Water-Reuse in Industrieparks

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TECHNISCHE UNIVERSITÄT DARMSTADT

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Water-reuse concepts for industrial parks in water-stressed regions in South East Asia

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Introduction

Shanghai, own photograph

- **South East Asia** belongs to the world's **fastest-growing regions**
- **Urbanization** has a huge influence on **new** or on the **expansion** of **industrial park (IP) locations**

→ Due to **water shortage** (e.g. in western/northern regions of China) new **IP developments** are **hindered** as they have water requirements with **respect to water quantity and quality** *(production water, cooling water, irrigation…)*

Shanghai Chemical Industry Park, own photograph

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Introduction

In times of **climate change**, **shortage of resources** and the increasing importance of **environmentalism** it is important to **ensure a <u>sustainable water supply</u>** to **enable new developments**

Source: https://amp.tagesspiegel.de/politik/kampf-gegen-den-klimawandel-wie-sich-die-erwaermung-rasch-aufhalten-laesst/20803316.html ***(Fight against climate change, How to stop warming quickly)***

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Introduction

Sustainable water management and water-reuse concepts for IPs are becoming more and more important

→ **Reducing** high **water consumption** from **natural resources**

→ Opportunity to **enable industrial developments** in **water-stressed** regions
(e.g. in regions of South-East-Asia)

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Introduction

Industrial **W**aste**W**ater **M**anagement **C**oncept with a focus on **R**euse

IW²MC→R

→ includes a **sustainable treatment** of **wastewater** in Industrial Parks

→ Providing **reuse-water** for different **infrastructure purposes** by a Water-Reuse Plant (WRP)

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Possible application of treated wastewater as…

Process water

Cooling water

Toilet flushing

Irrigation water

Fire-fighting water

Water for road cleaning

…etc.

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Methodology

Development of IW²MC→R

- **Investigations** in Germany, China and Vietnam (in 2017)
  - → The idea was to learn from the existing industrial parks for new ones
  - → 3 topics were decisive:
    - actual water supply situation
    - actual wastewater system
    - possibilities of water-reuse
  - → **2 typical, initial industrial park systems**

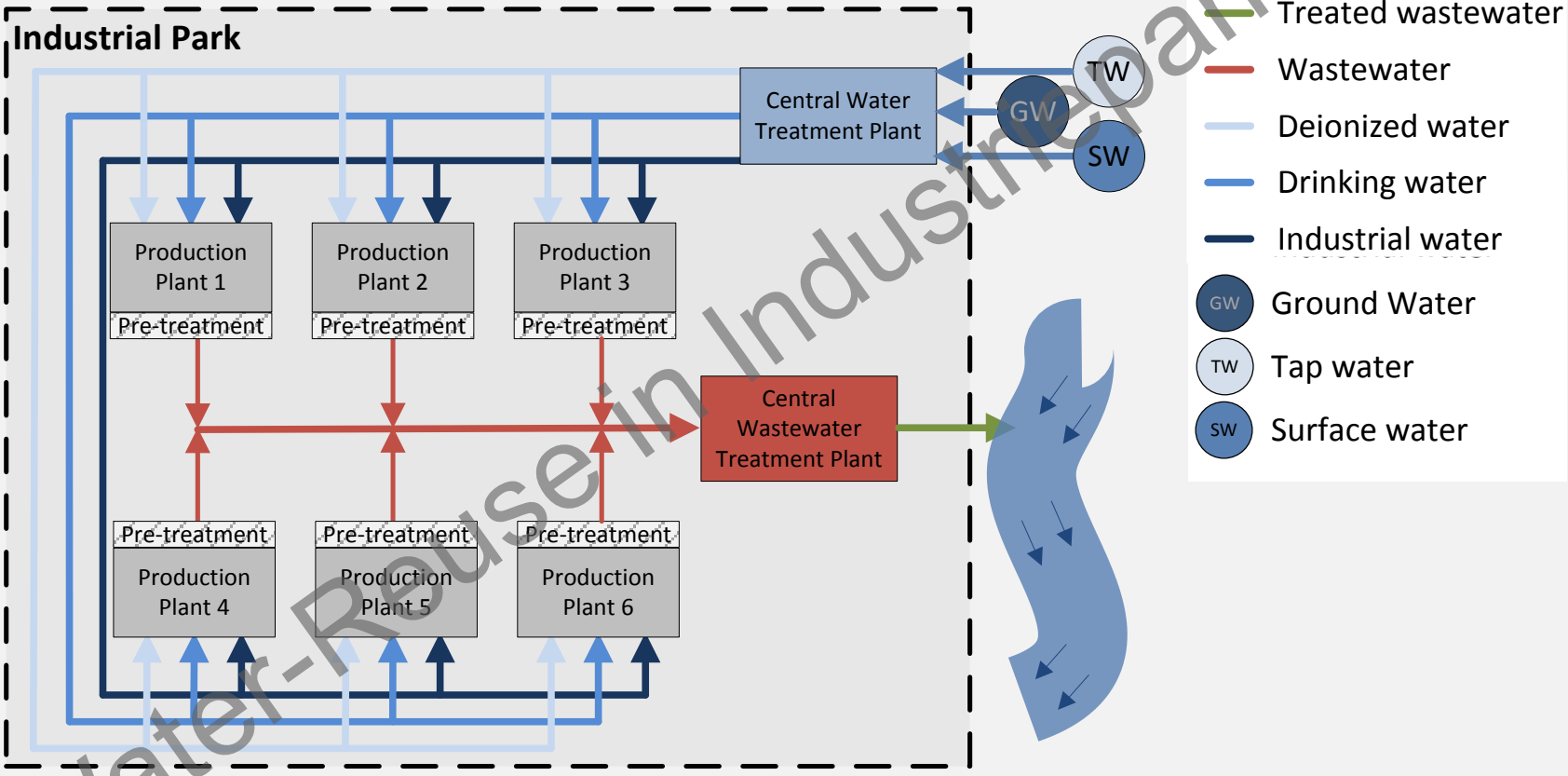
CHEMPARK Leverkusen, Germany

Shanghai Chemical Industrial Park (SCIP), China

Amata Industrial Park, Vietnam

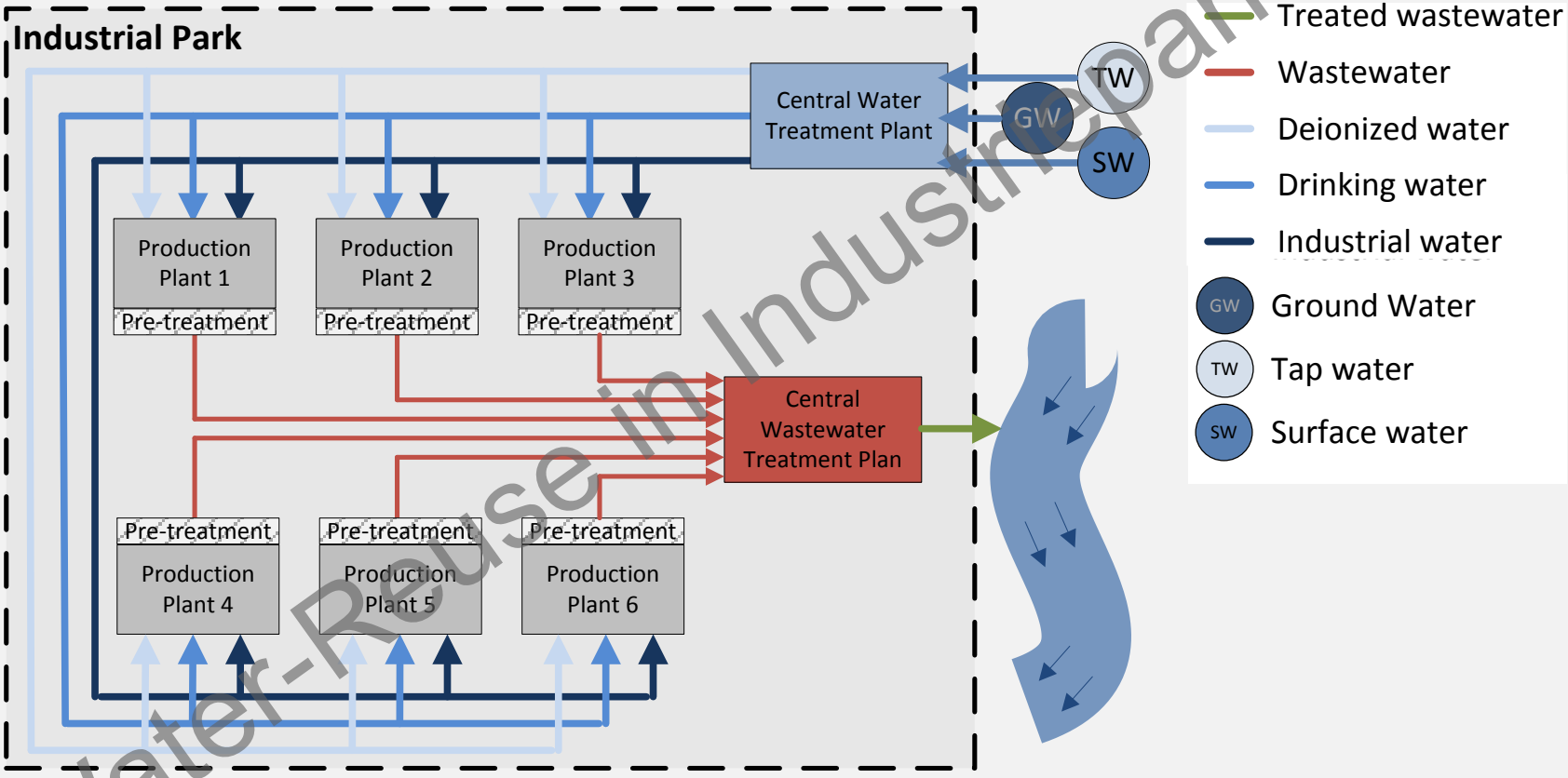
Methodology

Industrial Park System 1 (Germany, Vietnam, China)

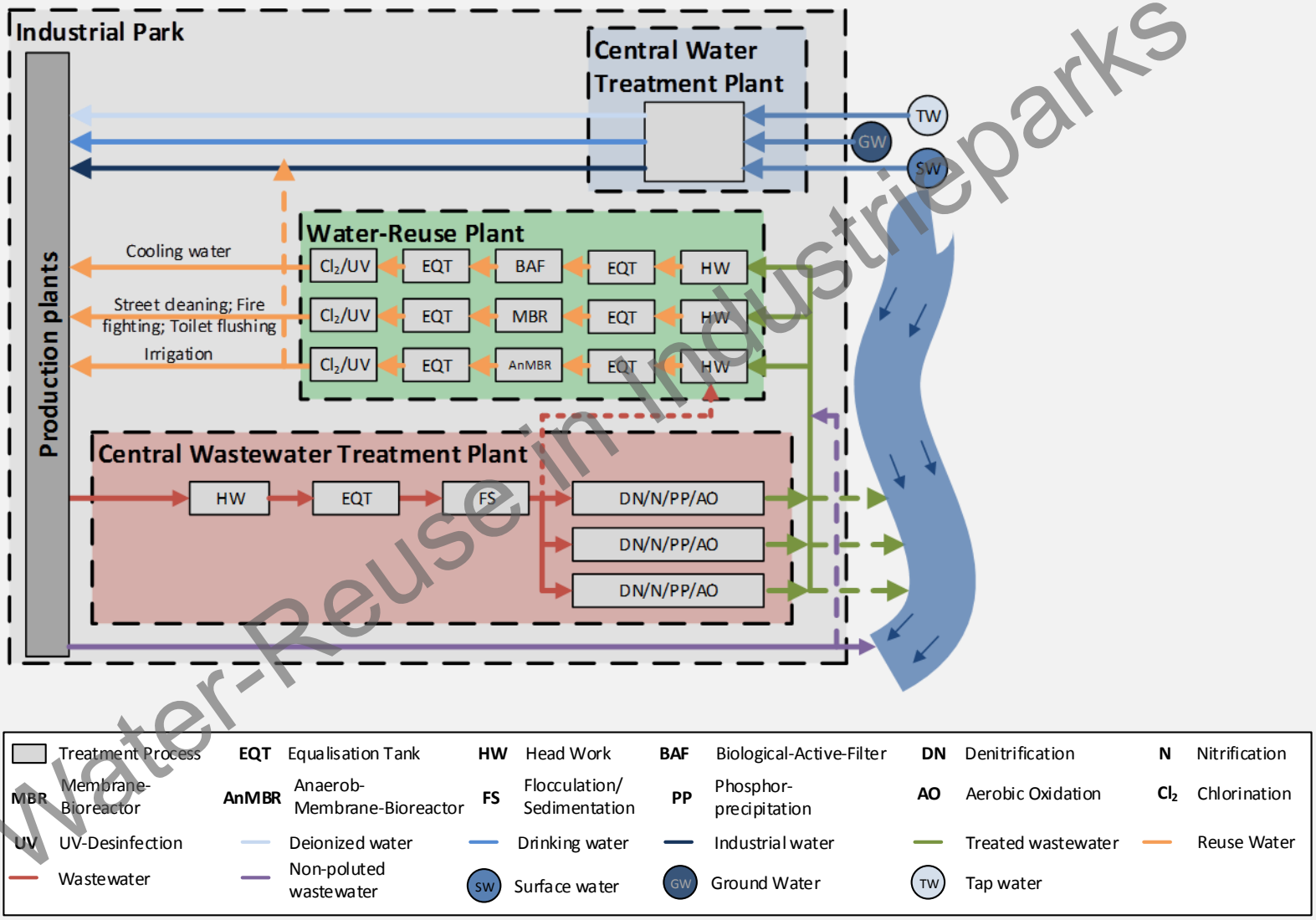


Methodology

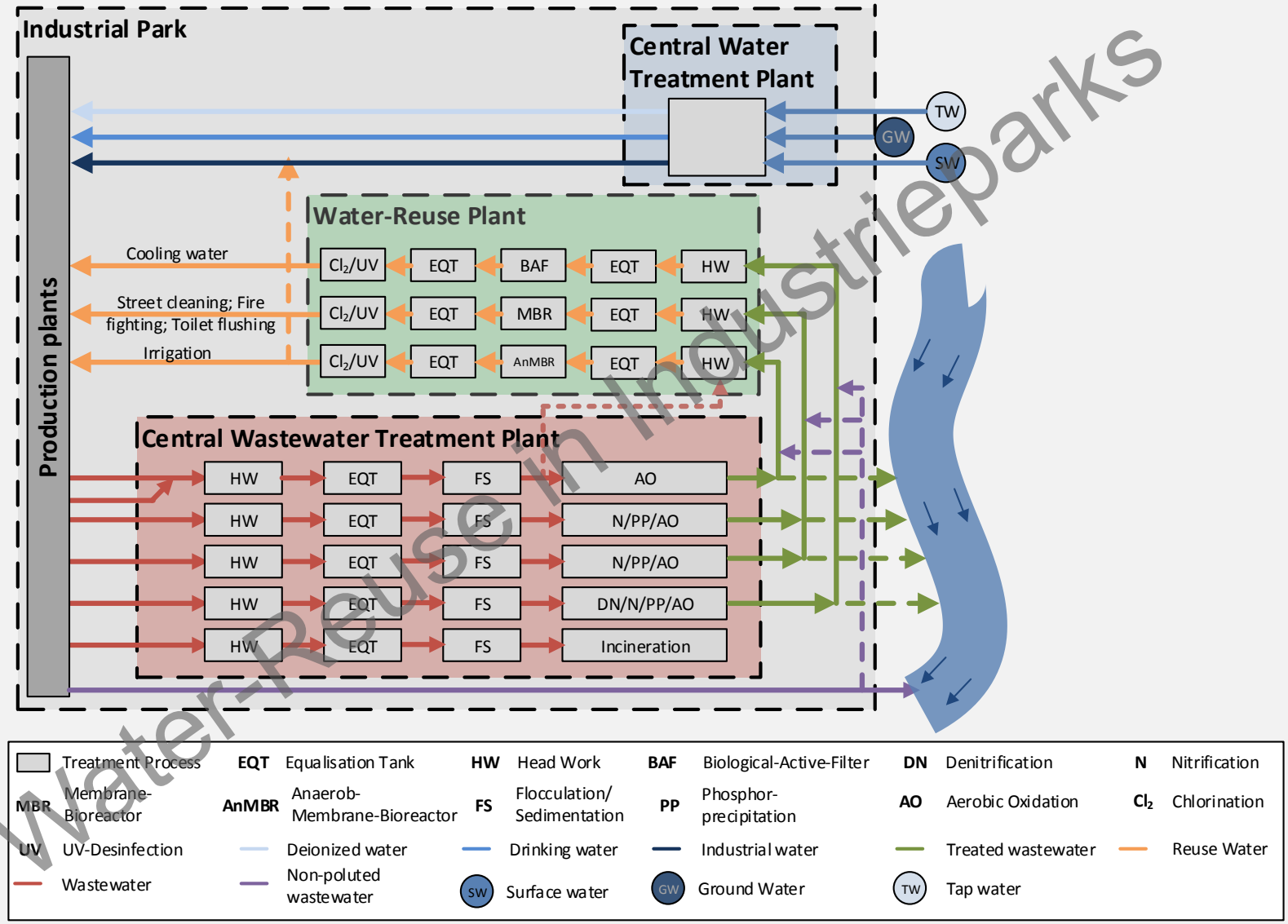
Industrial Park System 2 (China)



Water-Reuse Approach 1 (IW²MC→R)



Water-Reuse Approach 2 (IW²MC→R)



Definition of sustainability objectives

Sustainable objectives of the **IW²MC→R**

1. Highest possible **industrial park reuse-factor (IPRF):**

$$\text{IPRF} = \frac{\text{Reuse water flows}}{\text{Whole wastewater inflows to CWWTP}} > 25\ \%$$

2. Reducing…

   → energy consumption

   → land consumption

   → consumption of resources

3. High **automation level** of the treatment processes

Calculation: Industrial Park Reuse Factor (IPRF)

IPRF consists of:

→ **Production Plant Reuse Factor** (PPRF)
e.g. reuse water for process water

→ **Infrastructure Reuse Factor** (IRF)
e.g. reuse water for irrigation, toilet flushing, street cleaning

First calculation:

$$\text{IRF} = \frac{\text{Infrastructure reuse water flows}}{\text{Whole wastewater inflows to CWWTP}}$$

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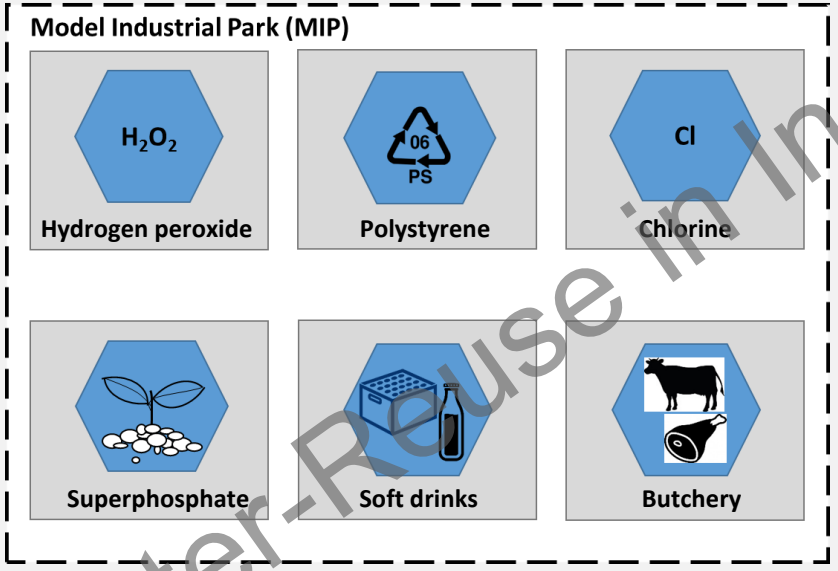
Model Industrial Park (MIP)

Calculation of IRF → Case study **China**

1. **Determination** of the **whole wastewater inflows** to **CWWTP**



- **<u>6 exemplary Production Plants</u>**
- wastewater effluents (m^3/t product) based on literature data (analysis)
- Production capacities (t product/a)
- Additionally: common sanitary wastewater quantities

Whole wastewater inflows to CWWTP

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Model Industrial Park (MIP)

Calculation of IRF:

1. **Determination** of the **whole wastewater inflows** to **CWWTP**

	Wastewater values	Production capacity due to example production plants	Calculated wastewater flows in m³/d
H_2O_2 production	1.5 m³/t product	230,000 t product/a	945
Polystyrene production (GPPS)	1.1 m³/t product	300,000 t product/a	904
Chlorine production	0.62 m³/t product	215,000 t product/a	365
Superphosphate production	1.25 m³/t product	850,000 t product/a	2,914
Production of soft drinks	1.56 m³/1000L product	600,000,000 L product/a	2,564
Butchery (cattle)	0.95 m³/cattle	100,000 cattle/a	260
Sanitary wastewater	50 L/employee×day	11,180 employees in the MIP	559
		Sum Wastewater flows	**8,511**

Model Industrial Park (MIP)

Calculation of IRF:

2. Determination of **reuse water flows/demand**

→ Calculation of different **average values** of **investigated parks** to the size of **6 production plants/companies**

→ **Indicators** to calculate the **reuse water flow**

- parks size
- size of **green spaces**
  → reuse water demand for **irrigation**
- size of **road spaces**
  → reuse water demand for **street cleaning**
- number of **employees**
  → reuse water demand for **sanitary water** (e.g. toilet flushing)

Reuse water requirements

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Model Industrial Park (MIP)

Park size	260 ha
Green spaces	20 % = 52 ha
Road spaces	9 % = 23 ha
Employees	11,209

Green spaces in Industrials Parks:
China: min. 20 % → Governmental regulations

Water demand:

Water-reuse application	Water demand values	Data referring to the MIP	Calculated reuse water demand in m³/d
Toilet flushing	40 L/employee×day (=0.8×50L)	11,180 Employees in the MIP	447
Street cleaning	2.5 L/m²×day	23 ha (=0.09×260ha)	585
Irrigation of green spaces	2.0 L/m²×day	52 ha (=0.2×260ha)	1,040
		Sum reuse water demand	**2,072**

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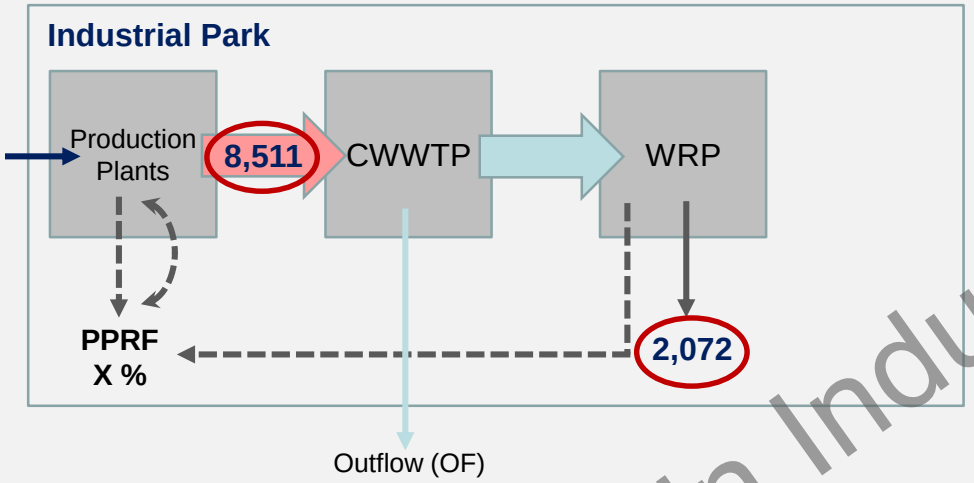
Calculation of IRF for MIP



$$\text{IRF} = \frac{\textbf{2,072 m}^3\textbf{/d } \textit{(infrastructure reuse water demand)}}{\textbf{8,511 m}^3\textbf{/d } \textit{(whole wastewater inflows to CWWTP)}} = \boxed{\sim 25\ \%}$$

Considering process, firefighting water, cooling water → **IPRF: > 25 %**

Reaching sustainability by the IW²MC→R

- ✓ **IPRF can be <u>higher than 25 %</u>**
- ✓ **Energy consumption of CWWTP plus WRP is less** to that of the CWTP
  → despite higher energy demand for CWWTP and WRP (1.7 kWh/m³) than for the CWTP (1.6 kWh/m³) <u>due to shorter transport routes</u>
- ✓ **Reducing land consumption** by an **area-saving construction**
  (the WRP is assumed to take up no more than an additional 10 % of the area of the CWWTP)
- ✓ **Reducing** the **consumption** of **resources** by **optimized treatment processes**
  (e.g. via biological phosphorus removal instead of precipitation)
- ✓ A high **automation level** of the treatment processes is to be achieved in order to secure a **high quality level** of the **produced reuse water by innovative measurement concepts**

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Thank you for your attention.

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