Water-Reuse in Industrial parks

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NaWaM WavE

TECHNISCHE UNIVERSITÄT DARMSTADT

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Session "WavE-Projects: Water Reuse in Industry“

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Introduction

- For reasons of regional compatibility and to ensure supply and disposal, **industrial production plants** are increasingly located in **industrial parks** around the world
- This opens up a wide range of possibilities for saving resources, energy and costs through **joint use, recycling or the exchange of material flows**
- Especially 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>**

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Introduction

Sustainable water management and water reuse concepts for IP's are becoming more and more important

- **demand** for **water** from **natural resources** can be **reduced**
- **valuable materials recovered** from the wastewater
- **costs** can be **reduced** (investment/running)

→ opportunity for **industrial developments** in regions with natural **water shortage** (e.g. in parts of South-East-Asia)

→ application potential for **chemical-pharmaceutical industry** due to their high water requirements/high amounts of wastewater

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The Project

Industrial **W**aste**W**ater **M**anagement **C**oncept with a focus on **R**euse: **IW²MC→R**

- includes a sustainable **treatment** of **wastewater in IP**
- **Providing reuse-water** for different purposes

→ Reduction water demand from natural resources

Objective: highest possible **industrial reuse-factor (IRF):** based on reuse water flow / whole water consumption

→ High application potential for IP in water-stressed regions (e.g. Western parts of China)

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First results

Investigations in Germany, China and Vietnam (conducted 2017)

- The idea was to learn from the existing industrial parks for new ones
- 3 topics were decisive: **actual water supply situation, actual waste water system** and **possibilities of water-reuse**

CHEMPARK Leverkusen, Germany

Shanghai Chemical Industrial Park (SCIP), China

Amata Industrial Park, Vietnam

Image sources: https://lanxess.de/de/corporate/presse/presseinformationen/2018-00010/; http://touch.shio.gov.cn/en/proposed-interviews/detailindex.aspx?id=13

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Industrial Parks – comparison of 3 countries

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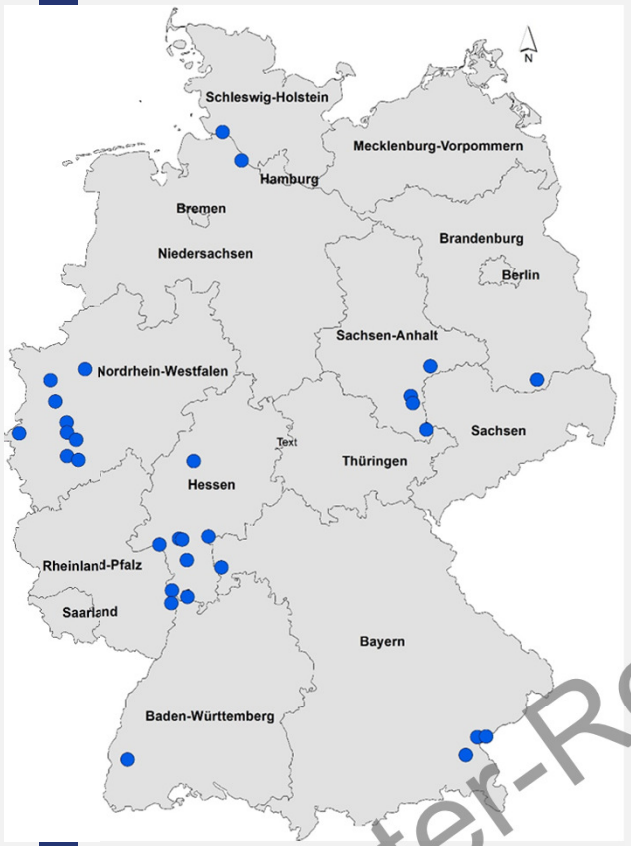
Germany



China

Vietnam

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● Investigated Industrial Parks

Industrial Parks – comparison of 3 countries

	Germany	China	Vietnam
Sample	39 parks	12 parks	23 parks
Park size	Ø 340 ha	Ø 3.800 ha	Ø 330 ha
Park types	usually historically grown chemical parks, gradually opened up to other industries	trend towards »theme parks« e.g. chemical parks	mixed parks (light industry)
Water supply	different, usually 3 different quality types (sometimes up to 9)	usually 3 different quality types (drinking-, industrial- und deionized-water)	just one quality (domestic water ≠ drinking water)
Central wastewater treatment plants	treatment techniques usually highly individualized (historically grown, built 20-40 years ago), common to treat municipal wastewater as well	Different (built in the last 10-20 years) – eye-catching: separate treatment lines for different wastewater qualities in one park	very similar (built in the last 10-20 years) - given standard: wastewater qualities A and B
Pipe system	above-ground pressure pipelines as well as underground pipelines	usually above-ground pressure pipelines	mainly underground pipelines
Water-Reuse	no comprehensive reuse standard available - internal water circuits close to the process usually available, can be expanded across companies	reuse standard available, but so far only isolated implementations in the industrial sector	no comprehensive reuse standard available - but interest exists and measures already implemented on a small scale

Summarized in 2 different initial situations

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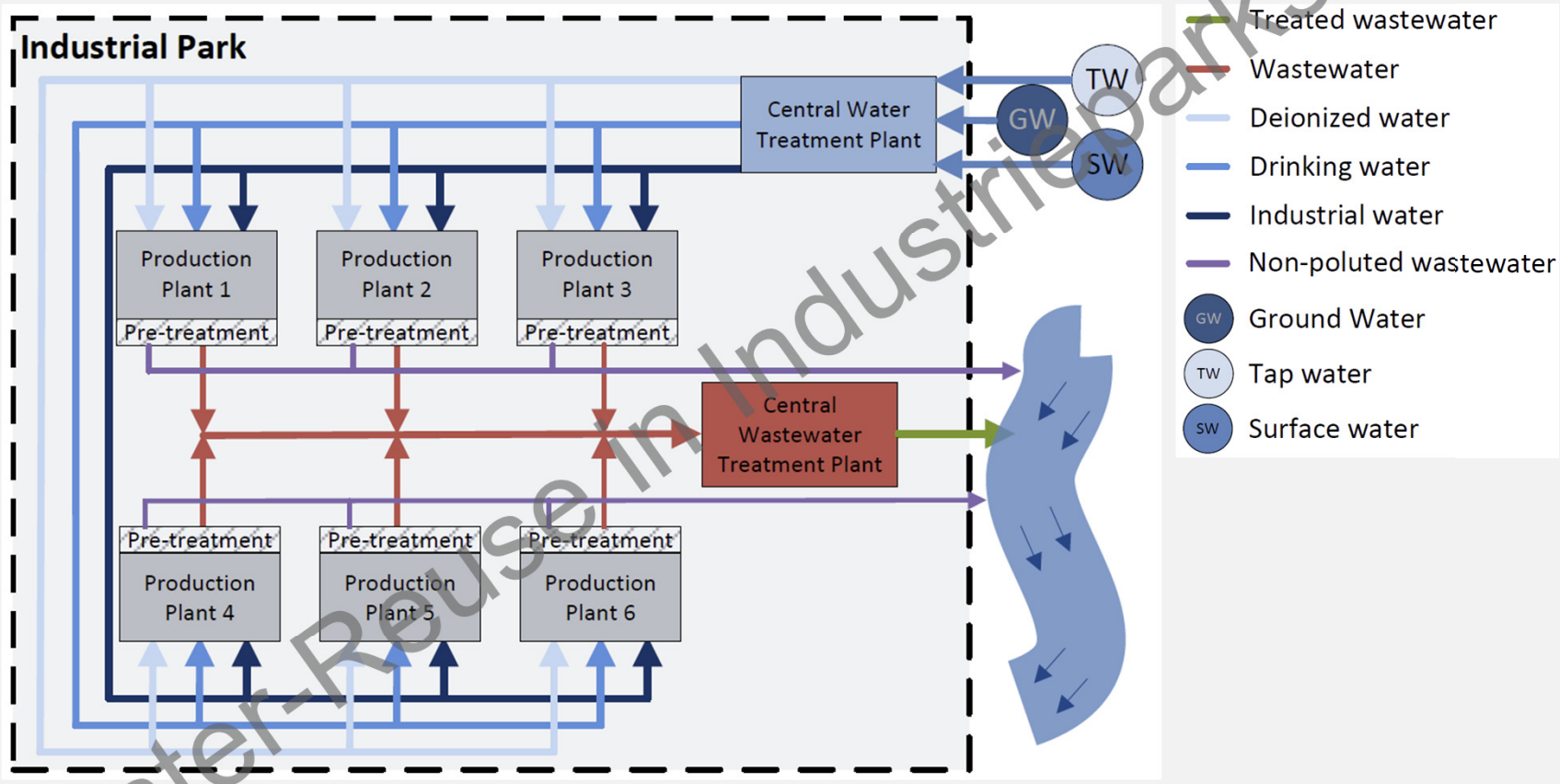
Initial situation

Situation 1: Germany, China - Vietnam (only one water supply quality)



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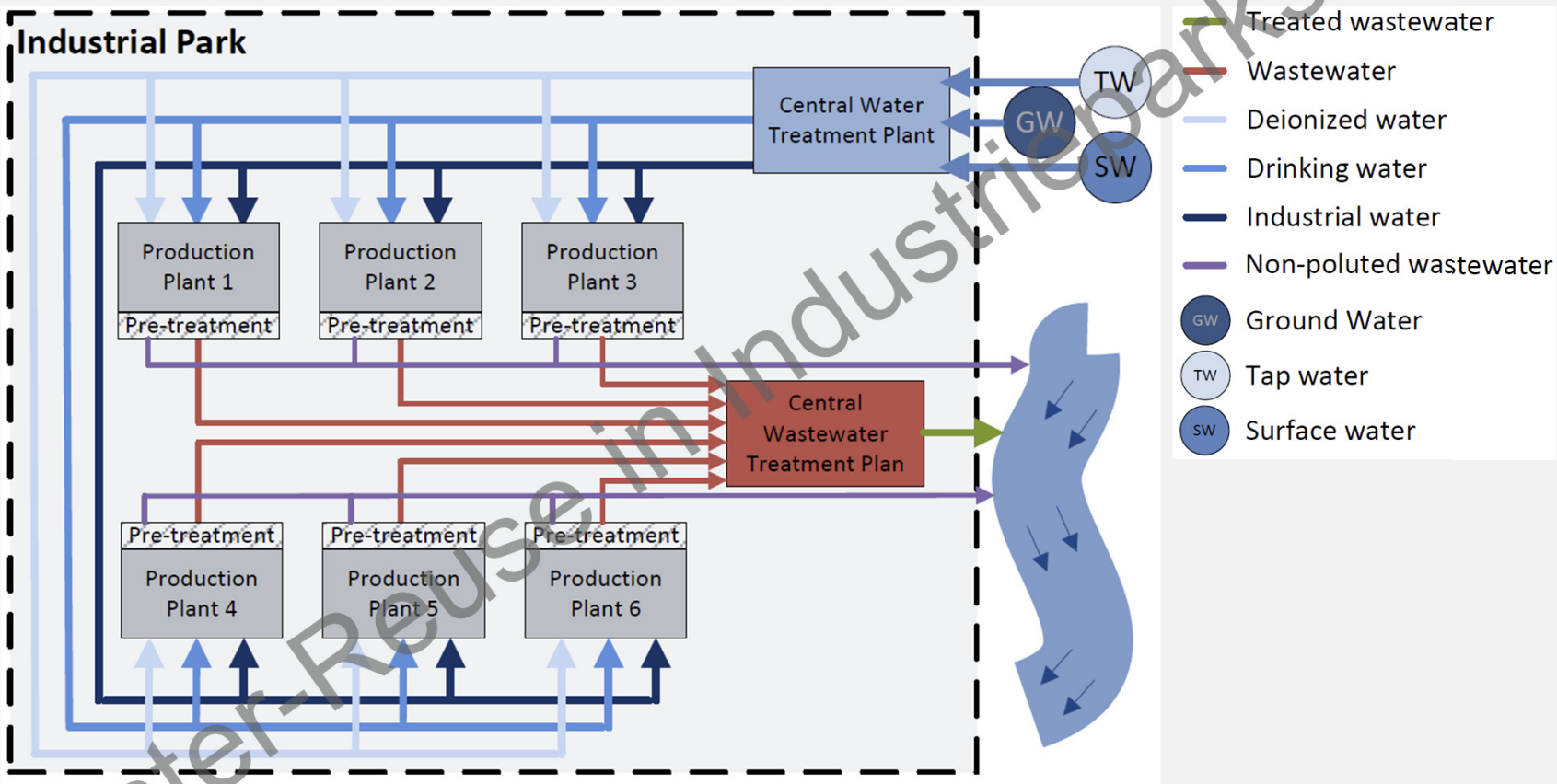
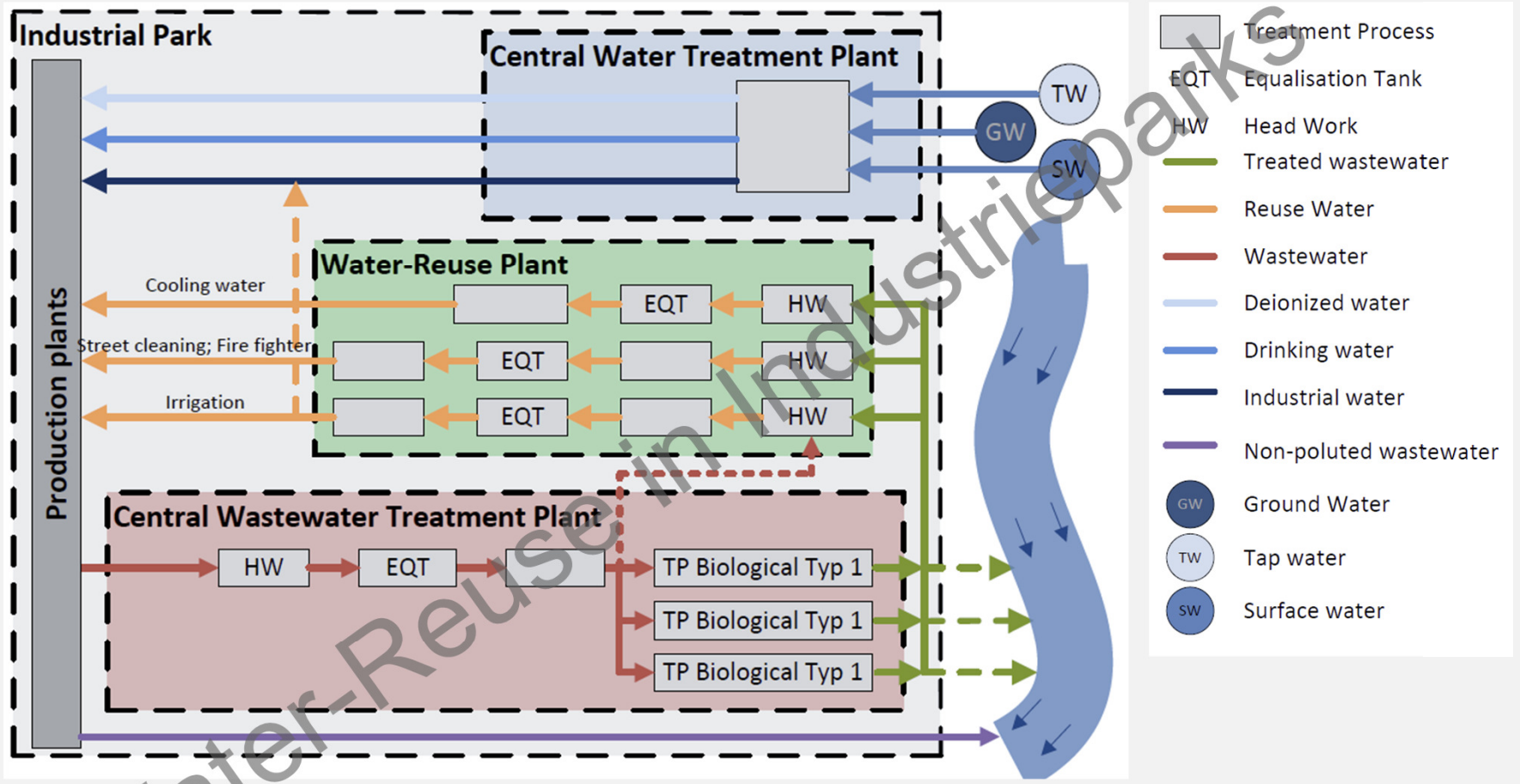
Initial situation

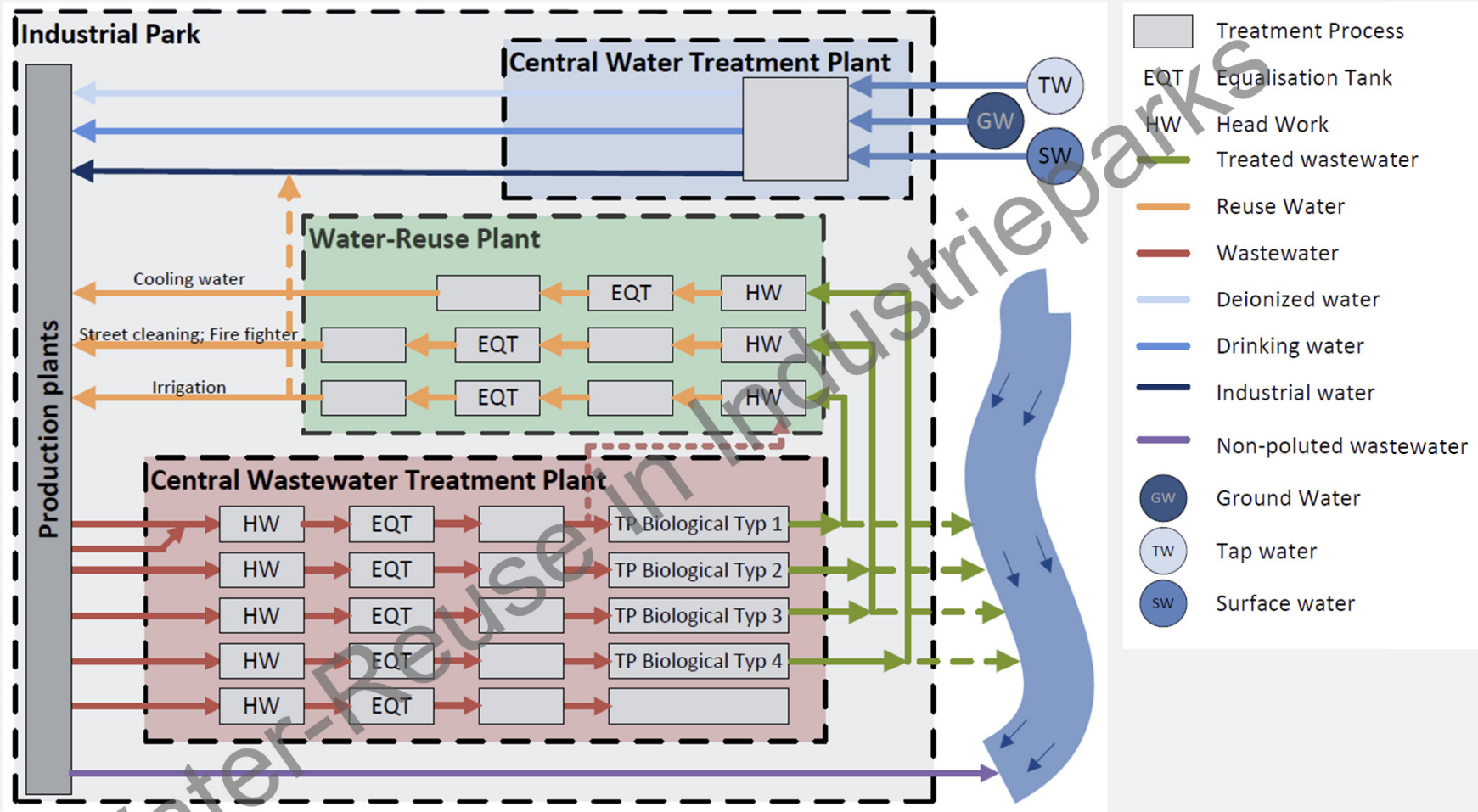
Situation 2: China



Reuse-Concept 1



Reuse-Concept 2



Identification of appropriate treatment technologies

… for linking existing water flows

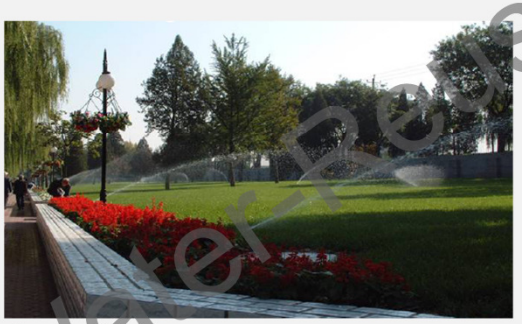
	Reuse-Water-Quality A	Reuse-Water-Quality B	Reuse-Water-Quality C
Wastewater Quality A	Treatment Technology X/ Treatment Technology Z	Tech. X	Tech. X / Tech. Y / Tech. Z
Wastewater Quality B	Low development need	No technical solution identifiable	Economic solution is not known
Wastewater Quality C	Low development need	High development need	Tech. X + Tech. Y

Possible application of treated wastewater as…

Process water

Cooling water

Toilet flushing



Irrigation water

Fire-fighting water

Water for road cleaning

…etc.

Calculation: Industrial Reuse-Factor (IRF)

IRF: based on reuse water flow / whole water consumption

Model Industrial Park (MIP):

→ 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 (6 Production plants)
- 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)

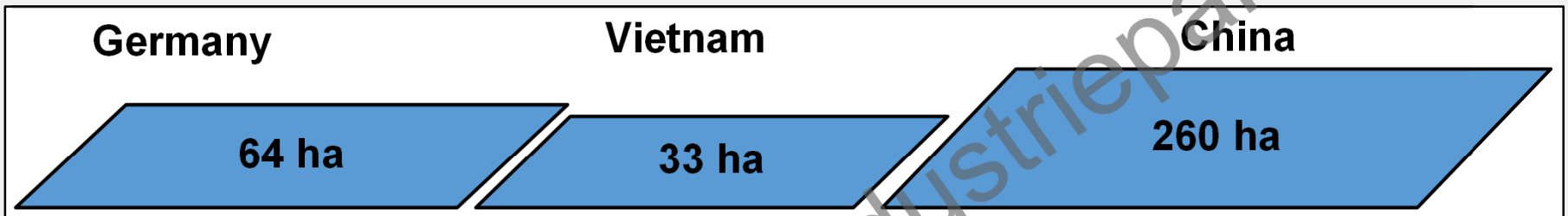
→ Calculation of **whole water consumption**

- Amounts of wastewater of 6 exemplary production plants/processes

Source: e.g. Best Available Techniques (BAT) reference documents

Calculation: Industrial Reuse-Factor (IRF)

Model Industrial Parks (MIP) downsized to 6 production plants/companies:



	Germany	Nr. of available data	Vietnam	Nr. of available data	China	Nr. of available data
Ø **Park size**	64 ha	35	33 ha	15	260 ha	12
Ø **Green spaces**	12% = 8 ha	3	10% = 3,3 ha	regulation	20% = 52 ha	regulation
Ø **Road spaces**	11% = 7 ha	4	8% = 2,6 ha	regulation	9% = 23 ha	2
Ø **Employees**	1.594	39	4.102	13	11.209	4

Calculation: Industrial Reuse-Factor (IRF):

Case study CHINA – 6 Prod. Plants

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:

For irrigation	Irrigation of public greens	**1,5-4 l / m²*d**	*GB 50282-1998, China*
For street cleaning	Street cleaning, China: *2-3 work tours per day*	**1-4,5 l / m²*d**	*GB 50282-1998, China*
Sanitary water	Mixed industrial areas	**50 l / Empl./*d**	*DVGW-Regelwerk Arbeitsblatt W 410*
Fire fighting water	Depends on the existing system		
Cooling water	Depends on the existing system		
Process water	Depending on the production plant		

First calculation for MIP China (6 PP)

Calculation of the requirements of reuse water:

▪ Irrigation:	1430 m³/d
▪ Street cleaning:	644 m³/d
▪ Sanitary water:	448 m³/d
	2522 m³/d

Calculation of **wastewater amounts:**

Amounts of wastewater of 6 exemplary production plants/processes:

1. H_2O_2:	945 m³/d
2. Polystyrene:	904 m³/d
3. Chlorine:	365 m³/d
4. Superphosphate:	2914 m³/d
5. Berverages:	2052 m³/d
6. Butchery:	2497 m³/d
Sanitary WW:	918 m³/d
Sum:	**10238 m³/d**

Source: e.g. Best Available Techniques (BAT) reference documents

IRF: ~25 % → Process-, fire fighting-, cooling water → **IRF: >25 %**

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Potentials

- Industrial parks with their large number of production facilities offer particularly favourable conditions for **joint use, recycling or the exchange of water flows**
- Positive ecological and economic aspects by **saving drinking water and groundwater** in industrial parks
- The **example of China** has shown, that the existing governmental regulations due to **green spaces and street cleaning** already ensure a possible **reuse factor of almost 25%** (even without process water reuse)
- Adding **more reuse purposes** (process-, firefighting and cooling water) suggests an even **higher reuse factor**
- **Climate change and increasing restrictions on wastewater discharge** suggests a higher reuse potential also for Germany

Challenges

- **Data availability:** due to aspects of manufacturing secrets especially in the pharma industry it isn't easy to get water demand or wastewater data for different production plants

  Our data is mostly literature based (e.g. Best Available Techniques (BAT) reference documents)

- **Process water reuse**: even production plants usually don't know about minimum water-qualities they could possibly use

  Therefore we have to calculate with usual qualities such as drinking or deionized water

- **Costs:** In the reuse discussion the cost-factor is always the main one

  Our focus has to be on regions where the water-stress-level already minimizes the cost aspect

- **Minimum water quality**: Which quality parameters are relevant for what kind of reuse purpose? Is it necessary to measure everything?

  In the project we are focusing on existing reuse standards, but there still is a lot of research potential

Summary and further project goals

Conceptual approach: Treatment of **wastewater generated in an industrial park** via **cascaded treatment stages according to the requirements** by taking technical, ecological and economic aspects into account, and **reuse it** for various purposes in the park.

- Development of a **multicriterial decision support** in the area of process selection
- Development of a **dynamic pipeline network** and a **measurement concept** for an industrial park with a reuse concept
- Development of approaches to keep the **burden on employees appropriate** as process control becomes more complex
- Development of **new treatment techniques** for problematic fields of industrial wastewater treatment

→ Consolidation of the results to a **transferable planning guideline** for industrial park planners/operators

Joint partners of the project

- Technische Universität Darmstadt
  - Landmanagement (**LM**)
  - Wastewater Technology (**AT**)
  - Material Flow Management and Resource Economy (**SuR**)
  - Work and Engineering Psychology (**AI**)
- Institute for Sanitary Engineering and Waste Management of Leibniz Universität Hannover (**ISAH**)
- Institute of Environmental Engineering & Management at the Witten/Herdecke University (**IEEM**)
- EnviroChemie GmbH (**EC**)
- Endress+Hauser Conducta (**EH**)
- Kocks Consult GmbH (**KC**)

Additional Partners

- Associated Partner: Merck KGaA
- Tongji University Shanghai, China
- University of Technology Qingdao, China
- Hanoi University of Civil Engineering, Vietnam

Thank you for your attention!

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