Enhancement of Waterworks' Revenue Water Ratio (RWR) :

Policy implementation by disseminating successful cases and transferring know-how

Cheol Han Kim

K-water HRD Institute

CONTENTS

1. Introduction

Overview of K-water

Korea Water Resources Corporation

- Established in 1967
- Number of employees 5,600

Total Water Service Provider

Water Resources

20 multi-purpose dams
14 water supply dams
3 flood control dams
16 multi-function weirs

Water Supply

35 wide area waterworks
13 industrial water supply systems
23 local waterworks by consignment

Sewage Treatment

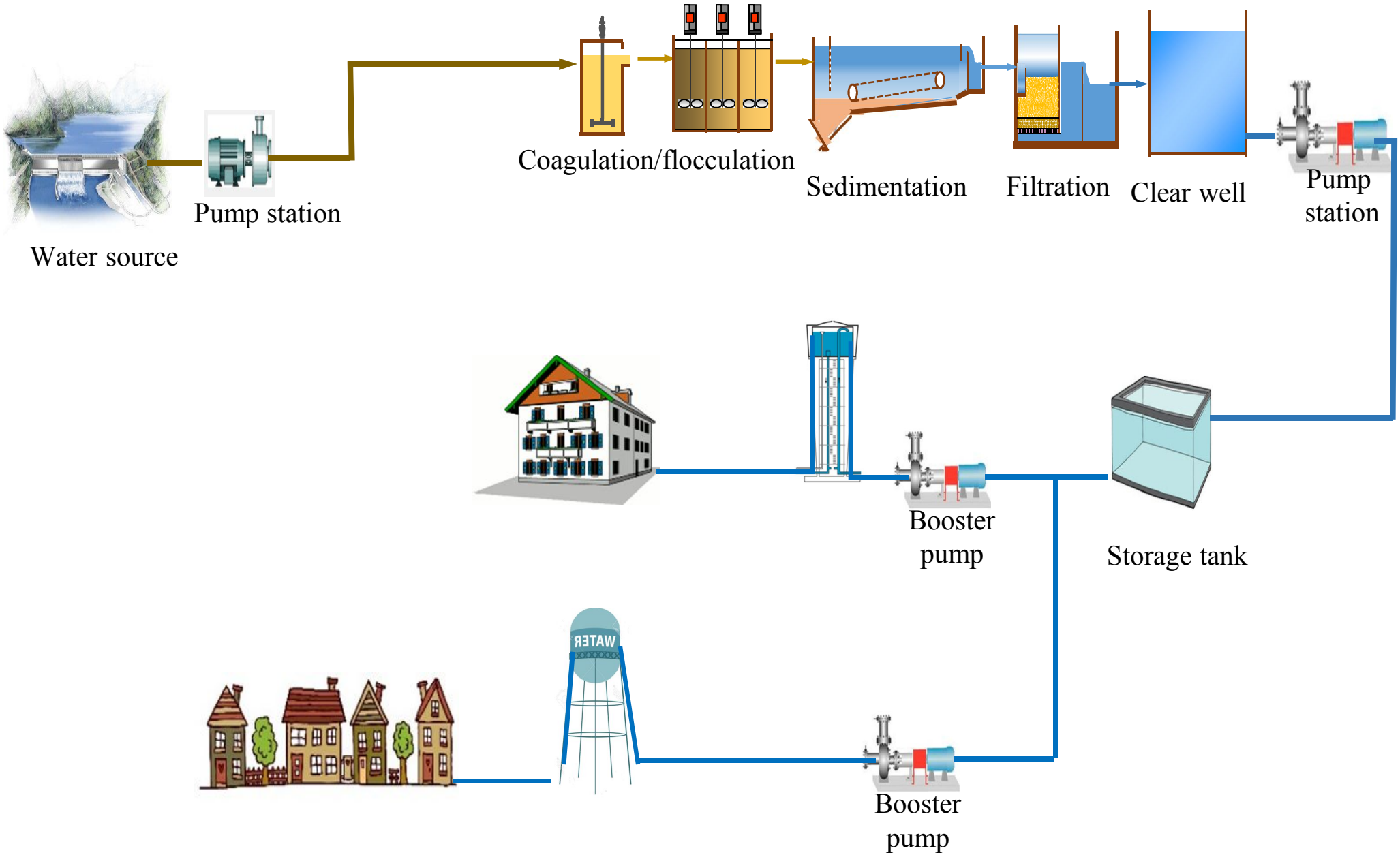
18 sewage treatment facilities by consignment

Renewable Energy

12.3% (1,356MW) of the nation's new renewable energies (10,991MW)

2. Context of the Case

Basic Water Supply System



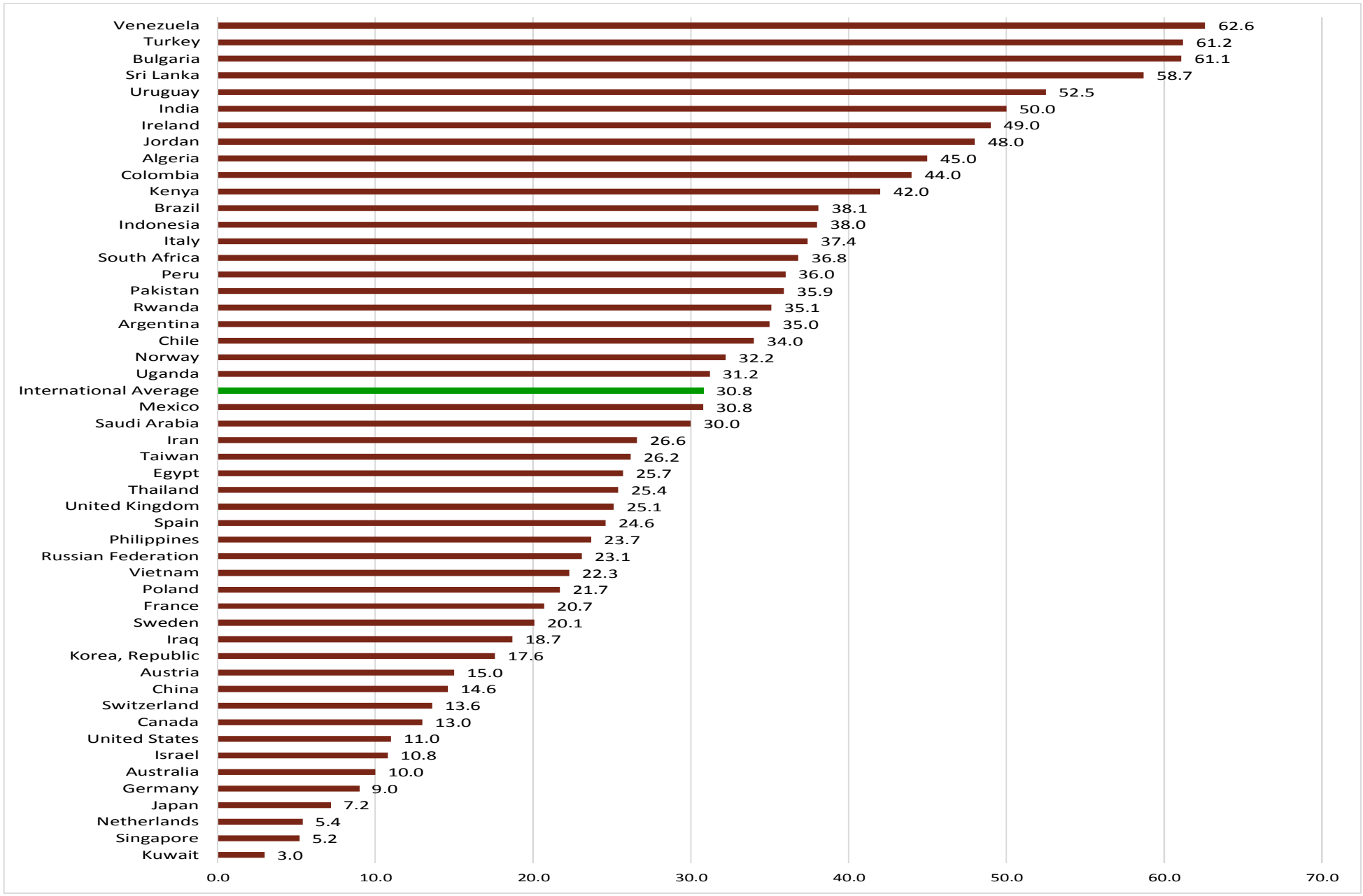
Revenue Water and Non-Revenue Water

- Revenue Water (RW) : Billed Authorized Consumption
- Non-Revenue Water (NRW) : Water Losses and/or Unbilled Consumption
- Revenue Water Ratio (RWR) : the ratio of revenue water volume to the produced water volume which was provided into a distribution system

Contradiction of Water Service

- **Considerable Costs to Supply Water**
  - Construction cost to build infrastructure
  - Human labor
  - Variable costs; material costs and electrical energy
- **Water Losses after Being Treated**
  - A significant portion of treated water is lost through underground pipe leakages
- **Water Shortage and Needs for New Water Resources**
  - Climate change, rapid urbanization and population growth accelerate water shortage globally
  - Needs to secure new water resources

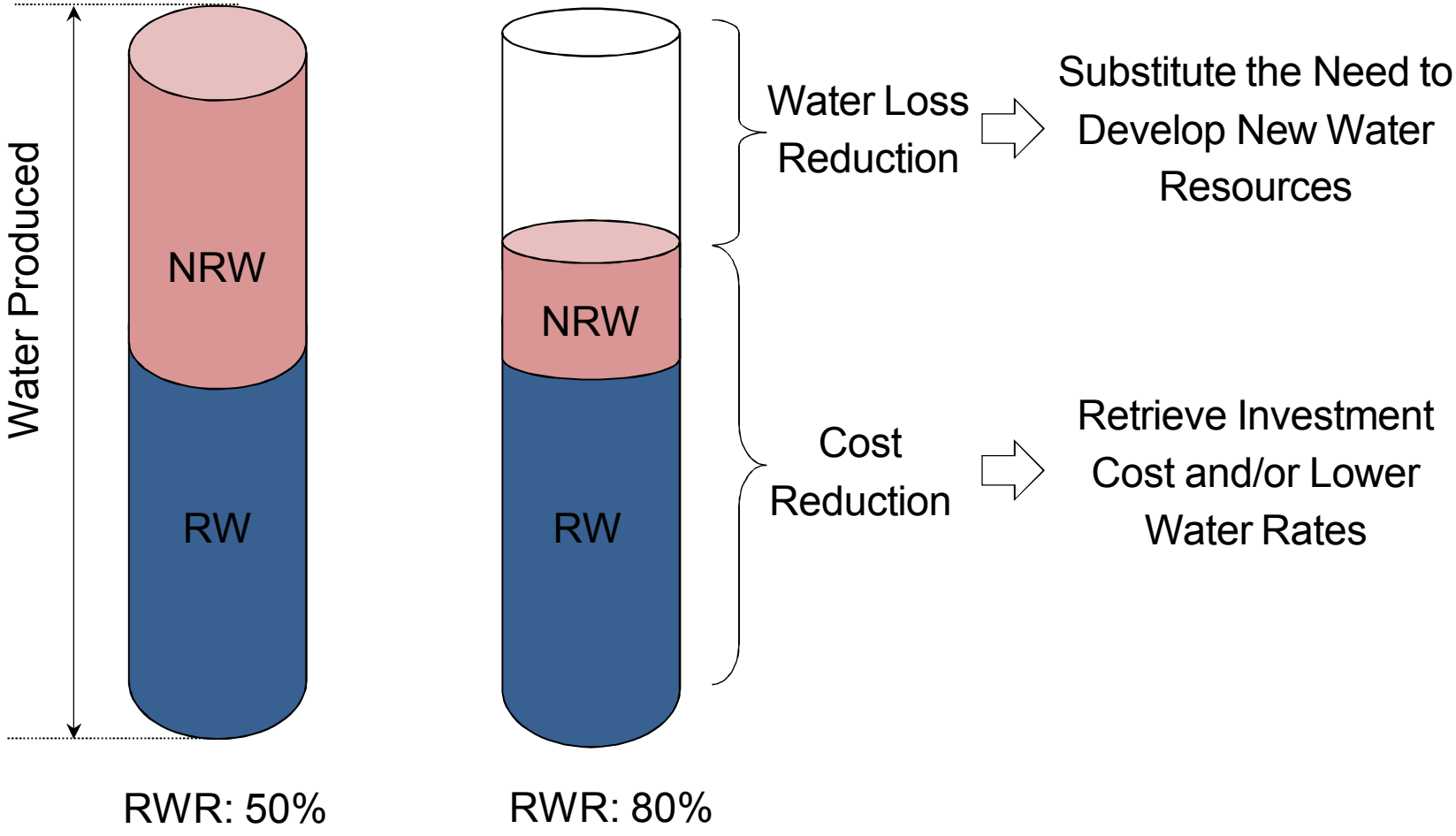
International Non-revenue Water Ratio



Source: Calculated from the *Global Water Market 2017*, Global Water Intelligence (GWI). 2017.

Concept of the Revenue Water Ratio (RWR)

- Reduce production cost for the same amount of water billed
- Reduce water losses and substitute the needs to develop new water resources



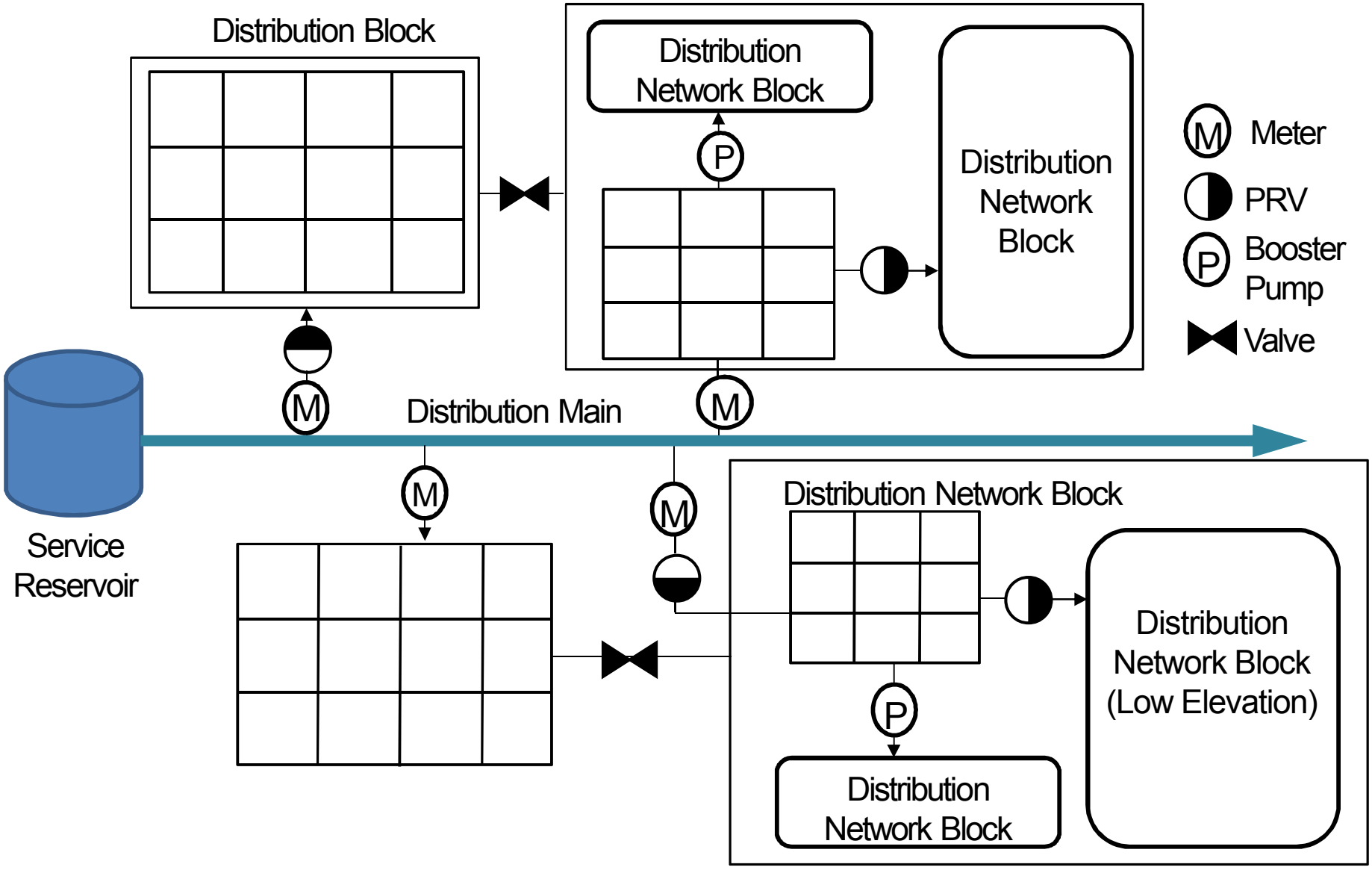
Saved production Costs are Used..

- To invest in the improvement of infrastructure of local water supply systems and retrieve the investment cost through the savings generated by reducing leakages

RWR	Before (50%)	After (80%)	Difference
Total Production Cost	600	375	225
Revenue Water	300	300	-
Non-Revenue Water	300	75	225

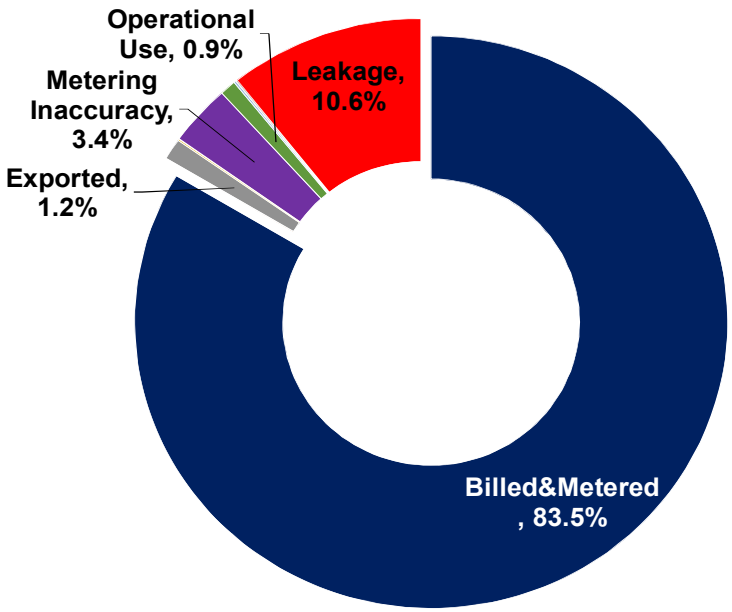
Pipeline Network and Leakage

- Total length of the pipeline network in Korea is 203,859km : 5 times that of the equatorial circumference of the Earth



Water Balance of Waterworks in Korea

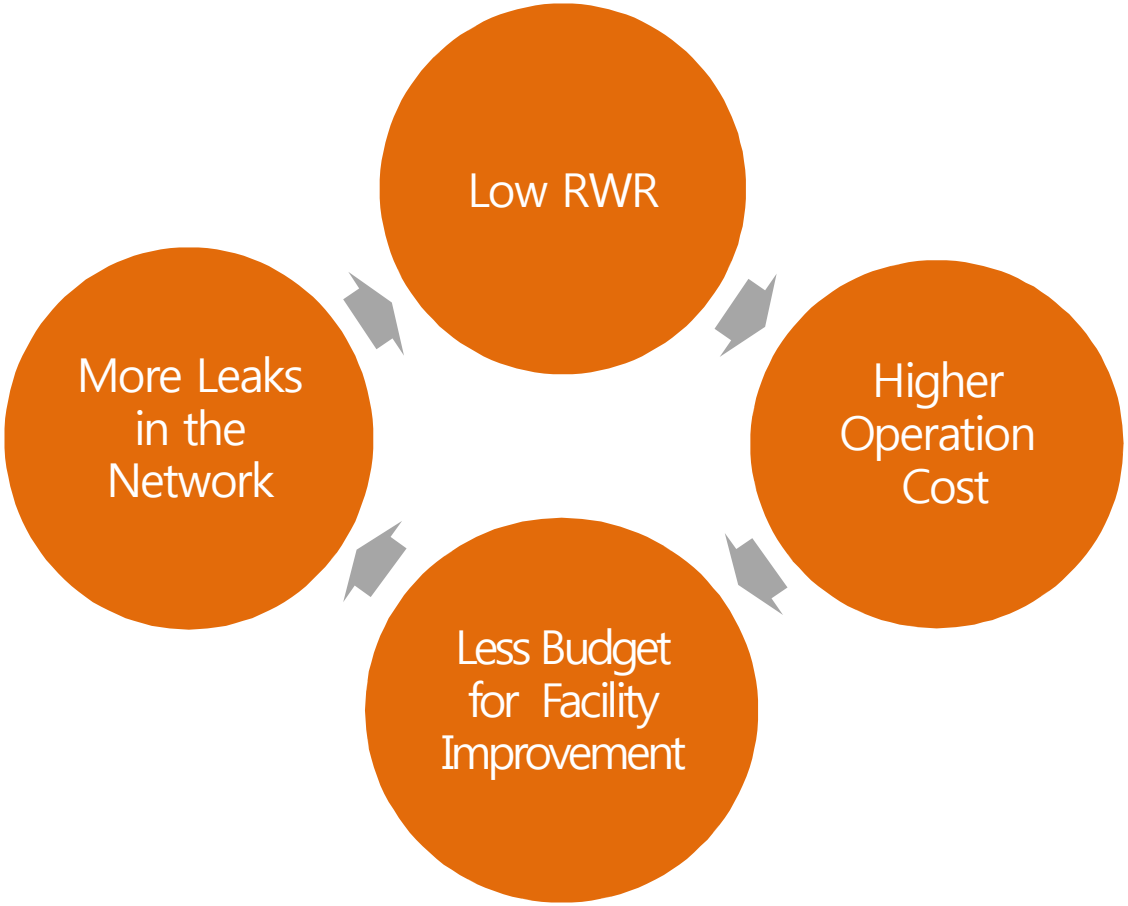
- Annual quantity of water loss is about 682 million tons
- Total revenue loses amount to 436 million USD.
  - 16 dams need to be built to secure the same amount of water loss at a cost of 5.96 billion USD (6,550 billion KWR)



Category	Water Components	Quantity	Ratio
Revenue Water (RW)	Billed & Metered	5,363,113,495	83.54
	Billed & Unmetered	652,370	0.01
	Water Exported	76,096,403	1.19
	Other Billed Water	6,116,190	0.10
Non-revenue Water (NRW)	Operational Use	56,718,624	0.88
	Public Use	8,082,743	0.13
	Usage Adjustment	6,009,555	0.09
	Metering Inaccuracy	220,195,397	3.43
	Unauthorized Use	460	0.00
	Leakage	**682,503,905**	**10.63**

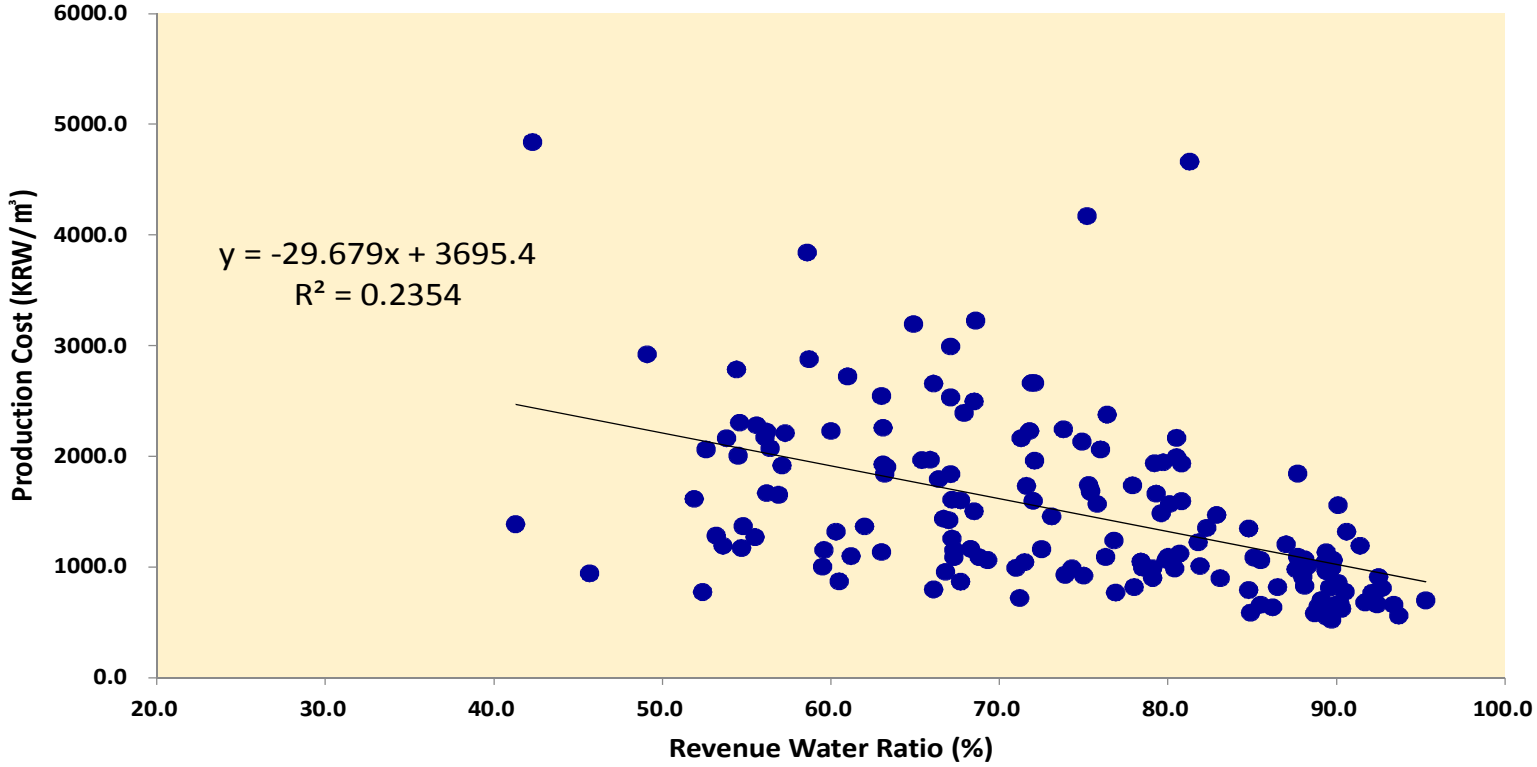
Downward Spiral of a Vicious Circle

- High water losses increases operation cost → less budget to improve the facility → cannot perform proper maintenance → further water losses and lower RWR



With Lower RWR, Higher Production Cost

- Statistical analysis shows a close relationship between the RWRs and the total production cost of local water systems



- P-value of ANOVA is .0000 at the .05 level of significance.
- Correlation between RWR and production cost of treated water per unit is (-0.4852).

Source : Calculated from Statistics of Waterworks 2016

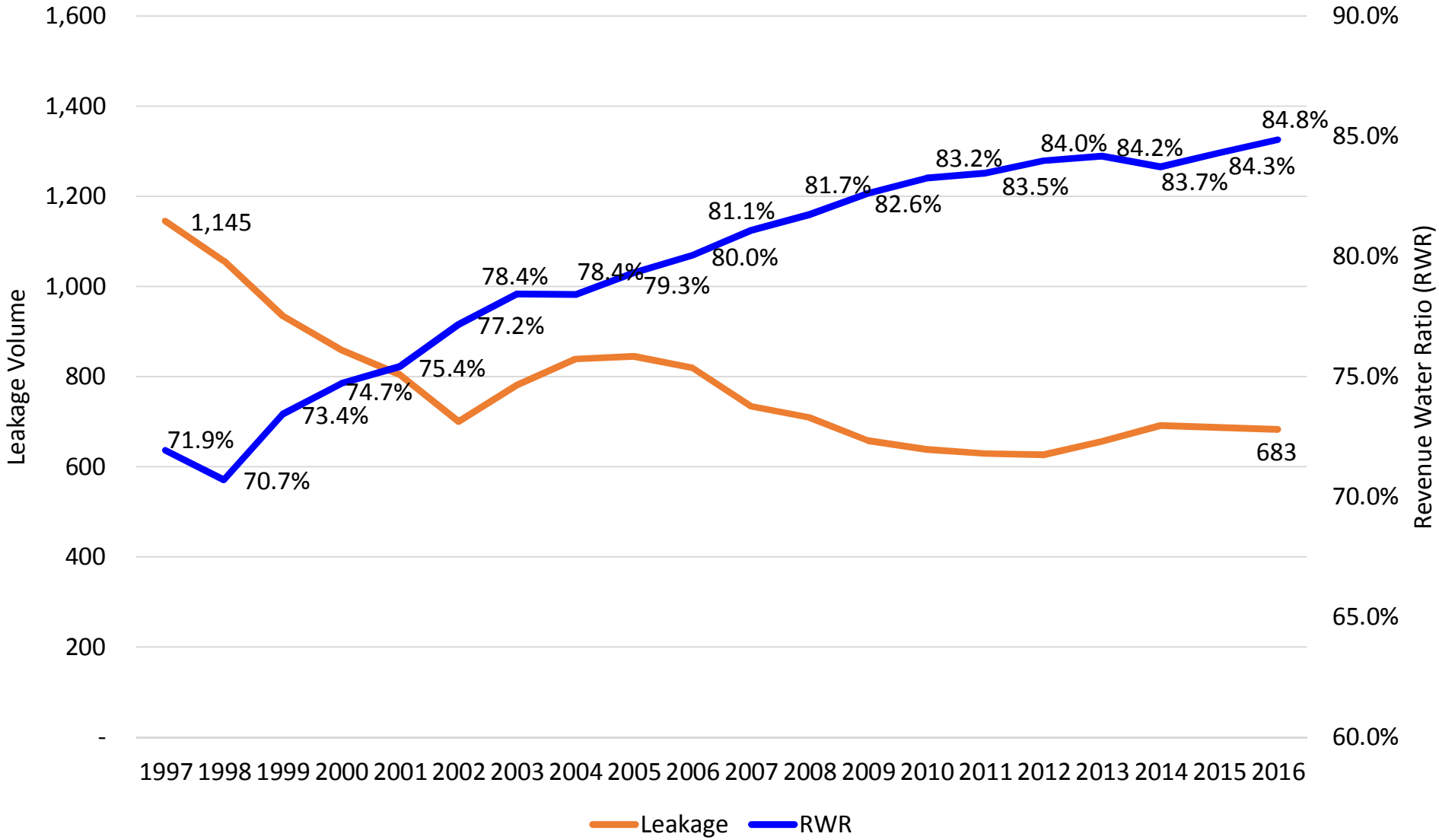
Weak Capacities of the Local Governments

- About, 58% of the 161 local governments are small scaled water providers whose populations are under 100,000 and water production capacity are under 50,000㎥ per day
- Mostly, they have limited investment capital and lack the ability to apply new technologies to improve their water supply system
- The basic infrastructure of the local governments, except metropolitan cities, are lagging behind the desirable standard to suitably implement an RWR enhancement project

National Policy for Enhancing RWR of the Local Waterworks by Consignment Contract

- From the early 2000s, the Korean government initiated a national policy to decrease the water loss of waterworks and consequently increase the portion of billed water
- Considering the weak capabilities of local governments, consignment of small local utilities to more specialized organizations was recommended
- K-water, as a specialized water management organization, participated in the government led initiative by way of consignment contracts with 23 local governments

National RWR and Leakage Volume Change



Source: Calculated from *Statistics of Waterworks (1997~2016),* Ministry of Environment

3. Challenges Confronted

Opposition from Various Interest Groups

- Difficulty to find any motivation for local governments to positively participate in national scale RWR enhancement projects
- The consignment of local waterworks facilities to a different water provider involves various parties which have different or even incompatible interests
- NGOs are generally opposed to consignment agreements for the reason of the privatization of public services to companies which have a tendency to pursue profit and will eventually rapidly increase the water rate

Resistance by the Workers of Local Water Systems

- Workers who engage in the operation of local governments' water facilities were negative for the consignment agreements
- Mostly for fear of employment instability when the right to operate the facilities passes over to specialized water management organizations
- The Government Employee Union were negative towards the waterworks consignment not only to defend union members' interests but also to prevent downsizing of the union membership

Difficulty in Transferring New Technology

- Technical standards such as manuals for RWR enhancement were not established in the initial stages
- For more effective management of water facilities, it is essential to apply more advanced technologies
- Typical technologies related to the modernization of a waterworks system are:
  - Building of a DMA (District Metered Area) system
  - Pressure management technology of pipeline networks
  - Technology to evaluate facility deterioration
  - GIS (Geographic Information System)
  - Tele-metering and control (TM/TC) and real-time data acquisition and transmission technology

4. Overcoming the Challenges

The Mechanisms of Policy Diffusion

"In the context of local policy adoption, policy diffusion involves a determination of whether a policy adopted elsewhere has been successful.

If the policy is deemed to be successful, then a city is more likely to adopt it."

(Shipan & Volden 2008)

Focusing on Developing Success Stories and Overcoming Initial Difficulties

- Initially focused on a few pilot projects to be promoted as a successful model and spread the necessity of consignment to the remaining local governments

- RWR ratio of the first two projects were successful
  - Nonsan City : from 53.4% in 2004 to 79.9% in 2008
  - Jeong-eup County: from 49.8% in 2005 to 80.8% in 2009

- Conflicts in the initial stage with the local governments which even led to lawsuits were successfully resolved
  - It was critical for introducing the policy because other local governments were closely watching the situation surrounding the disputes

Establishing a Standard Business Process

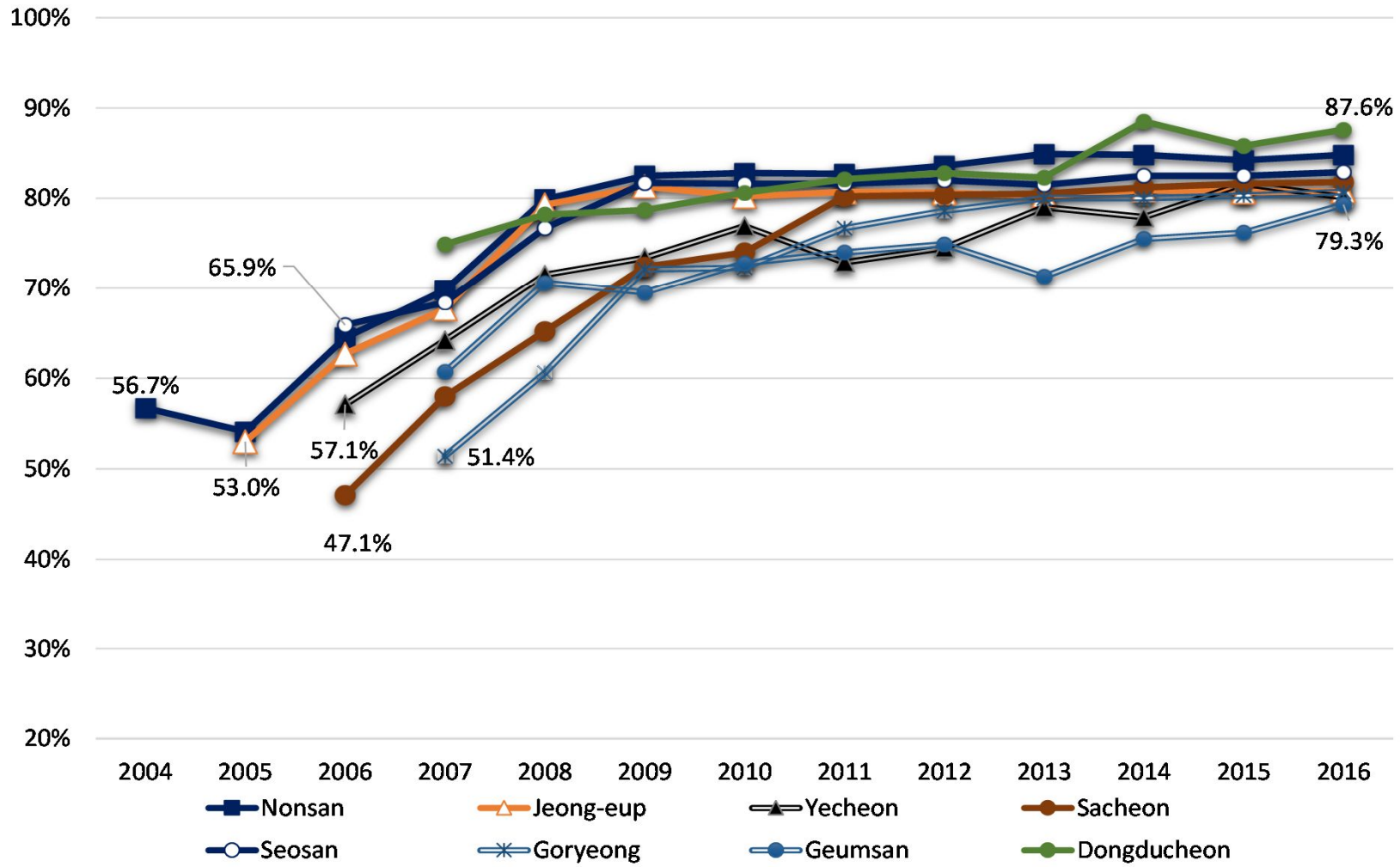
- *The Manual for Waterworks Revenue Water Ratio Enhancement* (2007) by the Ministry of Environment (ME)
- *The Guidebook for Enhancing and Keeping Waterworks Revenue Water Ratio* (2009) by K-water
- Other specific guidelines for conducting consignments and the defined procedure has made it possible to prosecute the projects with less trial and error
- Well-arranged statistics such as *Statistics of Waterworks* enabled to keep sound track of performance changes of local governments over the long-term

Enhancement of Customer Satisfaction

- K-water has adopted a new concept which is called Smart Water City (SWC) to the local water facilities. As SWC utilizes ICT, smart sensors and internet technologies were applied to provide better customer service and to add more economic value
- K-water also developed a new service standard for the customer service system of regional waterworks to provide differentiated services and enhancing customers' satisfaction
- The National Customer Satisfaction Index (NCSI) of the local waterworks rose from an average 66.3% to an average 81.0% as of 2016

RWR Enhancement Results by K-water

- Local waterworks which were operated by K-water for over 10 years, the average RWR was enhanced from 52.0% in each initial stage to 82.3%. (increased 30%)



5. Involvement of HRM

Strategic Needs to Rehire the Previous Worker

- HR policy to succeed the local governments' employees in order to provide them with employment stability
- Approached hiring of local government employees from a strategic perspective to implement the RWR projects
  - The succession of local government employees was necessary for forming a favorable atmosphere for the RWR projects and consignment of the facilities because the negative image of the consignments was a critical barrier for the implementation of the national policy
- They had tacit experience about their facility's history and current conditions

Job Security for Local Government Workers

- The policy included more favorable conditions for re-employment such as a salary level increase
- A few more privileges were also given for the re-employment of workers (e.g. exemption from the job rotation system which is applied to all K-water staffs)
- Various active efforts were made to promote re-employment like information sessions for the potential workers
- The number of re-employed workers : about 250

Transferring Technology to Local Water Facilities

- The Ministry of Environment (ME) institutionalized an education standard for the workers engaged in waterworks facility management to complete a 35 hour education program every 3 years after they took their positions (2007)
- K-water annually runs about 50~70 education programs for 900 to 1,100 local civil servants working for local government water facilities.
- A considerable number of the educational programs are performed to transfer advanced technologies to control waterworks leakage

Human Resources Issues arose

- Getting over organizational cultural difference and adaptation to new work environment
- Settlement of the dispute concerning working condition

  e.g. salary level differences
- Managing separate small labor union which some of the workers established

Annex A : Concepts of Waterworks Balance (1)

		Sub-category Used in Korea	IWA/AWWA Category
System Input Volume	Revenue Water	①Billed & Metered Water	Billed Authorized Consumption
		②Billed & Unmetered Water	
		③Water Exported	
		④Other Billed Water	
	Non-Revenue Water	⑤Operational Use	Unbilled Authorized Consumption (metered/unmetered)
		⑥Public Use	
		⑦Usage Adjustment	
		⑧Metering Inaccuracy	Apparent Losses
		⑨Unauthorized Consumption	
		⑩Leakage	Real Losses

Annex A : Concepts of Waterworks Balance (2)

① Billed & Metered Water: Directly metered and charged

② Billed & Unmetered Water: Unmetered but billed for use

③ Water Exported: Provided to other water suppliers

④ Other Billed Water: Water for public use (e.g. parks or public toilets) and funded by other budgets

⑤ Operational Use: Water used in the distribution process by a water provider for system operation such as flushing pipelines

⑥ Public Use: Used for public purposes with no income (e.g. firefighting)

⑦ Usage Adjustment: Water used and billed less than regular for water provider's responsibility (e.g. adjusting for water quality problem)

⑧ Metering Inaccuracy: Water used by a consumer but unbilled because it was undetected by a meter

⑨ Unauthorized Consumption: Water used without permission or by illegal manipulation of a meter

⑩ Leakage: Water loss from the point of transmission to customers' meters

Annex B : RWR Enhancement Project Results for 21 Consigned Waterworks

Waterworks	Initial	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Average	55.7%	56.7	53.6	59.5	64.4	72.8	75.1	75.9	74.4	77.4	74.5	76.9	78.6	80.8
Nonsan	53.4	56.7	54.1	64.5	69.8	79.9	82.5	82.8	82.7	83.6	84.9	84.8	84.2	84.8
Jeong-eup	49.8	-	53.0	62.7	67.7	79.3	81.3	80.2	80.7	80.6	80.3	80.9	80.7	80.8
Yecheon	49.9	-	-	57.1	64.2	71.5	73.4	76.9	72.9	74.5	79.0	77.9	81.6	80.1
Sacheon	39.6	-	-	47.1	58.0	65.2	72.4	74.0	80.2	80.4	80.5	81.2	81.6	81.8
Seosan	65.3	-	-	65.9	68.4	76.7	81.7	81.6	81.6	82.0	81.5	82.5	82.5	82.9
Goryeong	48.0	-	-	-	51.4	60.6	72.1	72.3	76.7	78.6	80.0	80.0	80.3	80.7
Geumsan	49.1	-	-	-	60.7	70.6	69.5	72.8	74.0	74.9	71.3	75.5	76.2	79.3
Dongducheon	60.7	-	-	-	74.9	78.2	78.7	80.6	82.1	82.8	82.3	88.5	85.8	87.6
Geoje	59.9	-	-	-	-	-	66.4	67.8	72.5	72.6	74.8	80.4	80.5	80.0
Yangju	84.9	-	-	-	-	-	87.2	85.7	85.9	87.6	87.5	88.0	87.8	91.4
Naju	63.6	-	-	-	-	-	71.6	72.1	77.0	83.8	82.1	83.1	85.0	87.7
Danyang	53.1	-	-	-	-	-	64.1	71.4	74.0	76.0	79.3	80.1	80.4	80.5
Hampyeong	42.5	-	-	-	-	-	-	50.2	49.3	59.8	62.5	72.5	72.5	76.3
Paju	84.3	-	-	-	-	-	-	84.6	85.3	85.7	86.2	86.7	87.1	88.3
Gwangju	83.7	-	-	-	-	-	-	85.0	84.8	86.6	84.8	84.6	85.2	84.8
Tongyeong	40.9	-	-	-	-	-	-	-	47.1	59.6	70.0	78.5	80.7	79.9
Goseong	47.9	-	-	-	-	-	-	-	58.3	66.2	73.0	80.0	78.1	80.5
Jindo	47.5	-	-	-	-	-	-	-	-	-	45.8	54.8	66.7	76.0
Wando	34.0	-	-	-	-	-	-	-	-	-	40.1	50.6	59.3	67.9
Jangheung	57.6	-	-	-	-	-	-	-	-	-	63.6	71.2	75.8	79.7
Bongwha	53.4	-	-	-	-	-	-	-	-	-	-	52.2	57.6	64.9

Source: *Annual Statistics of Waterworks Management*, K-water (2017)

** This table does not include two local waterworks system among 23 which K-water operates by consignment; one is a system which does not apply the RWR concept and the other one is excluded because operations commenced recently in 2017 and has no relevant comparative data.

Annex C : National Water Balance Changes over a 20 Year Period

Million ㎥, %

Year	Total Production	RW	RWR	Leakage Volume	Leakage Rate
1997	6,039	4,344	71.9%	1,145	19.0%
1998	5,840	4,129	70.7%	1,056	18.1%
1999	5,798	4,258	73.4%	934	16.1%
2000	5,812	4,342	74.7%	859	14.8%
2001	5,791	4,367	75.4%	804	13.9%
2002	5,696	4,395	77.2%	700	12.3%
2003	5,723	4,489	78.4%	781	13.6%
2004	5,909	4,633	78.4%	839	14.2%
2005	6,002	4,761	79.3%	845	14.1%
2006	5,749	4,601	80.0%	819	14.2%
2007	5,747	4,659	81.1%	734	12.8%
2008	5,804	4,744	81.7%	709	12.2%
2009	5,760	4,759	82.6%	658	11.4%
2010	5,910	4,920	83.2%	638	10.8%
2011	6,021	5,025	83.5%	629	10.4%
2012	6,029	5,063	84.0%	626	10.4%
2013	6,159	5,184	84.2%	656	10.7%
2014	6,214	5,202	83.7%	691	11.1%
2015	6,279	5,293	84.3%	687	10.9%
2016	6,419	5,446	84.8%	683	10.6%

Source: Statistics of Waterworks 1997~2016, Ministry of Environment

Annex D : The Cost to Build Dams in Korea

Dam	Duration of Construction	Total Construction Cost (Billion KRW)				Total Storage Capacity (Million ㎥)
		Total	Construction Cost	General Manage-ment Expenses	Compensation Cost for Property	
Average	15.7 years	409.4	192.8	17.0	199.6	41.7
Gimcheon-Buhang	Apr. 1996 ~ Sept. 2014	555.9	225.1	20.3	310.5	54
Bohyunsan	Dec. 2008 ~ Dec. 2014	333.4	201.3	16.5	115.6	22
Gunwi	Jan. 1988 ~ Dec. 2010	338.9	152.1	14.1	172.7	49

Source: Internal data of K-water (2017)

References

- Cheol Han Kim. 2016. *Waterworks Leakage Management.* K-water

- Cheol Han Kim. 2018. Enhancement of Waterworks' Revenue Water Ratio (RWR)

  Written as part of the World Bank's Global Delivery Initiative (GDI) Case Study Projects by contract with KDI School

Thank you!

Cheol Han Kim

wkdal@kwater.or.kr

K-water HRD Institute