


Current Status and Future of Membrane Process in KOREA




Eun Namkung, Ph.D.
 Professor, Myongji University
 Director, Eco-STAR Project, Korea MOE



Contents


1. Background
2. Current Status of Wastewater Works
3. Future Directions – Membrane Process
4. Eco-STAR Project



Water Quality in Four Major Rivers

BOD Measurement Results of 4 Major Rivers (Unit: mg/L)

Classification	'95	'96	'97	'98	'99	'00	'01	'02	'03	'04	'05	'06
Han(Paldang)	1.3	1.4	1.5	1.5	1.5	1.4	1.3	1.4	1.3	1.3	1.1	1.2
Nakdong(Mulgeum)	5.1	4.8	4.2	3.0	2.8	2.7	3.0	2.6	2.1	2.6	2.6	2.7
Geum(Daecheong)	1.2	1.5	1.2	1.0	1.0	1.0	1.0	1.0	1.1	1.0	1.1	1.1
Youngsan(Juam)	1.5	1.1	1.3	0.9	0.9	0.8	0.7	0.9	1.2	1.0	0.9	1.1



Background of Korean Water & Wastewater Works

Water Works – The 1st Drinking Water Treatment Plant (DWTP) in 1908

Wastewater Works – The 1st Sewage Treatment Plant (STP) in 1976

4

Rapid Industrialization and Urbanization since 1960s till present

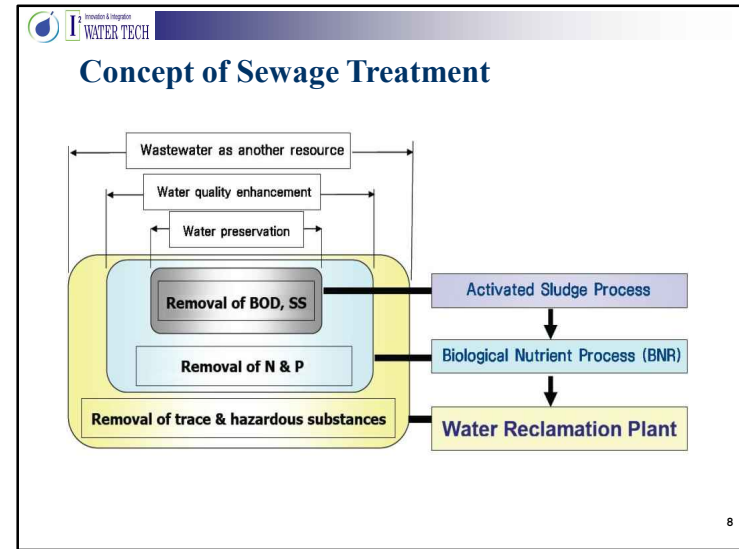
US\$100 to US\$20,000


Three Phases of Sewerage Development in Korea

Phase 1 – BOD/SS (late 1976 – 1990)
 Phase 2 – TN/TP (early 1990 – mid 2000)
 Phase 3 – Micropollutants (late 2000 - 2015)


Effluent Quality Standards

Policy	Classification	pH	BOD (mg/L)	CODmn (mg/L)	SS (mg/L)	TN (mg/L)	TP (mg/L)	E-coli (CFU/100ml)
64.10 Pollution Prevention Act	Activated Sludge Process, Trickling filter Process etc	≥ 5.8 ≤ 8.6	≤ 20		≤ 70			≤ 3,000
	High-rate Trickling filter Process Modified Aeration process etc	≥ 5.8 ≤ 8.6	≤ 60		≤ 120			≤ 3,000
	Sedimentation	≥ 5.8 ≤ 8.6	≤ 120		≤ 150			≤ 3,000
	Others	≥ 5.8 ≤ 8.6	≤ 150		≤ 200			≤ 3,000
78.7 Environment Conservation Act			≤ 30		≤ 70			
91.2 Water Quality Conservation Act	~95. 12. 31		≤ 30		≤ 70			
	96. 1. 1. ~		≤ 20		≤ 20	≤ 120	≤ 8	
93.7 Water Quality Conservation Act	~95. 12. 31		≤ 30	≤ 50	≤ 70			
	96. 1. 1. ~		≤ 20	≤ 40	≤ 20	≤ 120	≤ 8	
00.10 Water Quality Conservation Act	Specific Areas & Jamsil Area		< 10	< 40	< 10	< 20	< 2	
	Other Areas		< 20	< 40	< 20	< 60	< 8	
01.10 Sewerage Law	Specific Areas		≤ 10	≤ 40	≤ 10	≤ 20	≤ 2	≤ 3,000
	Other Areas		< 20	< 40	< 20	≤ 60	≤ 8	≤ 3,000
07.10 Sewerage Law	Specific Areas		≤ 10	≤ 40	≤ 10	≤ 20	≤ 2	≤ 3,000
	Other Areas		< 20	< 40	< 20	≤ 60	≤ 8	≤ 3,000






**New Policies in
Water Quality Management**



“Clean Water, Eco River 2015”

- Fishable and Swimmable Water Environment Vision & Policy announced by Ministry of Environment which requires more stringent effluent quality standards.


10



“Total Water Pollution Load Management System (TWPLMS)”

- Which was implemented to improve water quality in four major rivers and its basins. The TWPLMS requires more advanced sewage treatment in order to lower their total pollution load (currently BOD based, but additional TP criteria would be included from 2011).

11

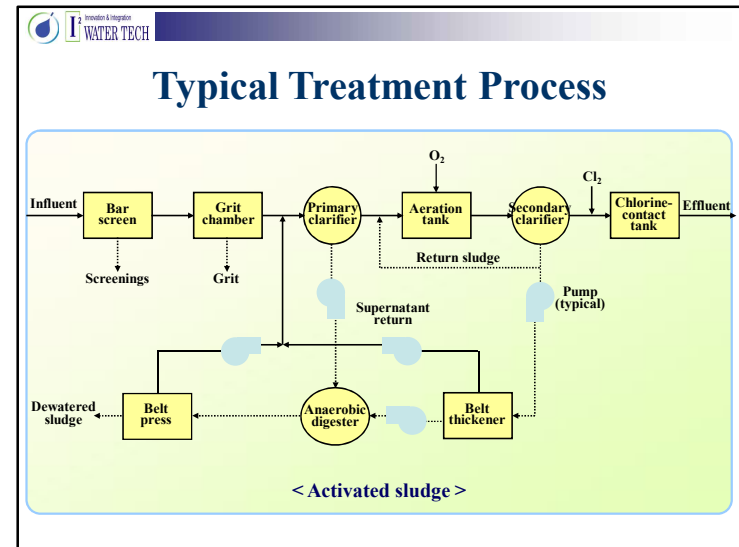
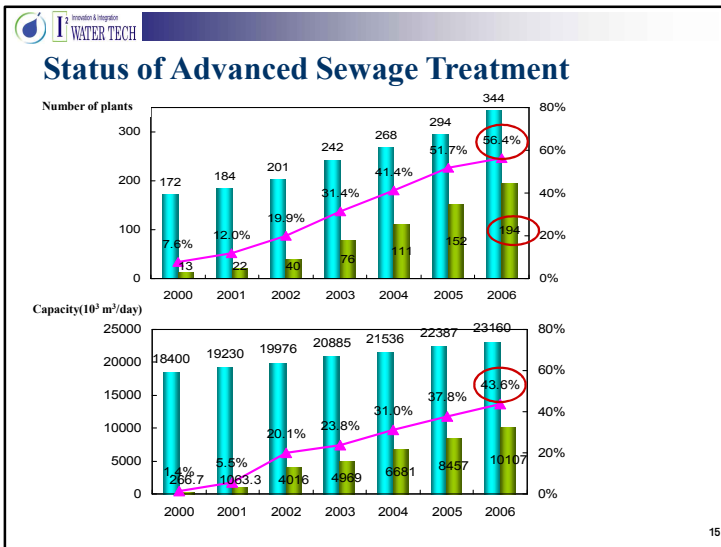
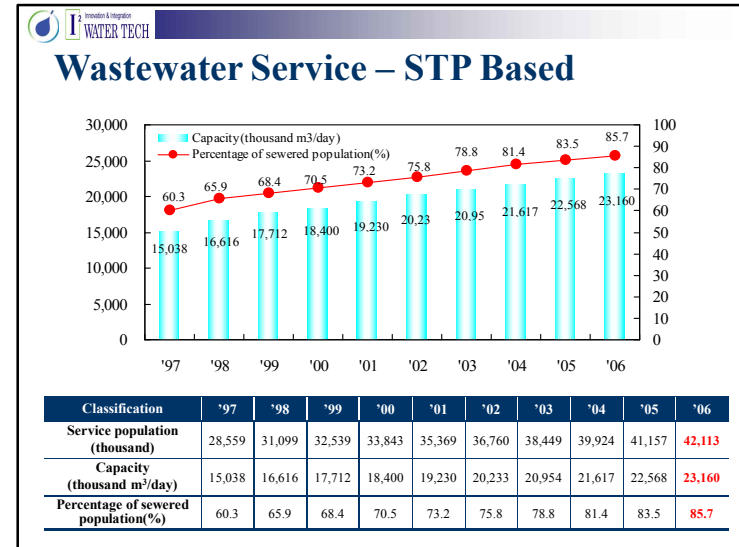


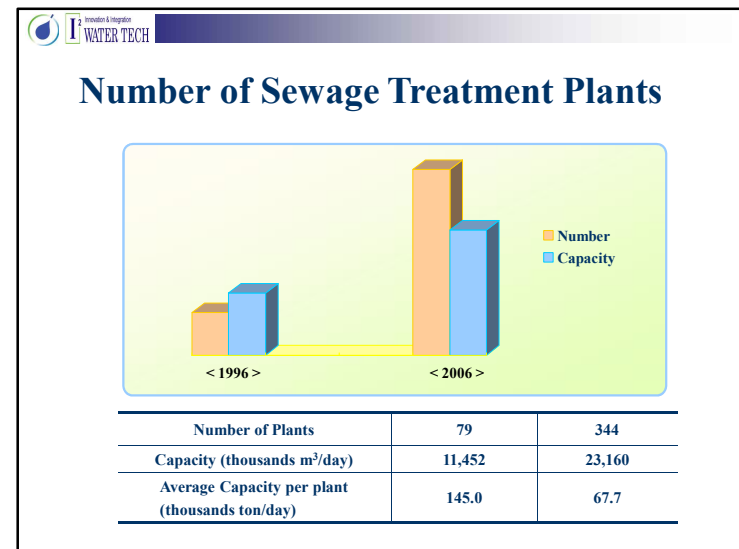
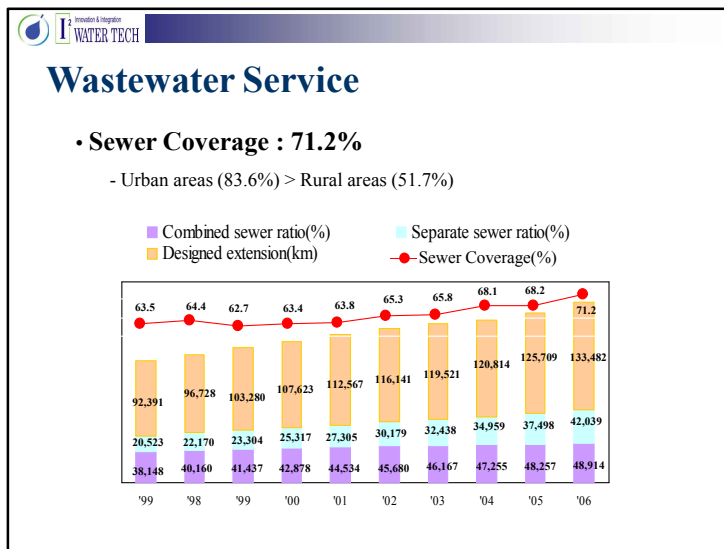
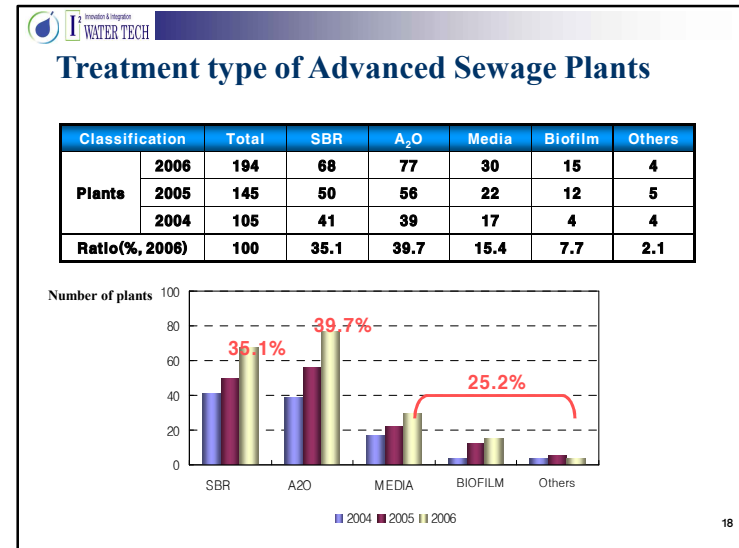
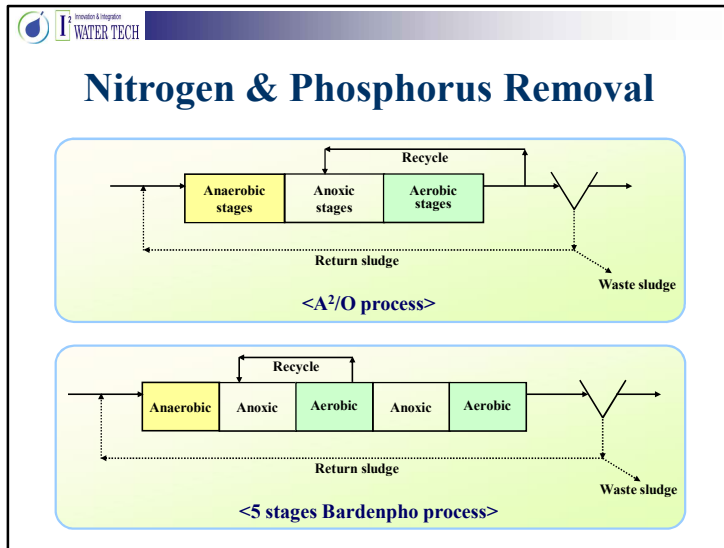
“Water Reclamation and Reuse Policy”

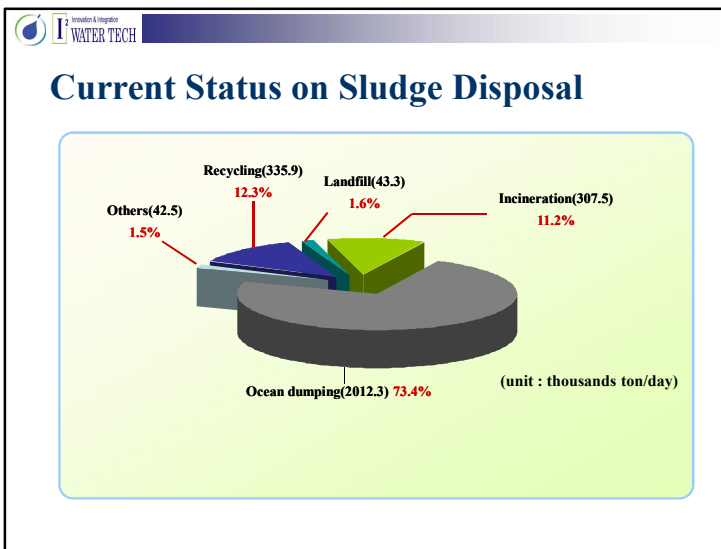
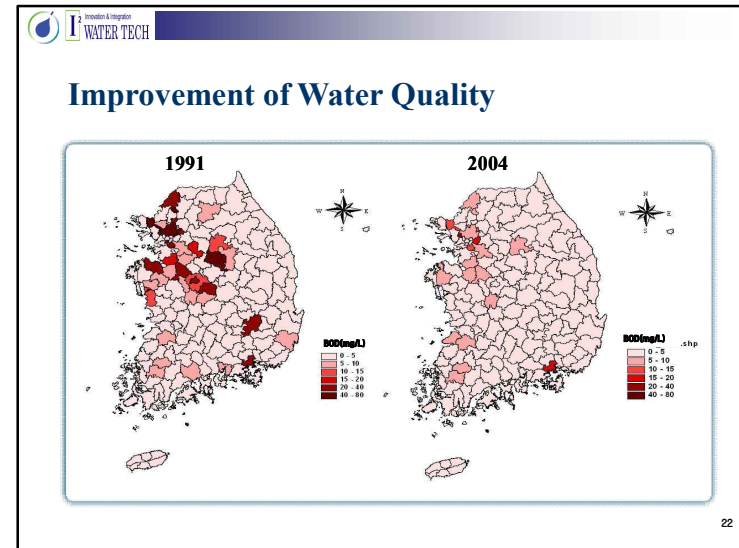
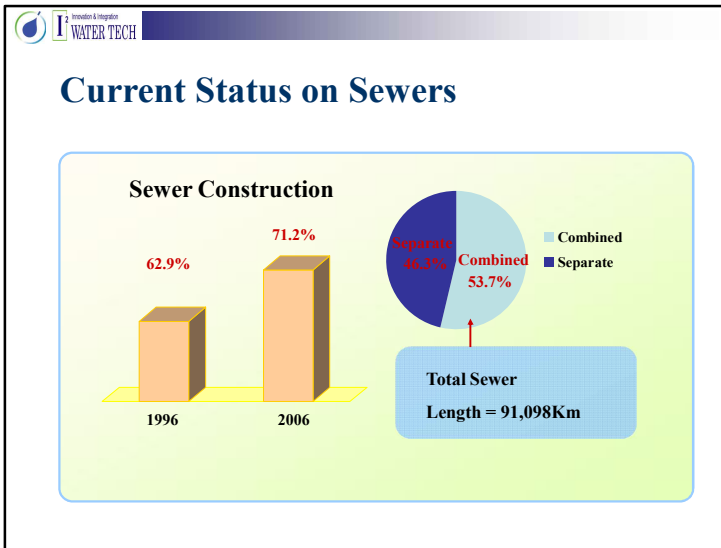
- Scheme supported by Korean government as "The Third Water Utility."

12

Current Status of Wastewater Works in Korea







Privatized O&M

Year	Classification	Number of Facility	Capacity, Inflow (thousand m ³ /day)		Management expenses (million)	Treatment expenses (Sewage (USD/m ³))
			Capacity	Inflow		
2001	Total	173	18,930	16,124	336,020	0.057
	Public	84	8,807	8,076	186,342	0.063
	Private	89(48.6%)	10,123	8,048	149,678	0.051
2006	Total	344	23,160	18,246	584,635	0.097
	Public	133	8,371	7,118	260,940	0.111
	Private	211(61.3%)	14,789	11,128	323,695	0.095

Working on ISO/TC224

- **Governmental countermeasures prepared for increased consumer desire and advent of ISO/TC224**
- **Korea MOE is currently developing Performance Index (PI) for Water & Wastewater Works**

Use of PIs

1. Tools for increasing O&M of Water & Wastewater Utilities
2. Basis for rational budget allocation in Water & Wastewater Utility retrofitting/rehabilitation
3. Standard to compare service qualities of Water & Wastewater utilities

Future Plan for Sewerage Management by 2015

Year	Sewerage Coverage Ratio (%)	Reuse rate of Treated Sewerage (%)	Recycle rate of Sewerage Sludge (%)
2006	85.5%	6.8%	13.7%
2010	90.0%	12.0%	67.0%
2015	92.0%	18.0%	70.0%

22

Future Directions

It is going to be Membrane Process

Membrane Bioreactor (MBR)

- **High efficiency**
- **Compact**
- **Reliability**

MBR Status in Korea

- Number of MBR Plants: more than 1,300 (mostly small STPs)
- Hollow fiber - 79%, Plate - 12%, Tubular - 9%
- More than 60 % of total plants are less than 50 m³/d

Year	Number of Plants
2002	~550
2003	~750
2005	~1300

The best membranes for MBR

- **Material properties**
 - Hydrophilic, high chemical-resistance,
- **Fiber and module dimensions**
 - High packing density
 - Minimum inter-fiber clogging
 - Small energy consumption
- **Operation and maintenance**
 - Easy to mount
 - Easy to clean

Summary


- Membrane Process will be a key technology in DWTP, STP and Water Reclamation and Reuse in Korea.
- It will be an effective tool for retrofitting DWTPs and STPs in Korea.
- Membrane Processes need to be further developed for its cost-effectiveness in O&M.

Eco-STAR Project




Innovation & Integration
I² WATER TECH


Eun Namkung, Ph.D.
 Professor, Myongji University
 Director, Eco-STAR Project, Korea MOE




Logo




- **Technical Innovation**
- **Technical Integration**






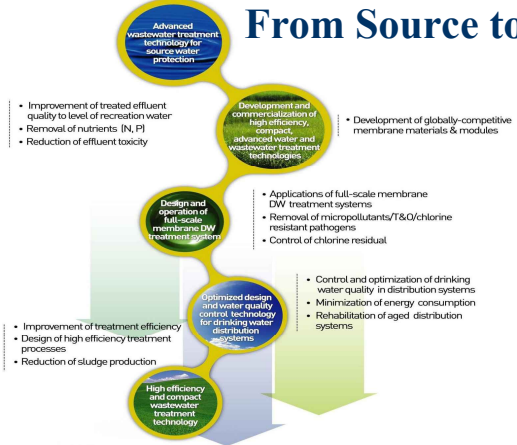
Vision

**To develop
and commercialize
the world-best water
treatment technologies
and systems**






From Source to Tap




Development and commercialization of high efficiency, compact, advanced water and wastewater treatment technologies



Project Duration and Budgets


Terms & Budget

- **Term : 2004. 12 ~ 2011. 05 (6.5 year)**
- **Budget : US \$65 million (Korea MOE Support)**
- **Development of 7 Different Technologies**




Technology Development - 1

	Technology
Development of advanced DW treatment technology	1. Development of membranes & modules for water treatment
Development of drinking Water distribution system & water quality control technology	2. Development of full-scale advanced membrane drinking water treatment processes & systems 3. Development of optimized design & water control technology for DW distribution systems



Technology Development - 2

	Technology
Wastewater treatment technology Satisfying recreation water criteria	4. Advanced wastewater treatment technology for recreation water 5. High efficiency, compact wastewater treatment technology by developing integrated operating systems & retrofitting technologies
	6. Treatment technology of electronic industry wastewater 7. High efficiency, compact treatment technology for highly concentrated food industry wastewater



Eco-STAR Project
Dec. 2004 – May, 2011

2. Development of full-scale advanced membrane drinking water treatment processes & systems

Advanced Membrane DW Treatment System

Final Goals

By using membrane separation water purification technology, we will develop and commercialize drinking water treatment system which satisfies WHO criteria, footprint reduction, low energy consumption

High efficiency	High compact/Energy Saving
<ul style="list-style-type: none"> • Protozoa removal above 4log • Turbidity below 0.05NTU • Complete removal of taste and odor compound • Recovery ratio with multi-stage membrane separation system above 99.5% 	<ul style="list-style-type: none"> • Footprint 50% • Chemical saving 40% • Enhancement of sludge dehydrate by decreasing Al/T ratio

Advanced Membrane DW Treatment System

Expectations

Conventional Advanced DW Treatment System

Advanced Membrane DW Treatment System

Eco-STAR Project
Dec. 2004 – May. 2011

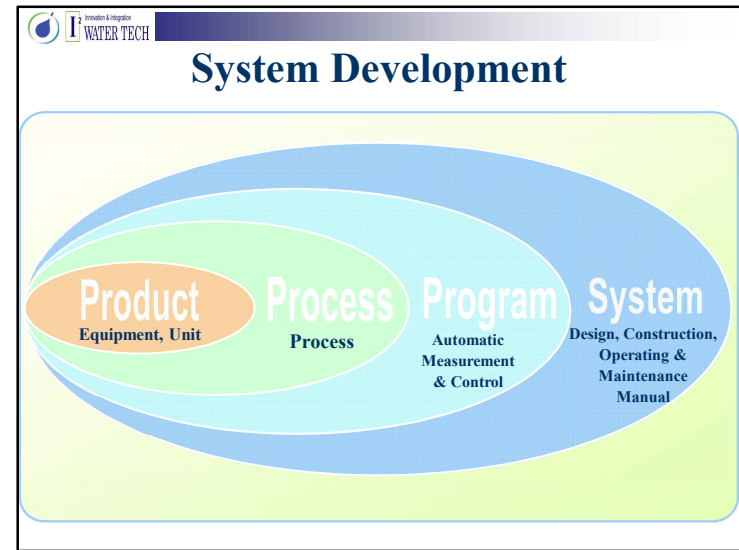
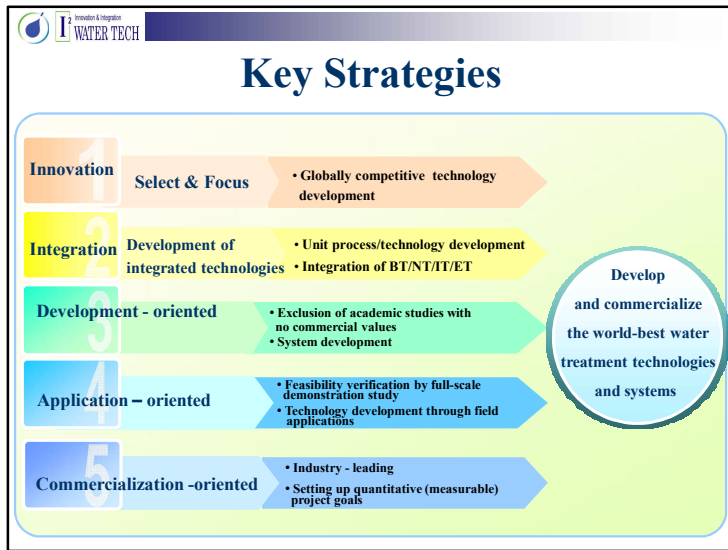
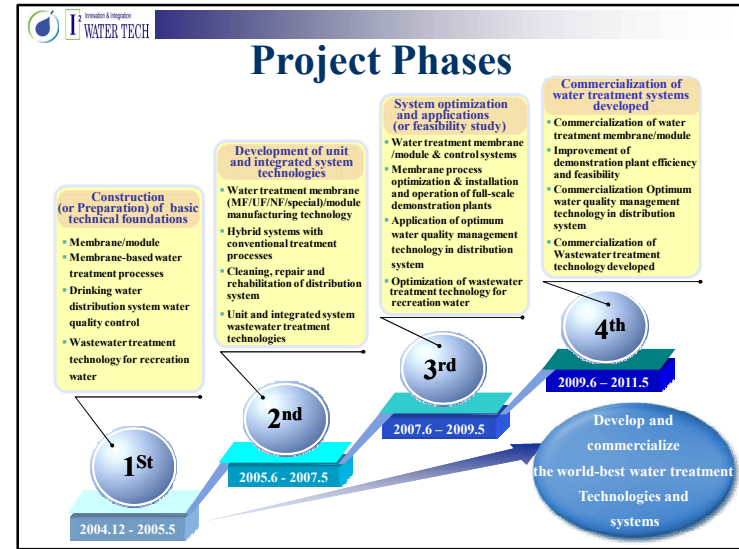
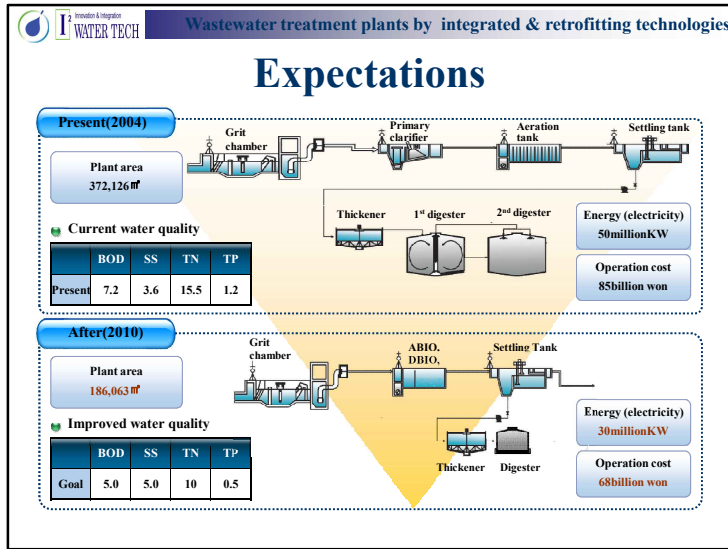
5. High efficiency, compact wastewater treatment plants by developing integrated operating systems & retrofitting technologies


Wastewater treatment plants by integrated & retrofitting technologies

Final Goals

Development of advanced pre-treatment facility & high compact advanced Treatment system based on Integrated operating system (IMET) and commercialization & packaging of combined retrofitting technology


High efficiency	High compact/Energy Saving
<ul style="list-style-type: none"> ▪ Capacity : 50% increase ▪ Required area : 50% reduce ▪ Water quality : 200% improve 	<ul style="list-style-type: none"> ▪ Energy saving : 50% increase ▪ Operation cost : 50% reduction ▪ Sludge production : 40% reduce






Eco-Design & LCC/LCA

- **High Efficiency**
- **Low Energy**
- **Multifunction**
- **Low Solids**
- **Compact**



Eco-Design & LCC/LCA


From Cradle To Grave



Final Outcome

3P strategy

- **Product / Process / Program / System**
- **Patent**
- **Paper**



Success Criteria for Commercialization

Performance + Cost Effectiveness

