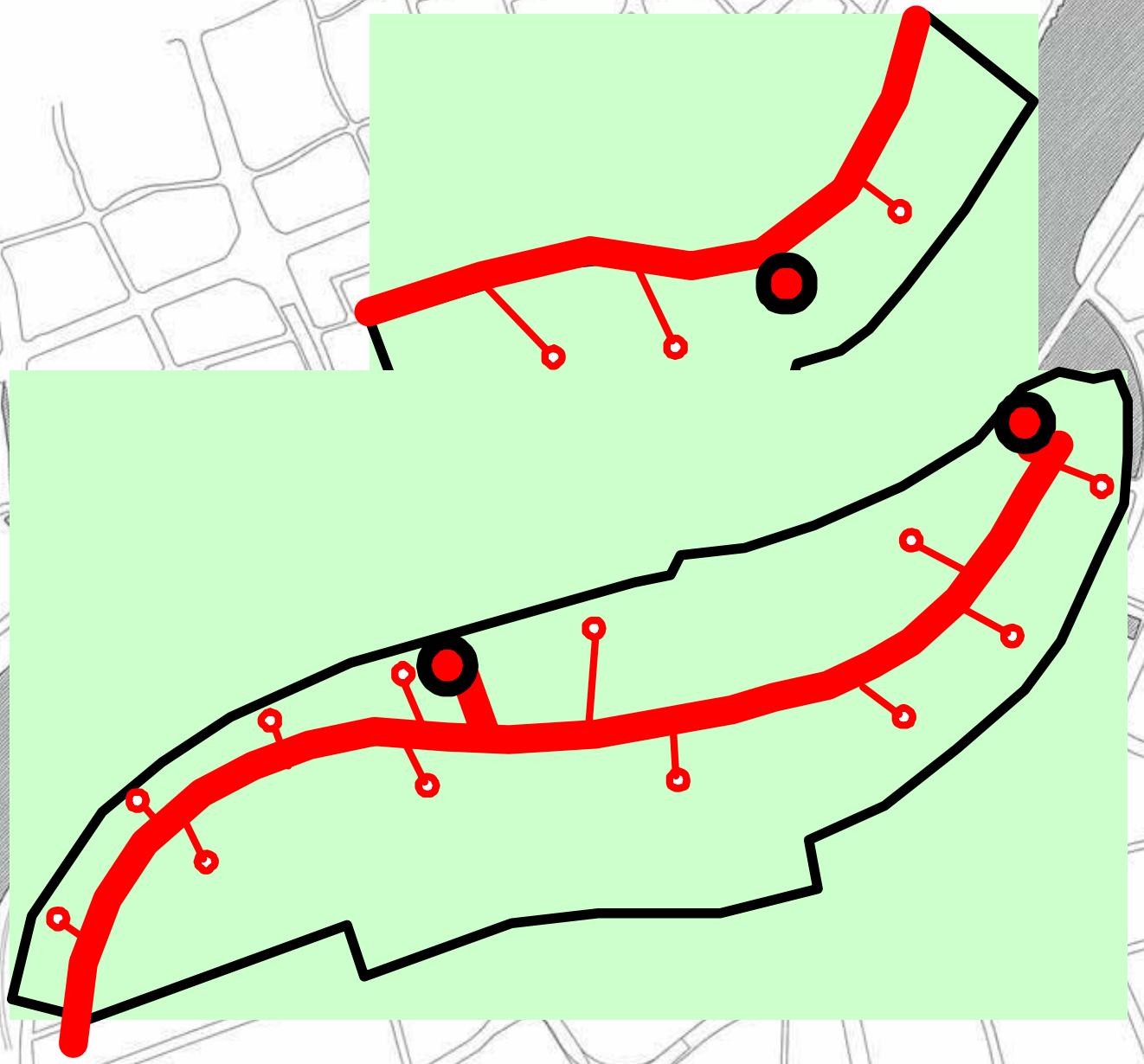
Utility tunnels during exposition



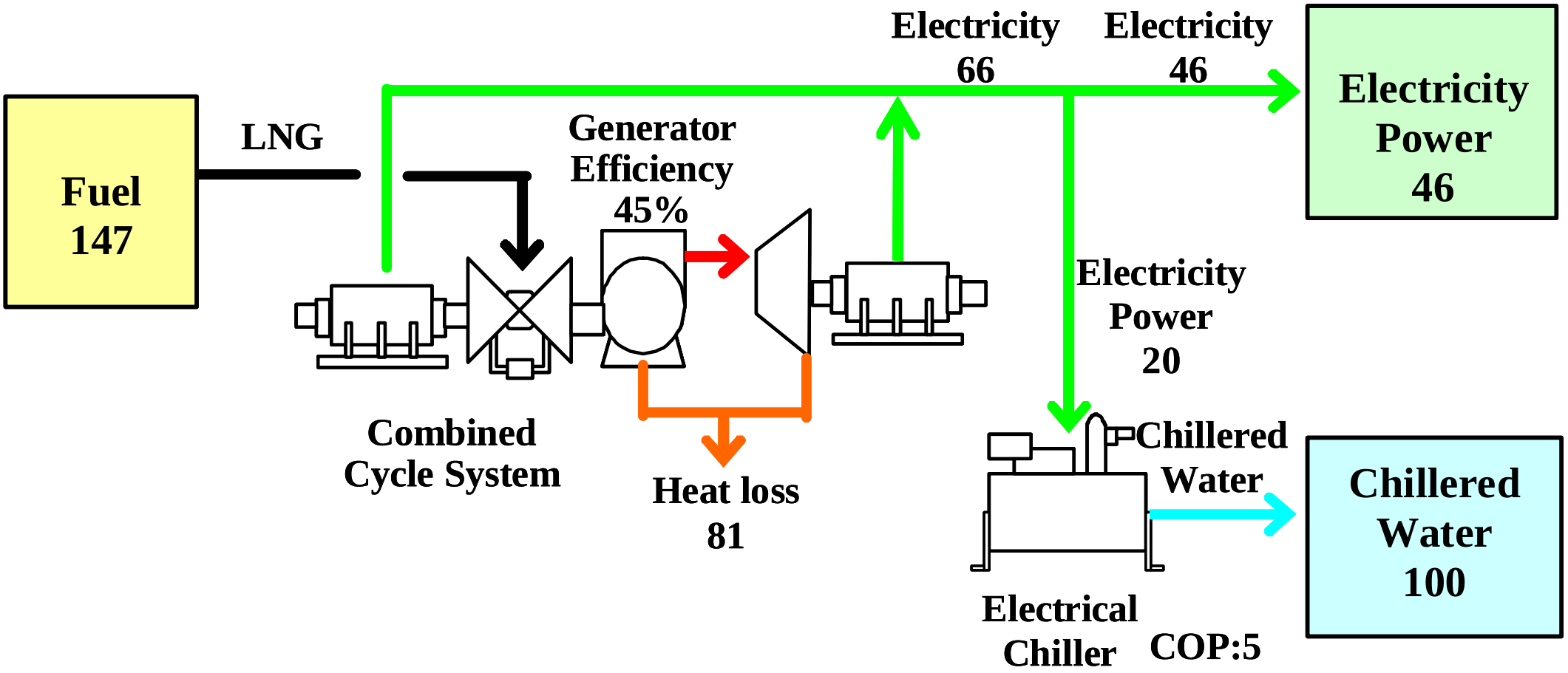
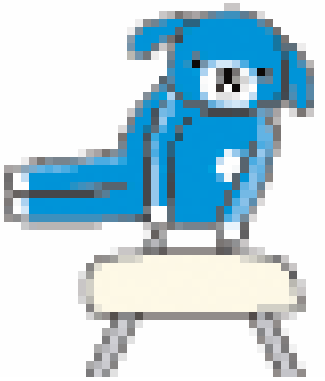


Diagram of combined cycle cogeneration system

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