Decentralized wastewater reclamation systems in Beijing

Adoption and performance under field conditions

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Beijing

- Capital and political centre of PR China
- 16,808 square kilometres
- Land climate; -20 to +40 °C
- Precipitation 585 mm; evaporation > 1500 mm per year

Beijing 2008

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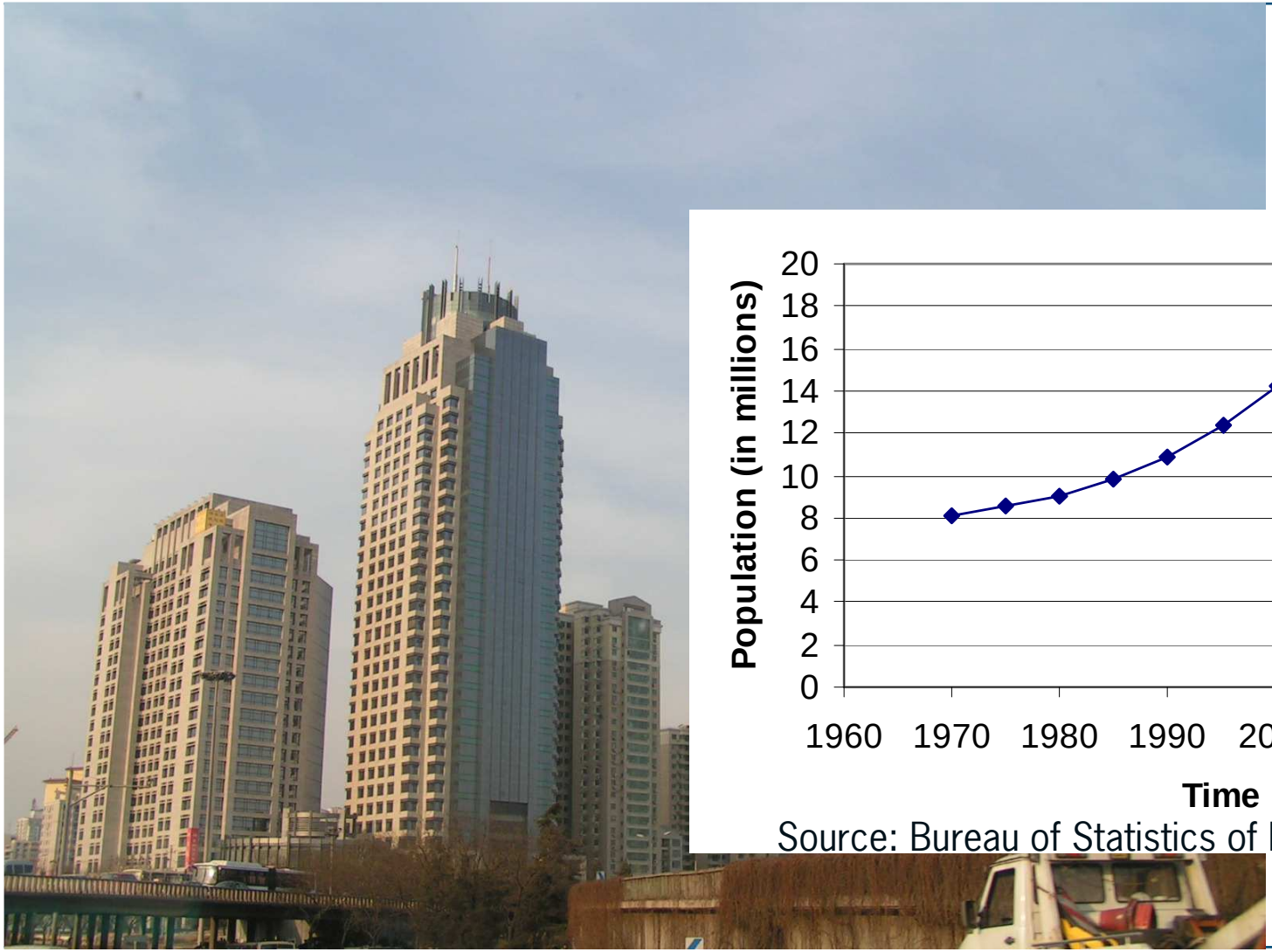
A rapidly growing city



Source: Bureau of Statistics of Beijing Municipality

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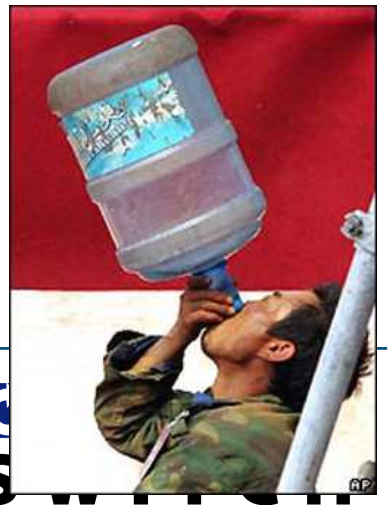
… and a very water scarce city

- Current water availability is < 300 m^3 per capita per year
- Severe overexploitation groundwater
- The shortfall between water supply and demand is estimated to be around 1.8 billion cubic meters by 2010

Measures for alleviating water scarcity in Beijing

- Water saving (410 million cubic meters is planned for 2010)
- South-to-north water diversion project (1.2 billion cubic meters yearly)
- Rain water harvest (150 million cubic meters)
- Wastewater reclamation (640 million cubic meters)

source: Wei et al,2005



Wastewater reuse planning

Current situation of wastewater reclamation systems in urban Beijing (note: this does not include wastewater reuse for agricultural irrigation and industrial reuse:

- four centralized wastewater treatment plants for reclamation with total treatment capacity of 255,000 m^3/day.
- 4000 km pipeline to redistribute the reclaimed water
- 300 - 400 decentralized wastewater reclamation systems with treatment capacity of 50,000 – 60,000 m^3/day

source: Water Saving Office,2006 - 2008

Wastewater reuse planning

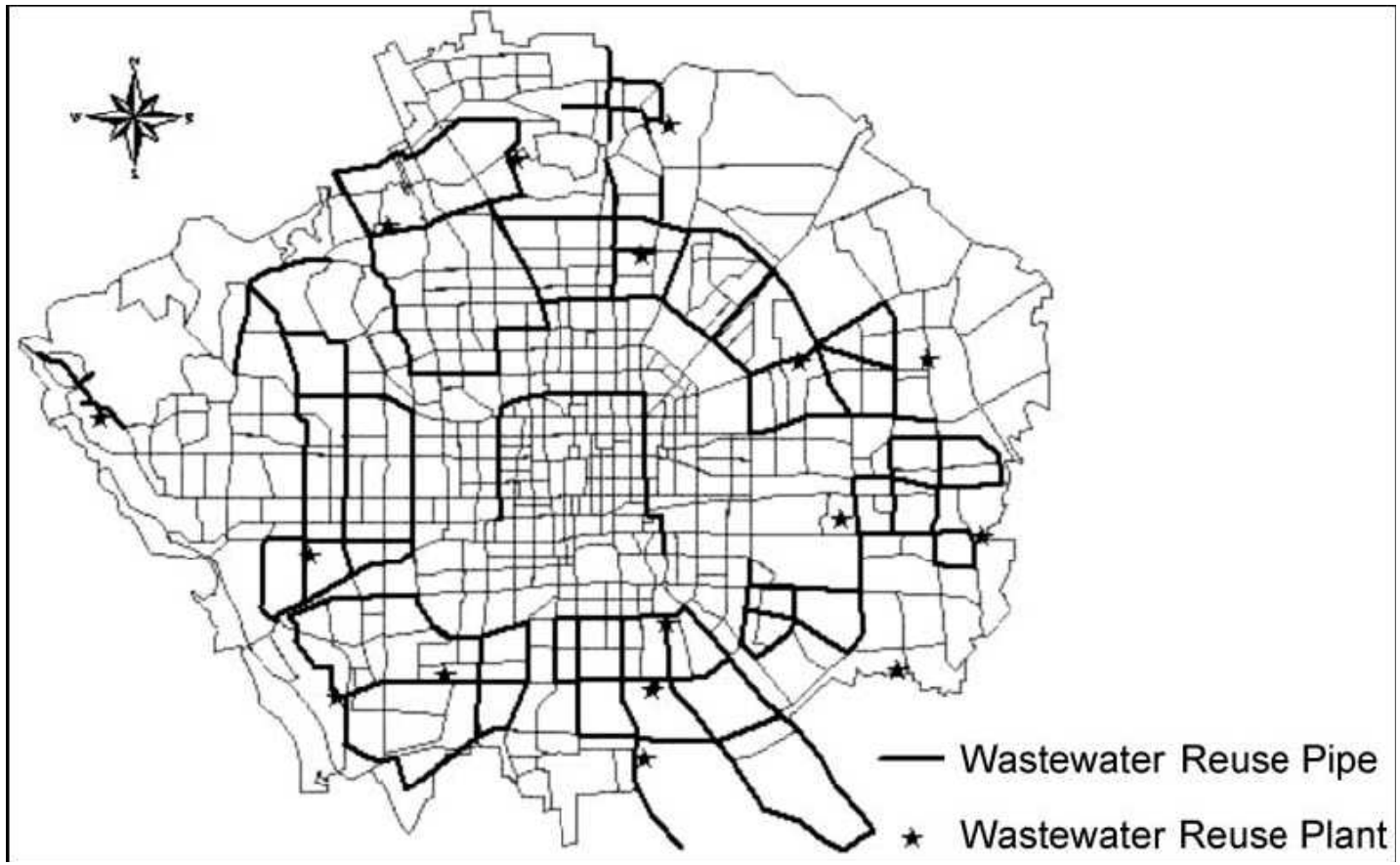


Figure 1. Wastewater reuse planning for the Beijing central region (source: Jia et al., 2005)

‘Management regulation on the construction of wastewater reclamation facilities in Beijing’ (1987)

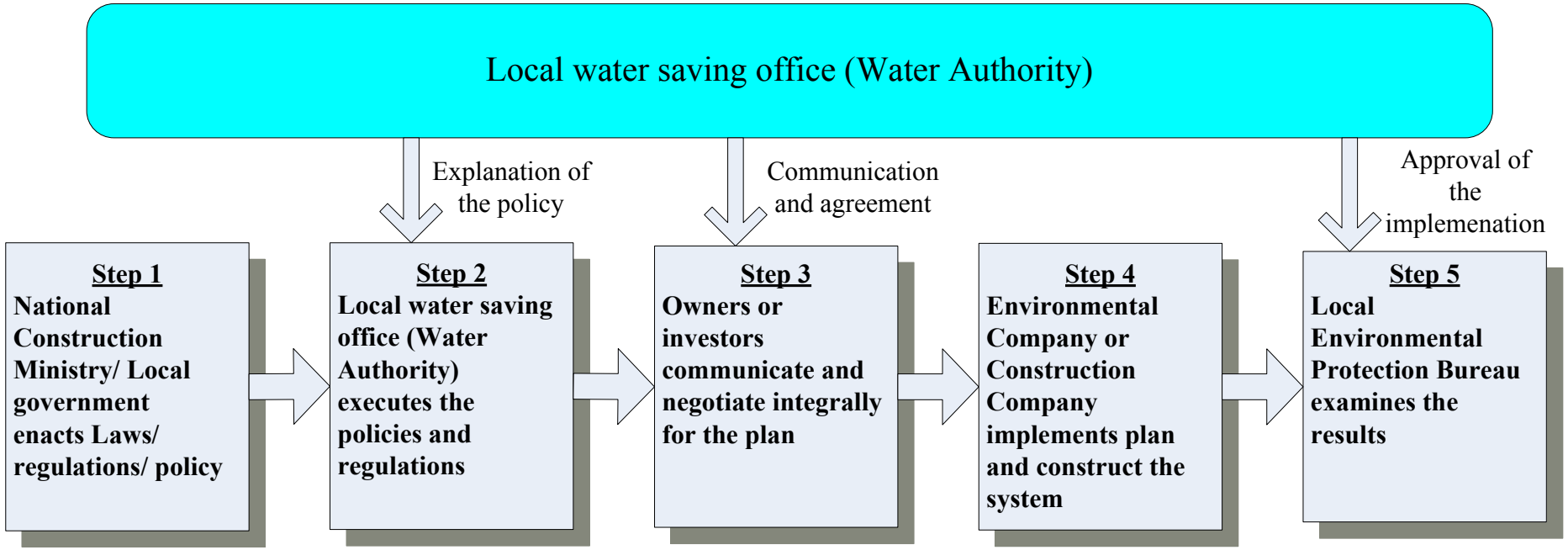
In this regulation the Beijing Municipal Government issued that:

- hotels with construction areas exceeding 20,000 m^2 and
- all public buildings with construction areas exceeding 30,000 m^2

should build a decentralized reclamation facility.

- As of 2001 also new residential areas exceeding 50,000 m2 fall under this regulation

Beijing Water Authority is the responsible local government organization



Reclaimed water quality standards (source: General Administration of Quality Supervision, Inspection and Quarantine, 2002)

No.	Parameter	Toilet flushing	Road cleaning / Fire-fighting	Urban afforestation / landscape irrigation	Car washing	Construction
1	Color ≤	30				
2	pH	6-9				
3	Odor	No unpleasant smell				
3	Turbidity(NTU) ≤	5	10	10	5	20
4	Dissolved Solids (mg/l) ≤	1500	1500	1000	1000	---
5	BOD_5 (mg/l) ≤	10	15	20	10	15
6	Ammonia nitrogen (mg/l) ≤	10	10	20	10	20
7	Anion surfactants (mg/l) ≤	1.0	1.0	1.0	0.5	1.0
8	Fe (mg/l) ≤	0.3	---	---	0.3	---
9	Mn (mg/l) ≤	0.1	---	---	0.1	---
10	Dissolved Oxygen (mg/l)>	1				
11	Free residual chloride (mg/l)	≥ 1.0 after 30 minutes contact ≥ 0.2 at the end of pipes				
12	Coliform Number/L ≤	3				

Research Questions

Although 300-400 systems are in operation hardly any monitoring data are available:

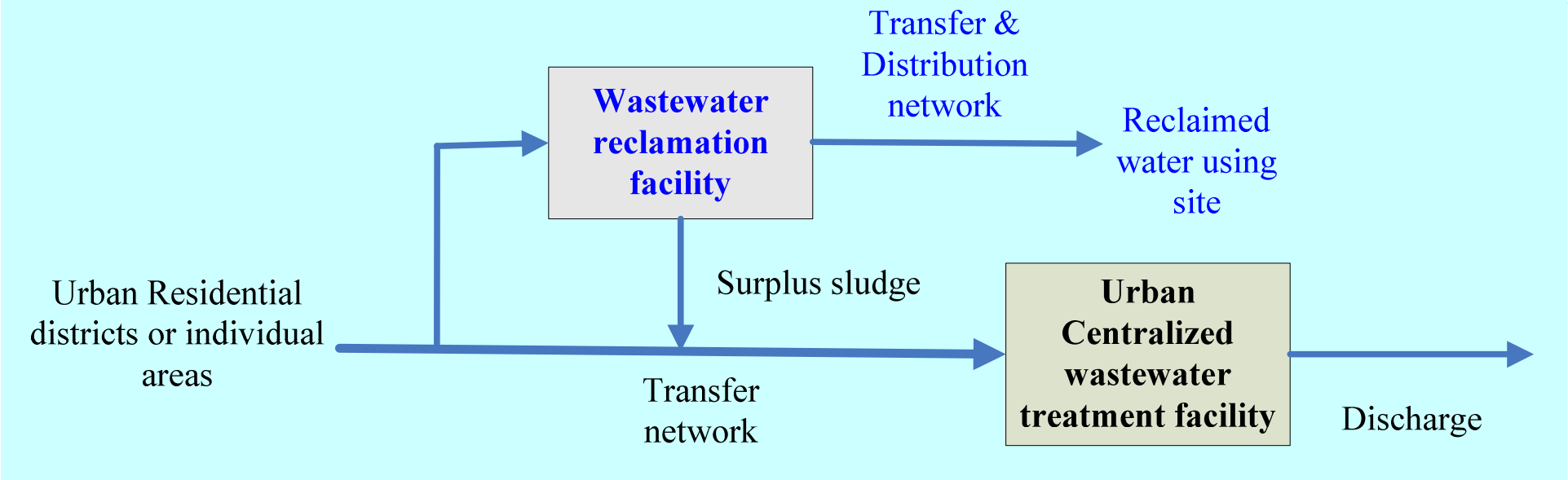
Main research question 1:

What is current performance of decentralized wastewater reclamation cases in Beijing?

Main research question 2:

What are the drivers and barriers of the stakeholders that were responsible for the implementation of the decentralized wastewater reclamation systems?

Decentralized Wastewater Reclamation System



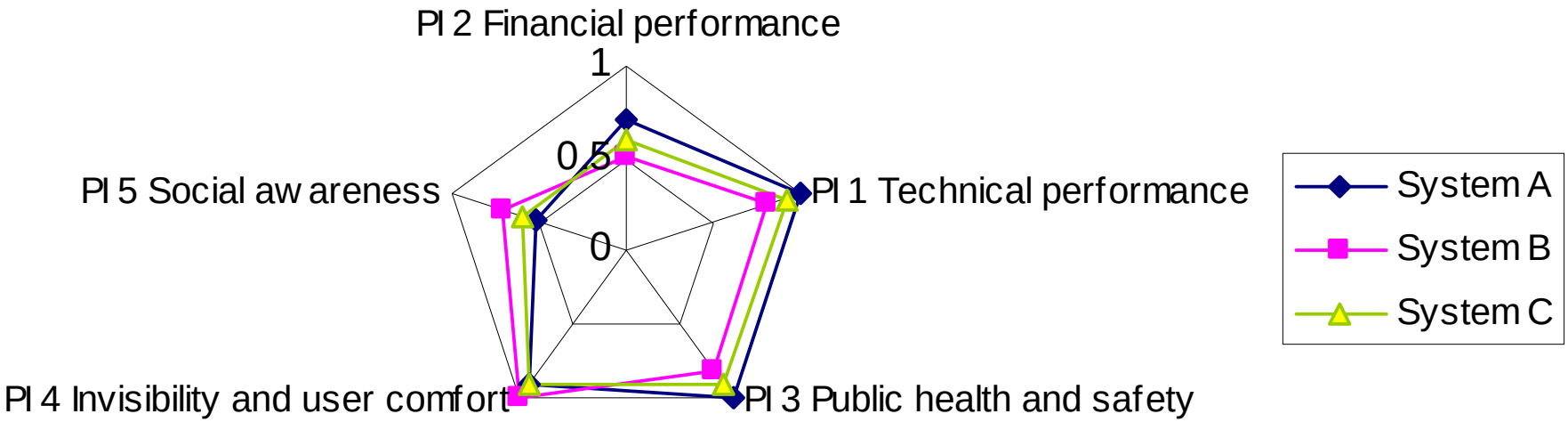
Reclaimed water use:

- Toilet water, road cleaning, landscape irrigation, car washing, construction, fire fighting

Performance Indicators (PIs)

PI 1 Technical performance	System monitoring	Electricity consumption (kWh/m^3)
	Compliance with effluent standards	Time input for O&M
	Effluent use	Yearly failures (frequency and down time)
PI 2 Financial performance	Investment cost (RMB)	Pay back time
	O&M costs (RMB / m^3)	
PI 3 Public health and safety	Effluent quality in relation to use purpose	System accessible for unauthorized personnel
	Illness records	Health and safety of operators
PI 4 Invisibility and user comfort	Odor events / complaints	Invisibility of system (& aesthetics)
	Noise	Space requirement
PI 5 Social acceptability	Awareness of users	Willingness to pay
	Satisfaction on the use of reclaimed water	

Technology selection tool (under development)



Five cases presented (of 9 investigated)

Beijing Jiaotong University

Beiluchun Residential Area

Beijing Normal University

Xin Bei Wei Hotel

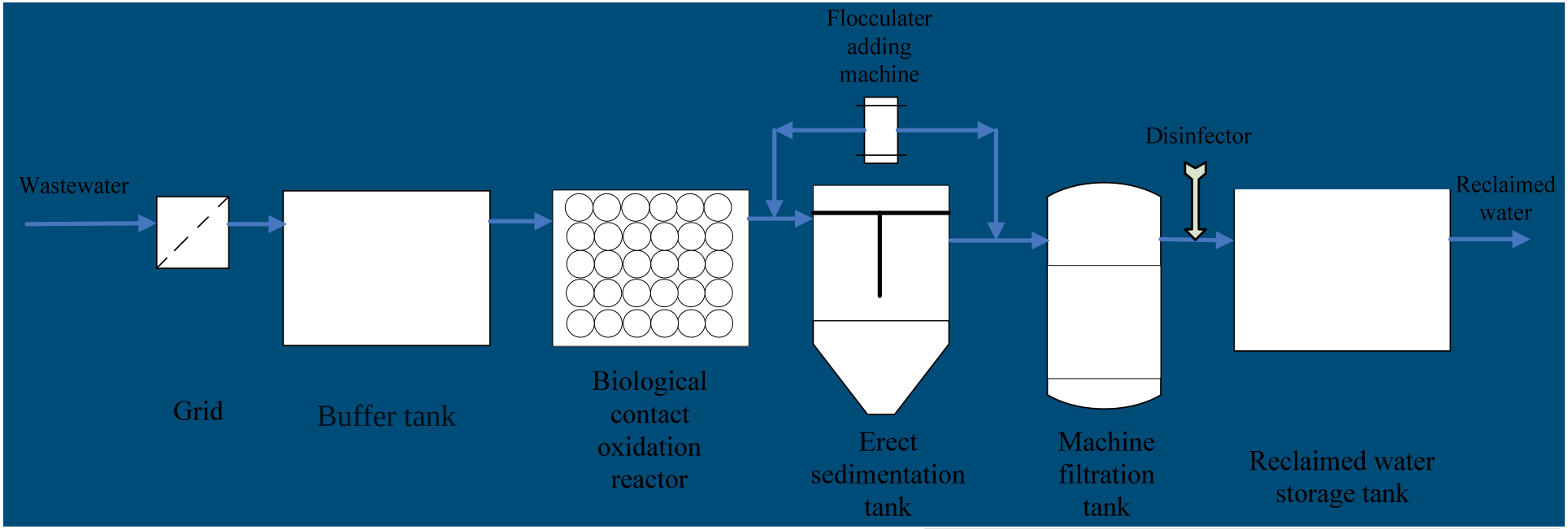
BOBO Garden House Residential Area

Technologies and capacities

Item	Beijing Jiaotong University	Beiluchun Residential area	Beijing Normal University	Xin Bei Wei Hotel	BOBO Garden House Residential area
Established in	1993	1999	2001	2002	2003
Influent source	Grey wastewater	Mixed wastewater	Mixed wastewater	Grey wastewater	Mixed wastewater
Main treatment technology	Activated sludge	Aerated Ceramic Filter	Activated sludge	Contact oxidation + disinfection	Contact oxidation + Activated sludge
Maximal reclamation capacity (m^3/day)	200	640	720	120	1,200
Average reclamation (m^3/day)	150	600	400	80	300[1]

[1] Another 700 m^3 per day are treated and than discharged to the sewer system

Beijing Rainbow Hotel (max. 120 m^3 / day)



Monitoring, operation and maintenance

Question	Beijing Jiaotong University	Beiluchun	Beijing Normal University	Xin Bei Wei Hotel	BOBO Garden House
Is the system being monitored?	yes*	yes*	yes*	yes*	yes*
Compliance with effluent quality standards?	yes	yes	yes	yes	yes
Electricity consumption (kWh/m^3)?	0.75	0.72	1.00	1.50	1.20
Time input (labour) for operation and maintenance (h / year)	n.a.f.**	n.a.f.**	Approx. 8760	Approx. 1825	Approx. 1095
What could be the reason causing a failure of the DWRS?	Power cut	Power cut	Power cut / pump mal-function	pump mal-function ***	Power cut
Any reported failures of the system?	n.a.f.**	n.a.f.**	0	0	0

* monitoring on voluntary basis once per year (no requirement)
** n.a.f. – not asked for, in the first interviews we did not include this question
*** Back-up generator for electricity supply available

Technical performance (final water use)

Item	Beijing Jiaotong University	Beiluchun Residential area	Beijing Normal University	Xin Bei Wei Hotel	BOBO Garden House Residential area
Use purposes for the reclaimed water (% of total)					
- toilet flushing	0%	yes[2]	80%	100%	80%
- landscape irrigation	100%	yes	20%	0%	15%
-street cleaning	0%	no	0%	0%	5%
- car washing	0%	yes	0%	0%	0%
- fire water storage	0%	yes	0%	0%	0%

Financial performance

Item	Beijing Jiaotong University	Beiluchun	Beijing Normal University	Xin Bei Wei Hotel	BOBO Garden House
Established in	1993	1999	2001	2002	2003
Investment costs for the treatment system (RMB)	300,000	1,400,000	3,400,000	600,000	3,000,000
Operation and maintenance costs (including labor costs) (RMB/m^3)	0.75	1.08	1.50	1.13	1.72
Current price of the tap water (RMB/m3)	3.7	3.7	3.7	6.1	3.7
Pay back time (years)	**1.9**	**2.4**	**10.6***	**4.1****	**13.8***

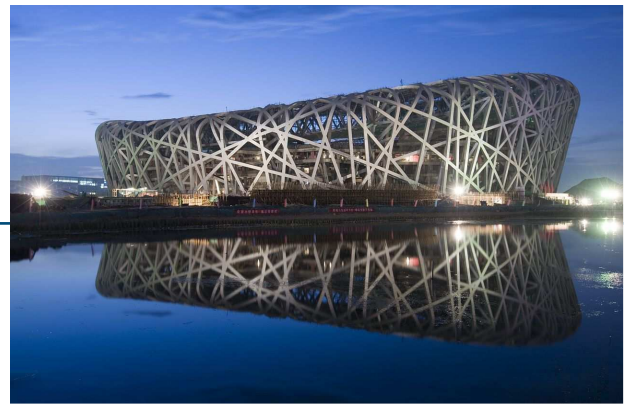
* pay back times of 5.1 and 6.3 years at a tap water price of 6.1 RMB / m^3
** pay back time of 8.0 years at a tap water price of 3.7 RMB /m^3

Awareness of users

Item	Beijing Jiaotong University	Beiluchun	Beijing Normal University	Xin Bei Wei Hotel	BOBO Garden House
Awareness on the use of reclaimed water	0%	--	80%	40%	50%
Wastewater reuse is considered positive (only asked if people were aware(	--	--	yes	yes	yes
Number of Respondents	10	--	14	10	10

Some conclusions

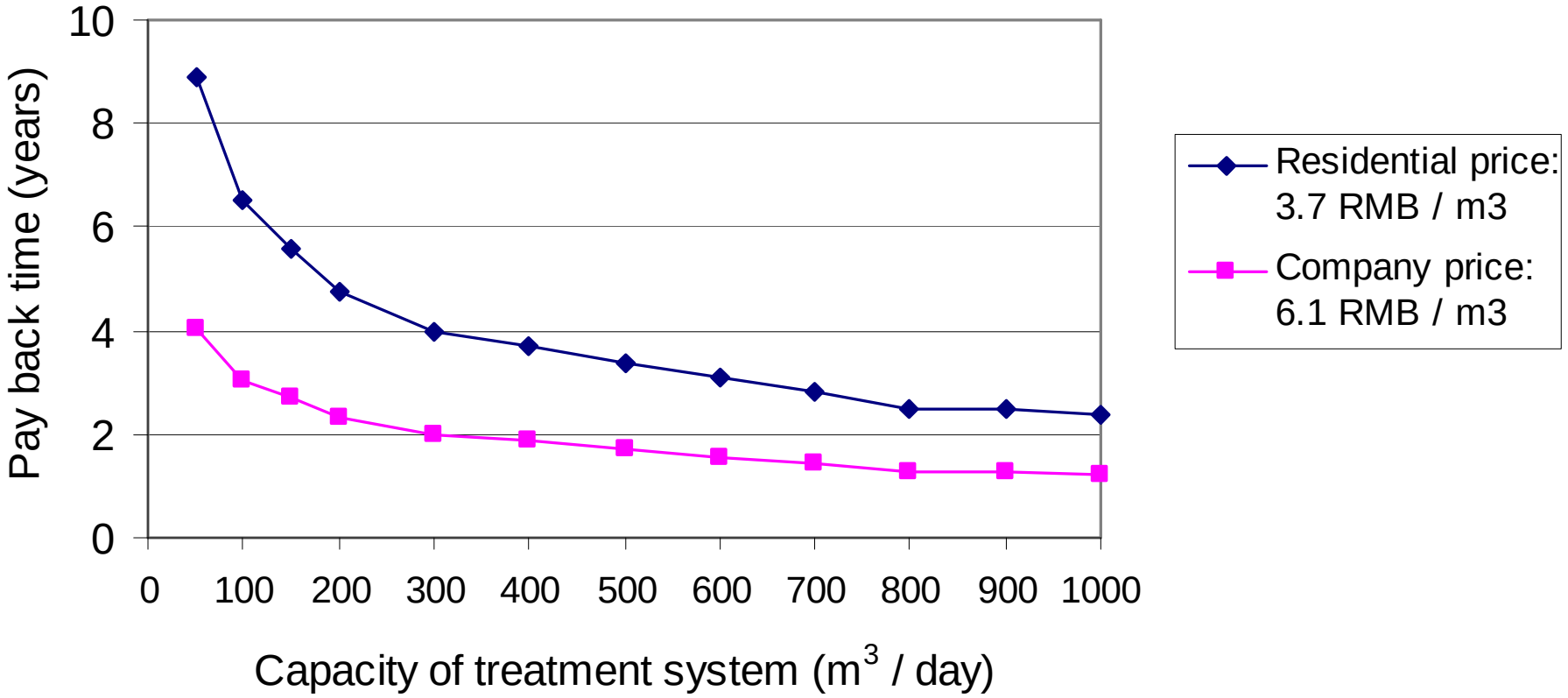
- Both mixed and grey wastewater is reclaimed, various techniques (contact oxidation, activated sludge systems, SBR systems).
- Systems function well although effluent monitoring is done on voluntary basis and real quality control by an independent party is lacking.
- Awareness is moderate to high, and users that are aware see it as positive



Drivers and barriers for implementation

- There is a strong financial driver to implement DWRSs, because of the relatively short pay back times, especially for the private sector.
- Other drivers are related to the regulations and to awareness on water scarcity issues.
- Universities (3) also use it as educational tool
- Barriers are high initial investment costs and uncertainty about water charge (for the residential areas)

Pay back time when using at full capacity



(based on data of Jia et al, 2005)

Acknowledgement

This study was supported by the European Commission through the 6th Framework Integrated Project SWITCH (Sustainable Water management Improving Tomorrow's Cities' Health)

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Questions?

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