Wastewater Management in Vietnam:
Business Opportunities

Hanoi - Tokyo, July 2020

Prof. Dr. Viet-Anh Nguyen

• Director, Institute of Environmental Science and Engineering (IESE), Hanoi University of Civil Engineering.

•Head of Science and Technology Department, Vietnam Association of Water Supply and Sewerage (VWSA)

VIETNAM WATER SECTOR IN BRIEF

Urbanization and Pressures on Technical Infrastructure

- 07/2019, MOC: 833 cities and towns; 38.5% population.
- Total urban water supply capacity: 9,0 million m^3/day.
- Urban population served with tap water: 86%.
- Non-revenue water: 21,5% (from 6% to 30%; reduced from 31% in 2010).
- Average water consumption: 110 l/cap/day (33…213 l/cap/day)

VIETNAM URBAN WASTEWATER MANAGEMENT

- **90%** of HHs have septic tank as a preliminary treatment step (only black wastewater passes through septic tank, in most of cases)
- **4%** of septage disposed satisfactorily
- **70%** of HHs have access to piped drainage/ sewerage systems
- **15%** of collected drainage/ sewerage treated by centralized WWTPs
- **54** municipal WWTPs currently in operation, with total capacity ~1,000,000 m^3/day.
- **77** municipal WWTPs in planning/construction, with total capacity 1.5 million m^3/day
- Investment over last 5 years: >USD 1 billion (USD 220 million/year) (>80% is ODA, rest is from state budget)
- Private sector is starting to take part in wastewater management (BT projects, Contract for Operation of WWTPs).

WW treatment technologies applied:

CAS, AO, A^2O, SBR, OD, TF, Stab. Ponds, CEPT, etc.

VIETNAM URBAN WASTEWATER MANAGEMENT

In-operation Municipal WWTPs

No	Name of WWTP	City	Design Capacity (m³/day)	Sewer Type	Treatment Process
1	Kim Lien	Hanoi	3,700	CSS	A2O
2	Truc Bach	Hanoi	2,500	CSS	A2O
3	North Thang Long	Hanoi	41,000	CSS	A2O with nitrification
4	Yen So	Hanoi	200,000	CSS	SBR
5	Ho Tay	Hanoi	22,800	CSS	Modified SBR
6	Bay Mau	Hanoi	13,300	CSS	CAS
7	Cau Nga	Hanoi	20,000	CSS	Modified SBR
8	Bắc Ninh	Bac Ninh	17,500	CSS	SBR
9	Từ Sơn	Tu Son	33,000	CSS	SBR
10	Bắc Giang	Bac Giang	10,000	CSS	Oxidation Ditch
11	Bãi Cháy	Ha Long	3,500	CSS	SBR
12	Hà Khánh	Ha Long	7,000	CSS	SBR
13	Vĩnh Yên	Vinh Yen	5,000	CSS	CAS
14	Hai Duong	Hai Duong	13,000	CSS	Mecanical Treatment
15	Quy Luu	Phu Ly	2,500	CSS	A2O with fixed film
16	Thanh Chau	Phu Ly	5,000	CSS	
17	Thanh Hóa	Thanh Hoa	15,000	CSS	Stabilization Pond
18	Bim Son	Bim Son	3,500	CSS	
19	Sam Son	Sam Son	4,000	CSS	
20	Vinh	Vinh	25,000	CSS	CAS
21	Cửa Lò	Cua Lo	3,700	CSS	SBR
22	Thai Hoa	Thai Hoa	4,500		OD
23	Duc Minh	Dong Hoi	10,000	CSS	Aerated lagoon
24	Phú Lộc	Da Nang	40,000	CSS	SBR
25	Ngũ Hành Sơn	Da Nang	10,000	CSS	Anerobic Pond with float cover
26	Sơn Trà	Da Nang	25,500	CSS	Anerobic Pond with float cover
27	Hòa Cường	Da Nang	47,600	CSS	Anerobic Pond with float cover
28	Hòa Xuân	Da Nang	20,000	CSS	SBR
29	Nhon Binh	Quy Nhơn	14,000	CSS	AnF + TF
30	Buôn Ma Thuot	Buon Ma Thuot	8,500	SSS	Stabilization Pond

VIETNAM URBAN WASTEWATER MANAGEMENT

In-operation Municipal WWTPs (cont.)

No	Name of WWTP	City	Design Capacity (m³/day)	Sewer Type	Treatment Process
31	Da Lat	Da Lat	7,400	SSS	Imhoff tank + Trickling Filter
32	Da Lat (Expansion)	Da Lat	14,000	SSS	
33	South Nha Trang	Nha Trang	40,000	CSS	OD
34	Thap cham	Phan Rang	5,000	CSS	Aerated lagoon
35	Phan Thiet	Phan Thiet	5,000	CSS	
36	Thủ Dầu Một	Thu Dau Mot	17,650	SSS	SBR
37	Thuan An	Thuan An	17,000	SSS	SBR
38	Binh Hung	HCMC	141,000	CSS	CAS
39	Bình Hưng Hòa	HCMC	30,000	CSS	Aerated Pond + Maturation Pond
40	Nam Vien (Phu My Hung)	HCMC	15,000	SSS	OD
41	Canh Doi (Phu My Hung)	HCMC	10,000	SSS	OD
42	Vung Tau	Vung Tau	22,000	CSS	OD
43	Soc Trang	Soc Trang	13,200	CSS	Mechanical Treatment
44	Chau Doc	Chau Doc	5,000	CSS	Aerated lagoon
45	Ninh Binh	Ninh Binh	15,000	CSS	Aerated lagoon
46	Tam Ky	Tam Ky		CSS	
47	Hoi An	Hoi An	2,000	CSS	PTF
48	Binh Phuoc	Dong Xoai		CSS	
49	Dong Ha	Dong Ha		CSS	
50	Gia Nghia	Gia Nghia	4,000	CSS	
51	Tuy Hoa	Tuy Hoa	4,000	CSS	WSP
52	Cam Ranh	Cam Ranh	4,000	CSS	
53	Phan Thiet	Phan	4,000	CSS	
54	Can Tho	Can Tho	30,000	CSS	TF
	Total		**1,002,850**		


Truc Bach, Ha Noi (2005)

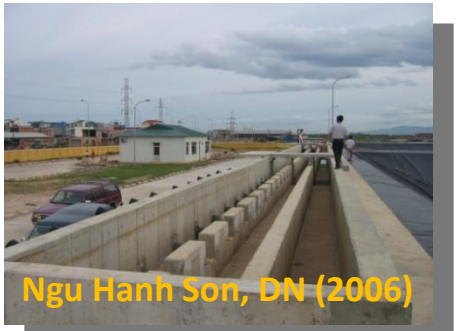

Kim Lien, Ha Noi (2005)

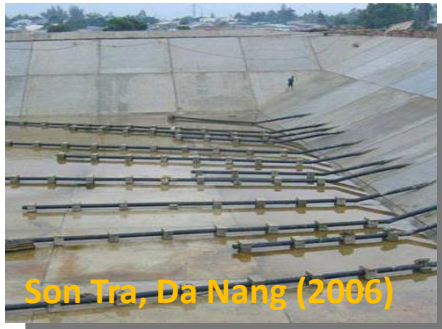

Da Lat, Lam Dong (2006)


Buon Ma Thuot, Dak Lak (2006)


Hoa Cuong, Da Nang (2006)

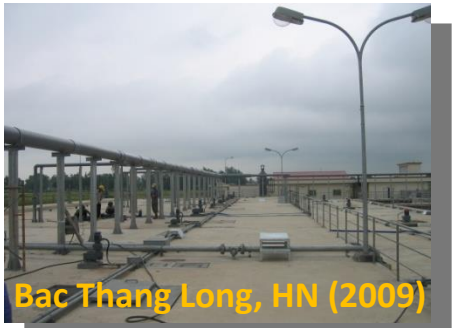

Phu Loc, Da Nang (2006)


Ngu Hanh Son, DN (2006)


Son Tra, Da Nang (2006)


Bai Chay, Quang Ninh (2007)


Binh Hung Hoa, HCMC (2008)


Bac Thang Long, HN (2009)


Ha Khanh, QN (2009)


Nam Vien, PMH, HCMC (2009)

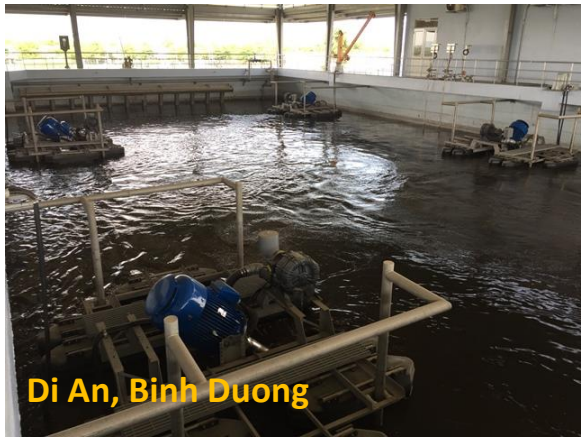

Binh Hung, HCMC (2009)


Bac Giang (2010)


Yen So, Ha Noi (2012)


Nhon Binh, Quy Nhon


Quy Nhon 2A


Di An, Binh Duong

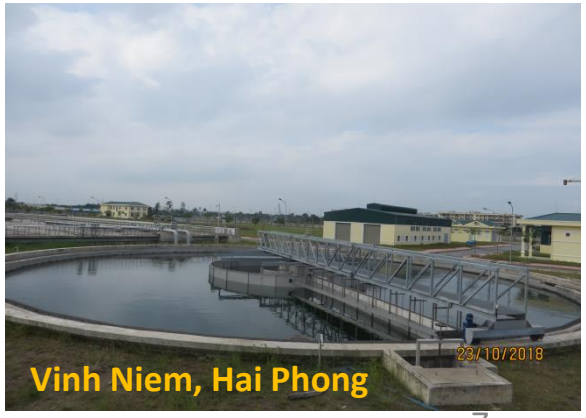

Da Lat (extension)


Phan Rang, Thap Cham


Long Xuyen, An Giang


Chua Cau, Hoi An


TRẠM BƠM NƯỚC BÙN
Sludge Water Pumping Station
Can Tho


23/10/2018
Vinh Niem, Hai Phong

VIETNAM URBAN WASTEWATER MANAGEMENT

Under-construction Municipal WWTPs

No	Name of WWTP	City	Design Capacity (m³/day)	Sewer Type	Treatment Process
1	Cao Bang	Cao Bang	3,000	CSS	Aerated Lagoon
2	Lang Son	Lang Son	5,200	CSS	
3	Bac Kan	Bac Kan	3,000	CSS	Biological Pond
4	Thái Nguyên North	Thai Nguyen	8,000	CSS	OD
5	Thái Nguyên South	Thai Nguyen		CSS	
6	Lao Cai	Lao Cai	4,300	CSS	Filtration
7	Tay Nam	Sa Pa	5,000	CSS	OD
8	Dong Bac	Sa Pa	2,500	CSS	OD
9	Ha Giang	Ha Giang	3,000	CSS	OD
10	Hoa Binh	Hoa Binh	5,200	CSS	
11	Việt Trì	Viet Tri	25,000	CSS	OD
12	Son La	Son La	7,000	CSS	
13	Dien Bien Phu	Dien Bien Phu	10,000	CSS	Anaerobic Pond
14	Vinh Yen	Vinh Yen	6,000	CSS	Aerated lagoon
15	Yen Xa	Ha Noi	270,000	CSS	CAS
16	Phu Do	Ha Noi	85,000	CSS	SBR
17	Hoa Lac High Tech Park	Ha Noi	36,000	CSS	A2O
18	Bac Giang (Expansion)	Bac Giang	10,000	CSS	OD
19	Ha Khau	Ha Long	19,000	CSS	PTF
20	Ha Khanh (Expansion)	Ha Long	17,500	CSS	PTF
21	Ha Phong	Ha Long	9,300	CSS	PTF
22	East Ka Long	Mong Cai	8,000	CSS	OD
23	West Ka Long	Mong Cai	4,000	CSS	OD
24	Vĩnh Niệm	Hai Phong	36,000	CSS	CAS
25	Hung Yen	Hung Yen	6,300	CSS	Unspecified
26	Thai Binh	Thai Binh	10,000	CSS	A2O
27	Bac Chau Giang	Phu Ly	3,000	CSS	
28	Phu Ly (x)	Phu Ly		CSS	
29	Quang Trung	Bim Son	3,500	CSS	OD
30	Dong Son	Bim Son	3,500	CSS	OD
31	Hong Linh	Hong Linh	5,000	CSS	OD
32	Huong Tich Pagoda	Can Loc	1,000	CSS	Onsite Plant
33	Ba Đồn	Ba Don Town	3,000	CSS	Aerated lagoon
34	Duc Minh (Expansion)	Dong Hoi	4,800	CSS	Aerated lagoon
35	Quang Tri	Quang Tri	5,000	CSS	SBR
36	Hue	Hue	30,000	CSS	CAS
37	Lang Co	Lan Co Vilage	3,500	CSS	Stabilization pond
38	Hoa Xuan (Expansion)	Da Nang	40,000	CSS	SBR
39	Sơn Trà (Expansion)	Da Nang	25,000	CSS	AO
40	Hoi An	Hoi An	6,750	CSS	

VIETNAM URBAN WASTEWATER MANAGEMENT

Under-construction Municipal WWTPs (cont.)

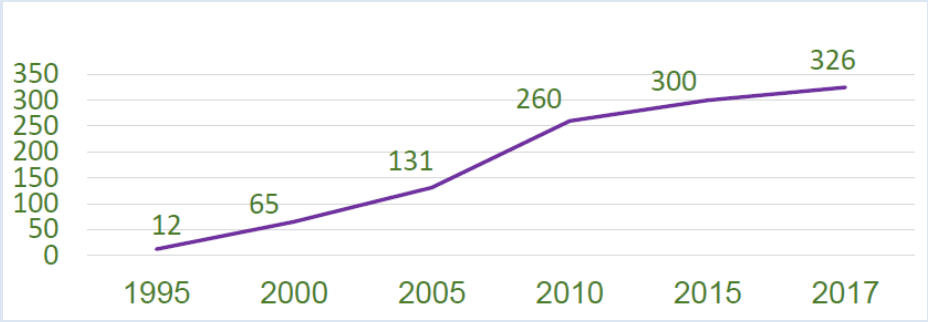
No	Name of WWTP	City	Design Capacity (m³/day)	Sewer Type	Treatment Process
41	Tam Ky	Tam Ky	8,000	CSS	Aerated lagoon
42	Nhon Binh (Expansion)	Quy Nhơn	14,000	CSS	AnF + TF
43	Bau Sen (2A)	Quy Nhơn	2,300	CSS	OD
44	North Nha Trang	Nha Trang	15,000	CSS	OD
45	Thap cham (Expansion)	Phan Rang - Thap Cham	10,000	CSS	OD
46	Thap cham (Expansion)	Phan Rang - Thap Cham	10,000	CSS	Aerated lagoon
47	Buon Ma Thuot (Expansion)	Buon Ma Thot	14,000	CSS	MBBR + Filter
48	Bao Loc	Bao Loc	5,000	CSS	
49	Vung Tau (phase 2)	Vung Tau	30,000	CSS	CAS
50	Ba Ria	Ba Ria	12,000	CSS	
51	Long Son - Go Gang	Vung Tau	13,300	CSS	
52	Long Dien	Long Hai Town	13,500	CSS	Aeroten
53	Phu My new urban area	Tan Thanh District	29,700	CSS	
54	Di An	Di An	20,000	CSS	ASBR
55	Thay Tho		20,000	CSS	ASBR
56	Bien Hoa (No. 1)	Bien Hoa	3,000	CSS	ASBR
57	Bien Hoa	Bien Hoa	39,000	CSS	CAS
58	Tham Luong Ben Cat	HCMC	250,000	CSS	SBR
59	Nhieu Loc - Thi Nghe	HCMC	480,000	CSS	SBR
60	Binh Hung (Phase 2)	HCMC	328,000	CSS	CAS
61	West Saigon	HCMC	150,000	CSS	CAS or Advanced SBR
62	Binh Tan	HCMC	180,000	CSS	CAS or Advanced SBR
63	Tan Hoa Lo Gom	HCMC	300,000	CSS	CAS or Advanced SBR
64	North Saigon	HCMC	170,000	CSS	CAS or Advanced SBR
65	North Saigon2	HCMC	130,000	CSS	CAS or Advanced SBR
66	Tay Ninh	Tay Ninh	5,000	CSS	Aerated lagoon
67	Ba Den Mountain	Tay Ninh	1,500	CSS	Onesite Plant
68	Moc Bai	Tay Ninh	9,000	CSS	Undefined (Lagoon/tank/pond)
69	Tra Vinh	Tra Vinh	9,500	CSS	
70	Cao Lãnh	Cao Lãnh	10,000	CSS	OD
71	Long Xuyên	Long Xuyên	60,000	CSS	OD
72	Phu Tu		1,500	CSS	Onesite Plant
73	Cần Thơ	Can Tho	30,000	CSS	TF
74	Vi Thanh	Vi Thanh	3,500	CSS	Aerated Lagoon
75	Ca Mau	Ca Mau	8,000	CSS	
76	Phan Rang - Thap Cham	Phan Rang - Thap Cham	10,000	CSS	
77	Phan Thiet	Phan Thiet			

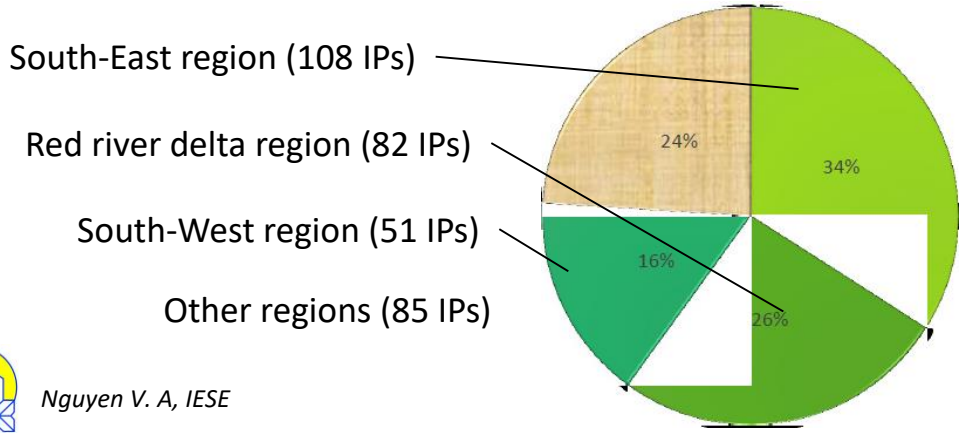
CHALLENGES IN URBAN W/W MANAGEMENT

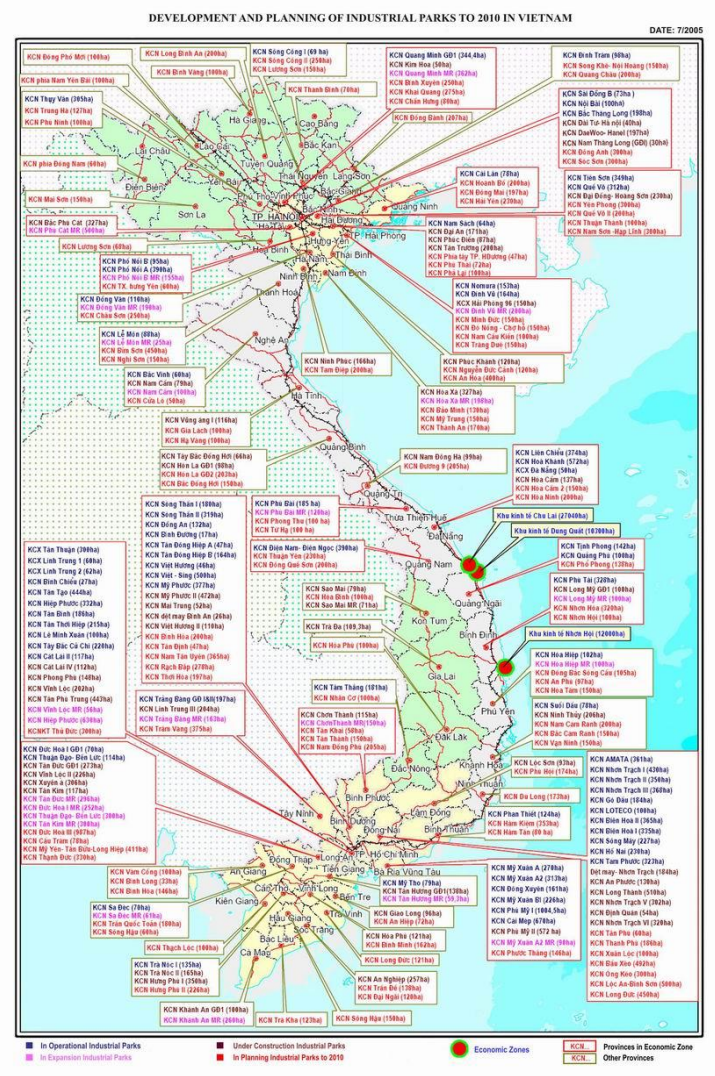
- ✓ **CSS** (Combined sewerage and drainage system) is dominating in most of existing urban areas in Vietnam. Most of wastewater projects in these areas prefer to stay with CSS, due to limited budget. **SSS** (Separate sewerage system) is compulsory only in the new urban development projects.
- ✓ **Low C/N** in incoming flow to WWTP from CSS is a challenge for biological wastewater treatment processes.
- ✓ Resource recovery from sewage sludge is not applied yet. It's time to discuss about **energy efficiency, and resource recovery** in wastewater management.
- ✓ **Septic tank sludge management** is among hot issues, but not well handled in all cities, so far.
- ✓ Many cities are still suffering from **floods.** Floods are becoming more and more unpredictable due to climate change. Big market for the **Smart and Green Solutions** !

VIETNAM INDUSTRIAL WASTEWATER MANAGEMENT

- 326 Is have been established. 230 IPs are in operation. Occupation ratio 73%.
- CETPs are at 203 IPs (=88%) (increased from 30% in 2005).
- Ratio of IPs with CETPs: 20%...100%.







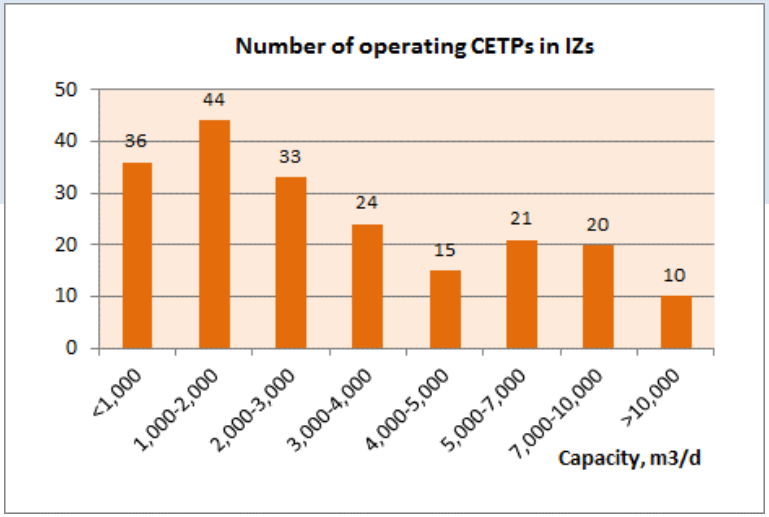
(MPI, 2018)

Nguyen V. A, IESE

WASTEWATER MANAGEMENT IN INDUSTRIAL PARKS

- Total amount of wastewater generated from IPs: 905,000 m^3/day (VEA, 2018).
- 80% CETPs at IPs are considered meeting effluent standards (JICA, May 2018).
- Among in operation IPs, there are 107 IPs with area >200ha.
- Common capacity of CETPs: 1,000 – 2,000 m^3/day.

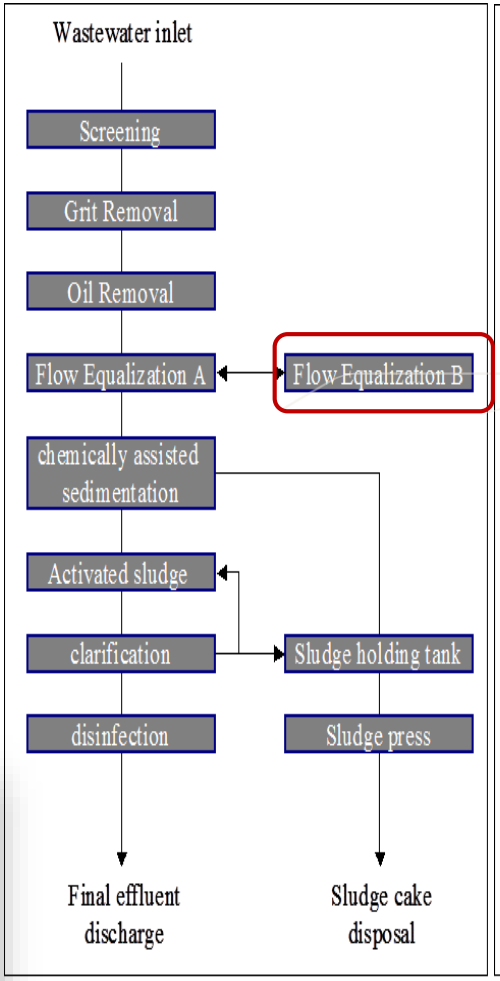
Province	Number of IZs	Total Area (ha)	Wastewater (m^3 / day)
Ho Chi Minh city (HCMC)	22	7,673	193,760
Binh Duong	28	16,336	136,700
Hanoi	14	3,450	75,000
Bac Ninh	15	6,690	65,000
Ba Ria – Vung Tau	11	7,511	42,560
Nghe An	5	1,185	26,578
Ninh Binh	7	1,472	13,000
Dong Thap	3	803	12,477
Khanh Hoa	5	887	10,000
Thanh Hoa	9	5,383	2,800
Total		**51,440**	**577,875**



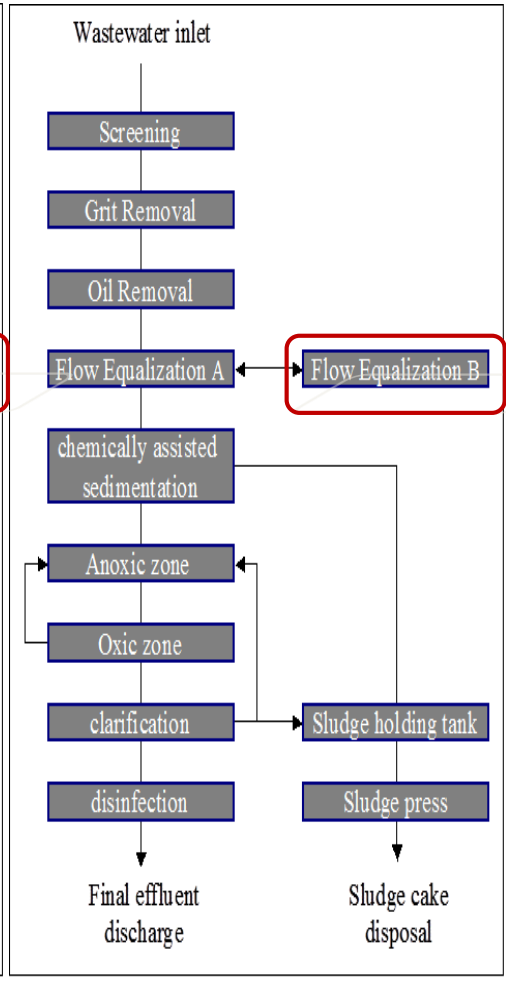
(JICA, 2018; VEA, 2018)

WASTEWATER TREATMENT AT CETPS

- **Common technologies**
  - — Physic-chemical
    - — Trash, Grit removal
    - — Oil and Grease separation
    - — Coagulation - Flocculation
    - — Dissolved air flotation
  - — Biological processes
    - — Activated sludge
    - — Attached growth
    - — MBBR
  - — Combination



Class B



Class A

(Nguyen Viet Anh and Son Le, CS11, VIPMP, 2011)

CHALLENGES IN INDUSTRIAL WW MANAGEMENT

- Control of incoming flows and O&M of CETPs
- On-site wastewater treatment + Cleaner production at Factories
- Energy efficiency and Energy auditing
- Sludge Management, recovery of valuable materials from sludge
- Treatment of organics, POPs, color, HMs at on-site WWTPs and CETPs: High efficient, less foot print, less energy consuming technologies at affordable costs
- Financing for Industrial wastewater projects: Investment, Cost recovery

CHALLENGES IN INDUSTRIAL WW MANAGEMENT

- Wastewater reuse: Standards are needed (detailed studies, with involvement of number of organizations)
  - Decree 38/2015/ND-CP to encourage reduction of water consumption and increase of wastewater reuse.
  - Vietnamese standard for wastewater ruse in irrigation QCVN 39:2011/BTNMT : not applicable anymore
  - QCVN 08-MT:2015/BTNMT is applied for wastewater reuse
- Reuse of wastewater and sludge: Monitoring, risk management
- Emergency control (esp. from 2016)

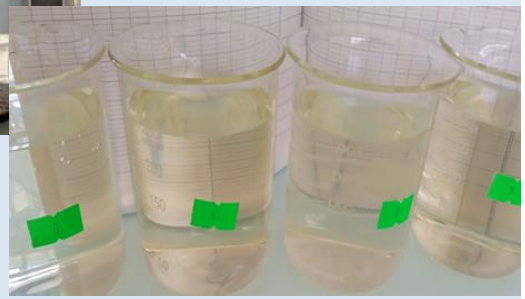
ON-GOING COMBATING MEASURES

- Industrial WW management: **Polluter-Pays-Principle**
- **Effluent standards** for CETPs and for selected industries: **Class A and Class B**
- Application of **EIA** report approval; Certification of completion of Envi. Protection facilities (**Post-EIA**); **Discharge License**;
- Installation of **AMS**; Inspection Campaigns; Environmental Police; Public Opinions; etc.
- New Decree 40/ND-CP, in force in 2018. Coming soon: **new Environmental Law**
- **New standard system:**

  BAT vs Receiving capacity (Under preparation)

EXAMPLE 1: CETP OPERATION OPTIMIZATION

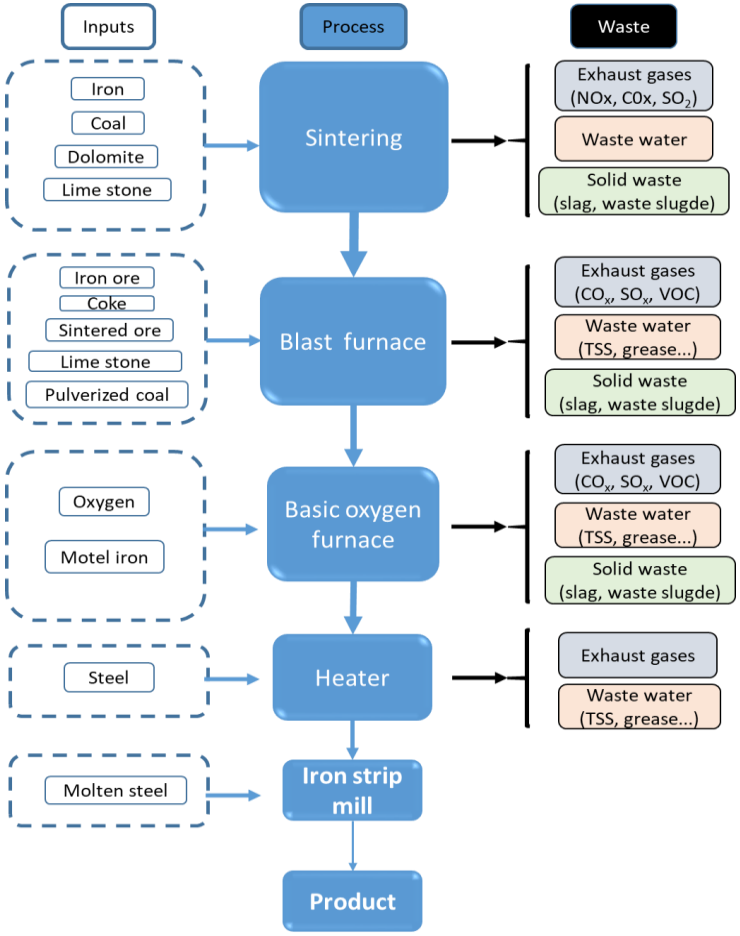
- Q = 5000 m^3/day
- SBR
- No Primary treatment
- Physic-Chemical treatment after SBR
- Manual dealing with shock loadings



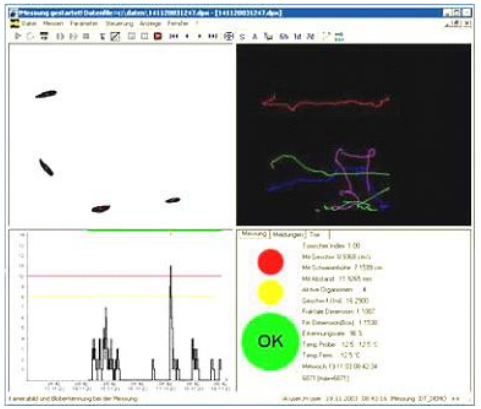
- Jar test for chemical dosing optimization
- Additional buffer volume
- SCADA upgrading

EXAMPLE 2: WASTEWATER EMERGENCY CONTROL FOR THE STEEL INDUSTRY

Cast iron and steel, 7.5 million tones /year (stage 1)



AMS + FISH TOXIMETER: EARLY WARNING SYSTEM



Zebrafish (Danio rerio)

CCTV SCADA AMS 1, 2, 3, 4

Effluent Pond System for Emergency Control

CONCLUSIONS AND RECOMMENDATIONS

✓**Vietnam Water Industry is in the intensive development period**: expansion of service area, improvement of service quality, with different stakeholders involved. **Government policy: PSP** is encouraged.

✓**Potential market in wastewater management:** to combat Hot issues in wastewater collection, treatment of wastewater and sludge, system efficiency and resource recovery, **in urban centers, industrial parks, and at the industries.**

✓**Cooperation and networking are needed**:

- *Sharing information of current situation, future plans, problems, needs, solutions*
- *Bridging to Vietnam's water industry network and players*

CONCLUSIONS AND RECOMMENDATIONS

- **For municipal wastewater treatment:**
  - Low-energy, small footprint technologies for wastewater treatment are needed.
  - Combined sewerage and drainage system: Appropriate technologies for N-removal for incoming flow with low C/N ratio are needed.
  - Storm water management, flood control, including early warning systems and appropriate technical flood remediation measures.
  - Sludge management is still open topic.
- **For industrial park wastewater management:**
  - Control of incoming flows from industries
  - Emergency control measures
  - Technologies for removal of color, heavy metals, resistant organics, etc.
  - Sludge treatment technologies for resource recovery + control of risks.
- **At industries:**
  - Technologies for wastewater, sludge treatment and recovery of resources
  - High efficiency, reliable technologies and equipment
  - Membrane technologies and wastewater reuse

THANK YOU VERY MUCH !

Prof. Dr. Viet-Anh Nguyen
Director, Institute of Environmental Science & Engineering (IESE), Hanoi University of Civil Engineering
Address: IESE, DHXD, 55 Giai phong Rd, HBT. Dist. Hanoi, VIETNAM
Tel.: +84-24-3869.1604; +84-91320.9689. Fax.: +84-24-38693714. Website: http://www.iese.vn.
Email: anhnv@nuce.edu.vn; vietanhctn@gmail.com.