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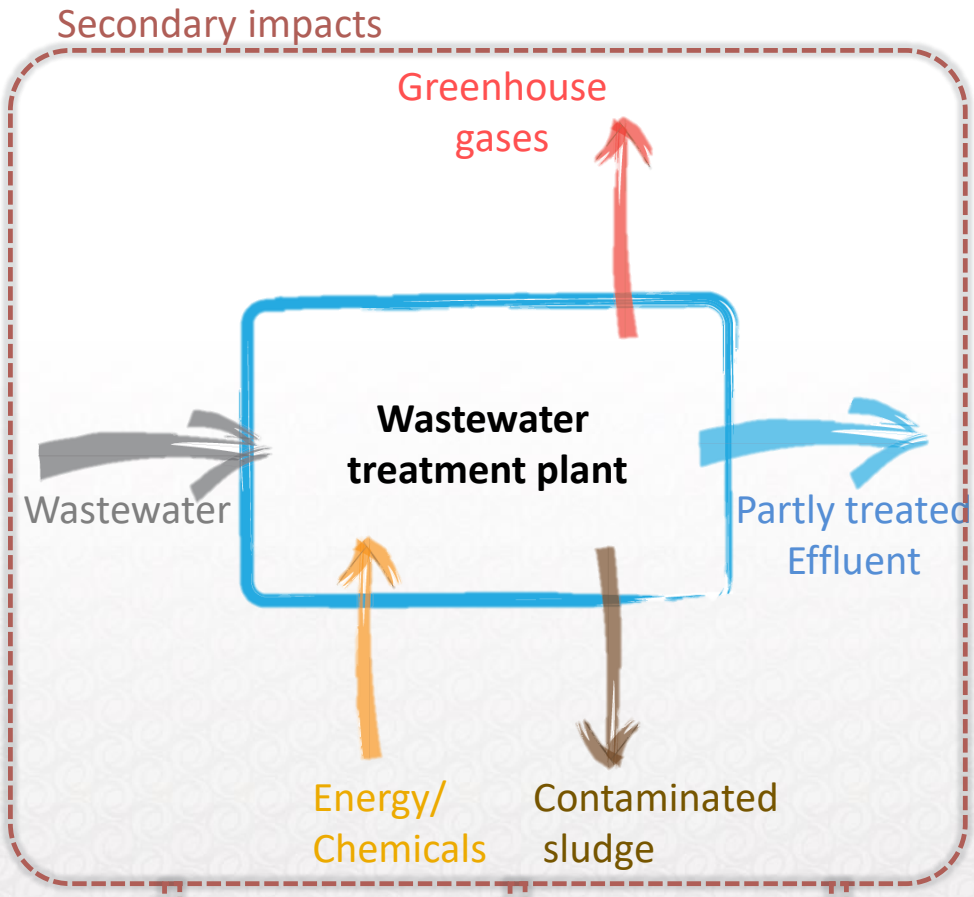
New approaches and technologies for wastewater treatment

Collaboration at the R&D-facility Hammarby Sjöstadsverk for research, development and demonstration

The main problem: A treatment facility



Challenges

- Use of energy and chemicals
- Greenhouse gas emissions
- Treated water is not clean enough
- Emissions also pose health risks
- Sludge a problem (even if often denied)
- Valuable resources not used
- Natural waters get polluted

Right approach for a sustainable society?

⇨ **High costs**

⇨ **High impact**

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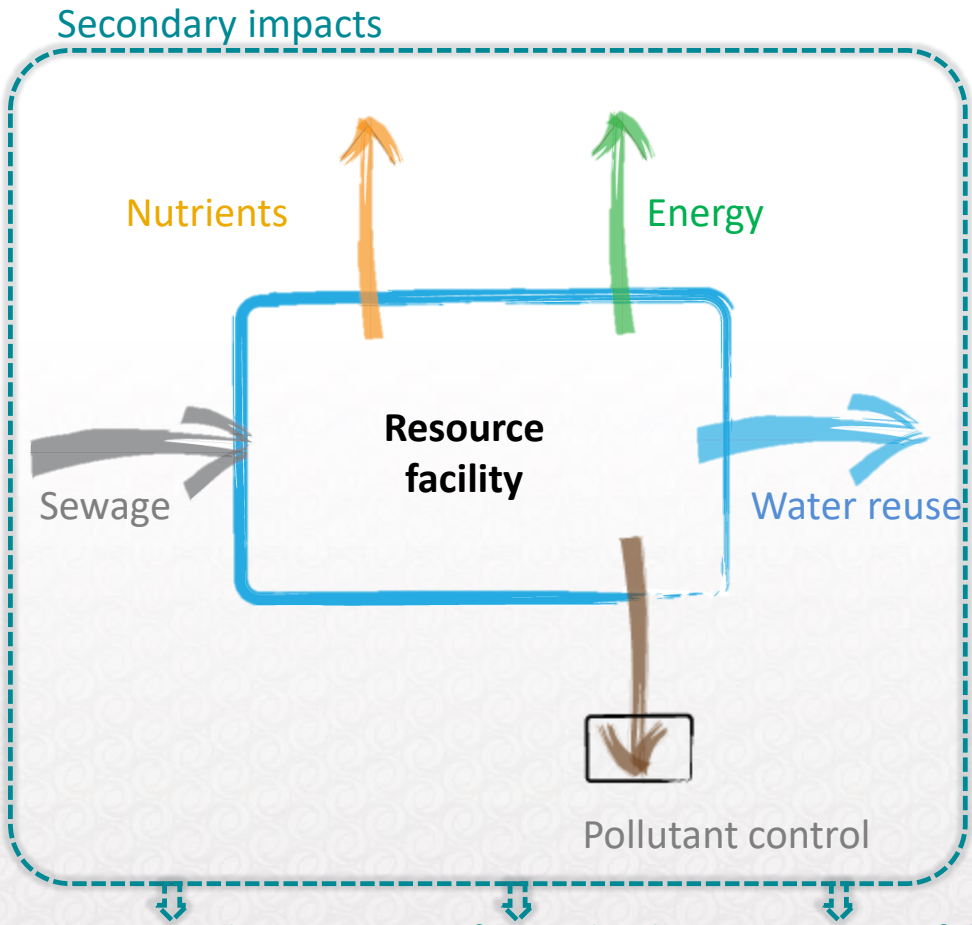
The solution: A resource facility



Opportunities

- Water and sludge as resource
- Net energy production
- Nutrients recovery/reuse
- Emission control
- Water reuse

➔ **Sustainable production of energy and resources**

➔ **Market opportunities**

⇨ **Lower costs**

⇨ **Less impact**

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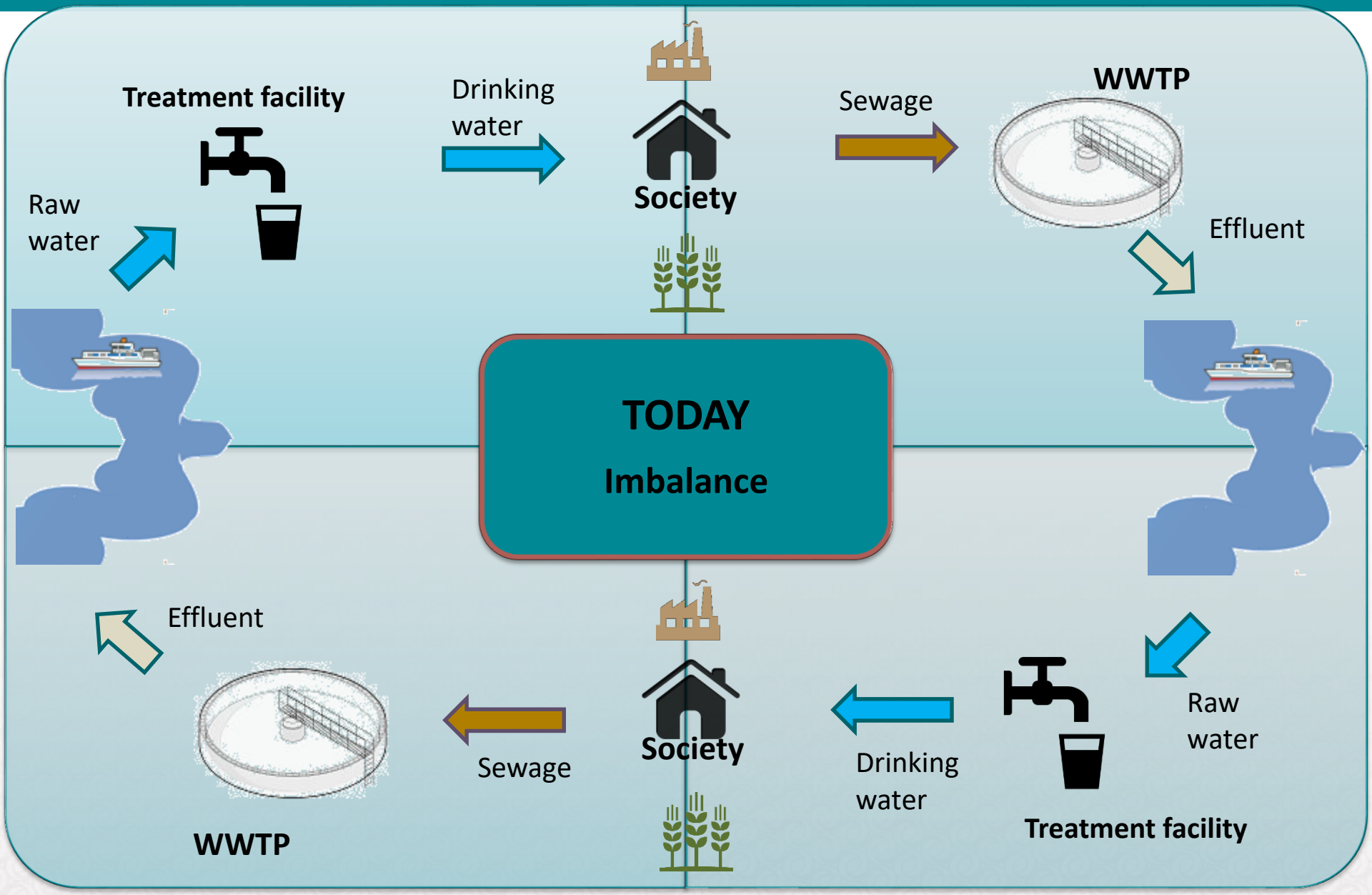

TODAY

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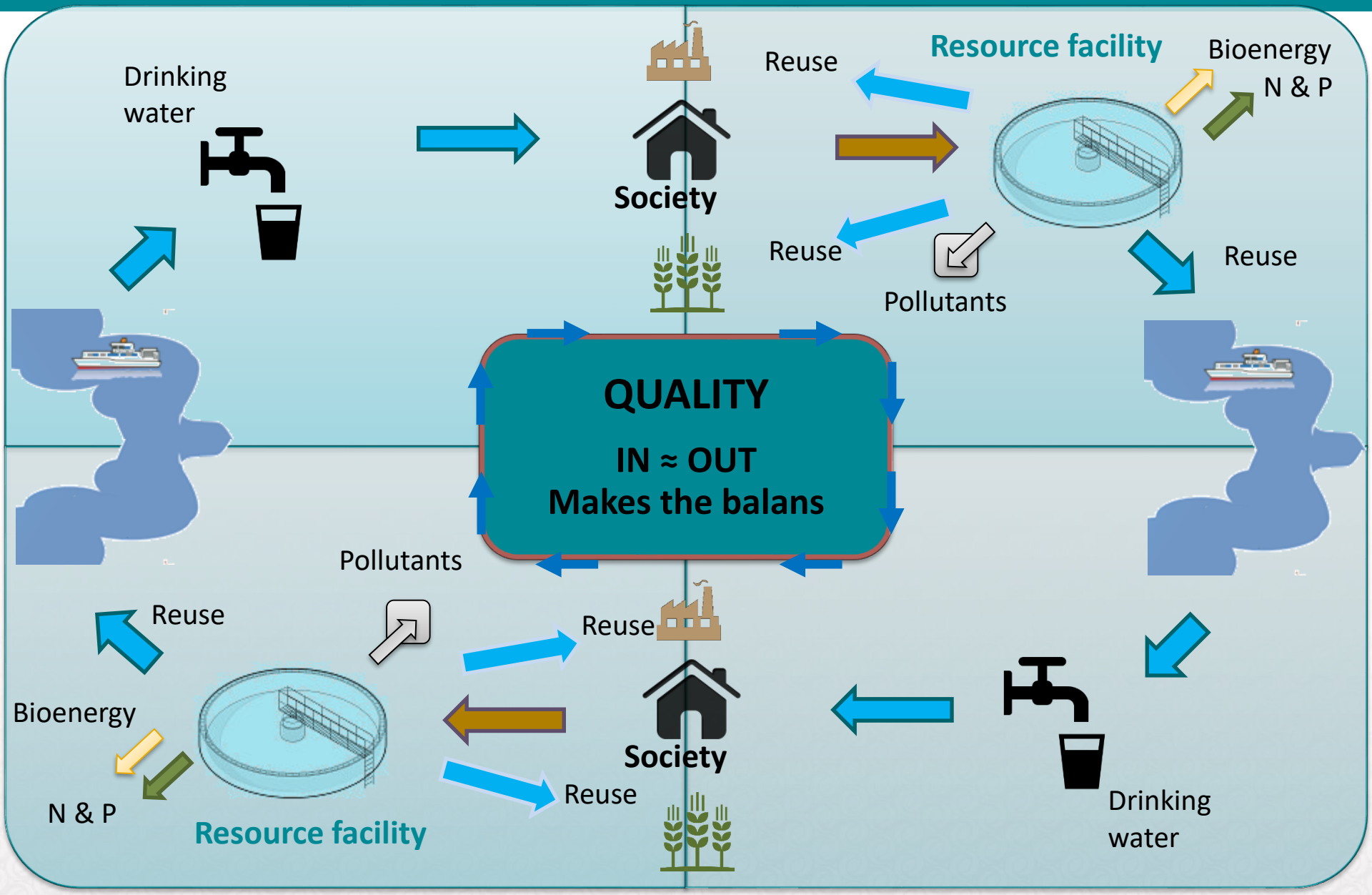

TOMORROW

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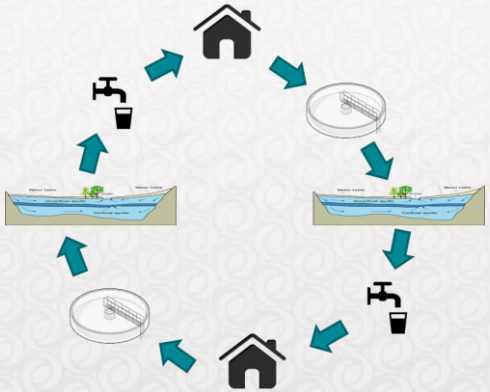
Side effects?

- Quantity problem can be controlled!
- Quality problems can be controlled!
  - ➔ reduced environmental damage and health risk!
- Most problems with environmental damage in the aquatic environment (both known and unknown) can be prevented and eventually natural systems can be restored.
- Functioning/restored ecosystem services
- Sustainable development and new market for innovations!
- Green growth!
- Towards sustainable society!



So what are we waiting for?

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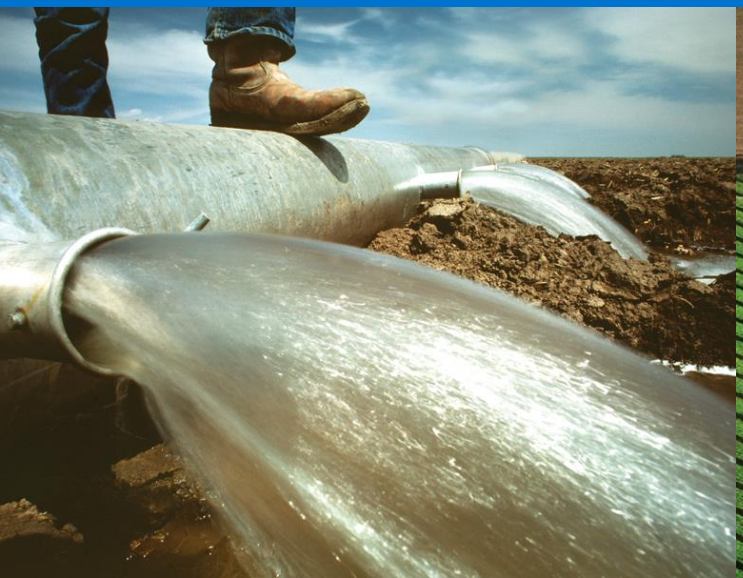
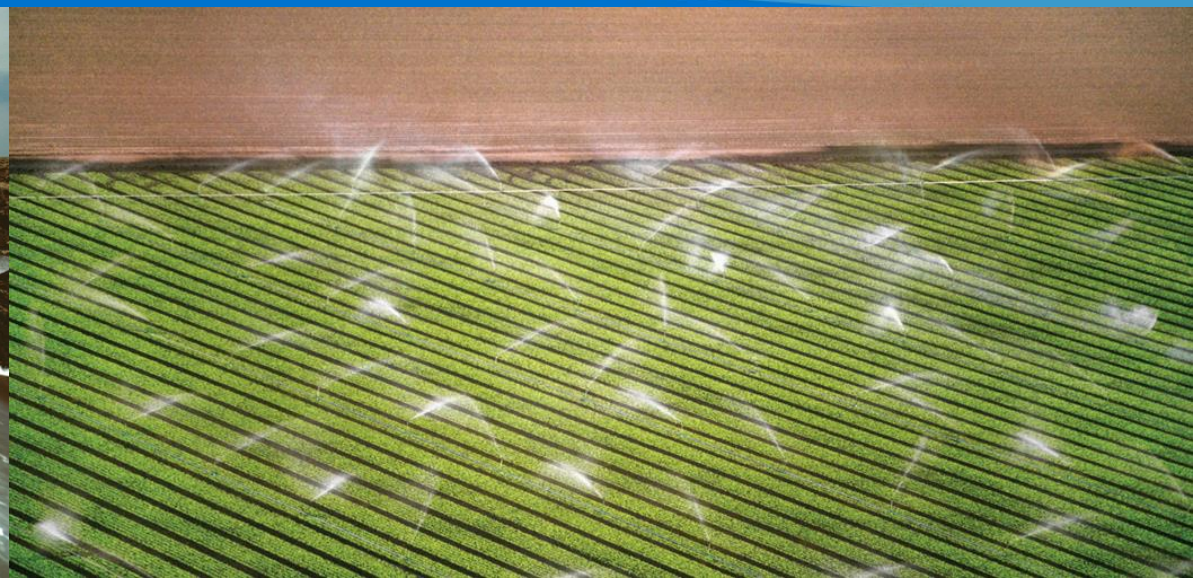
Sustainability evaluation of Non-potable water Reuse systems

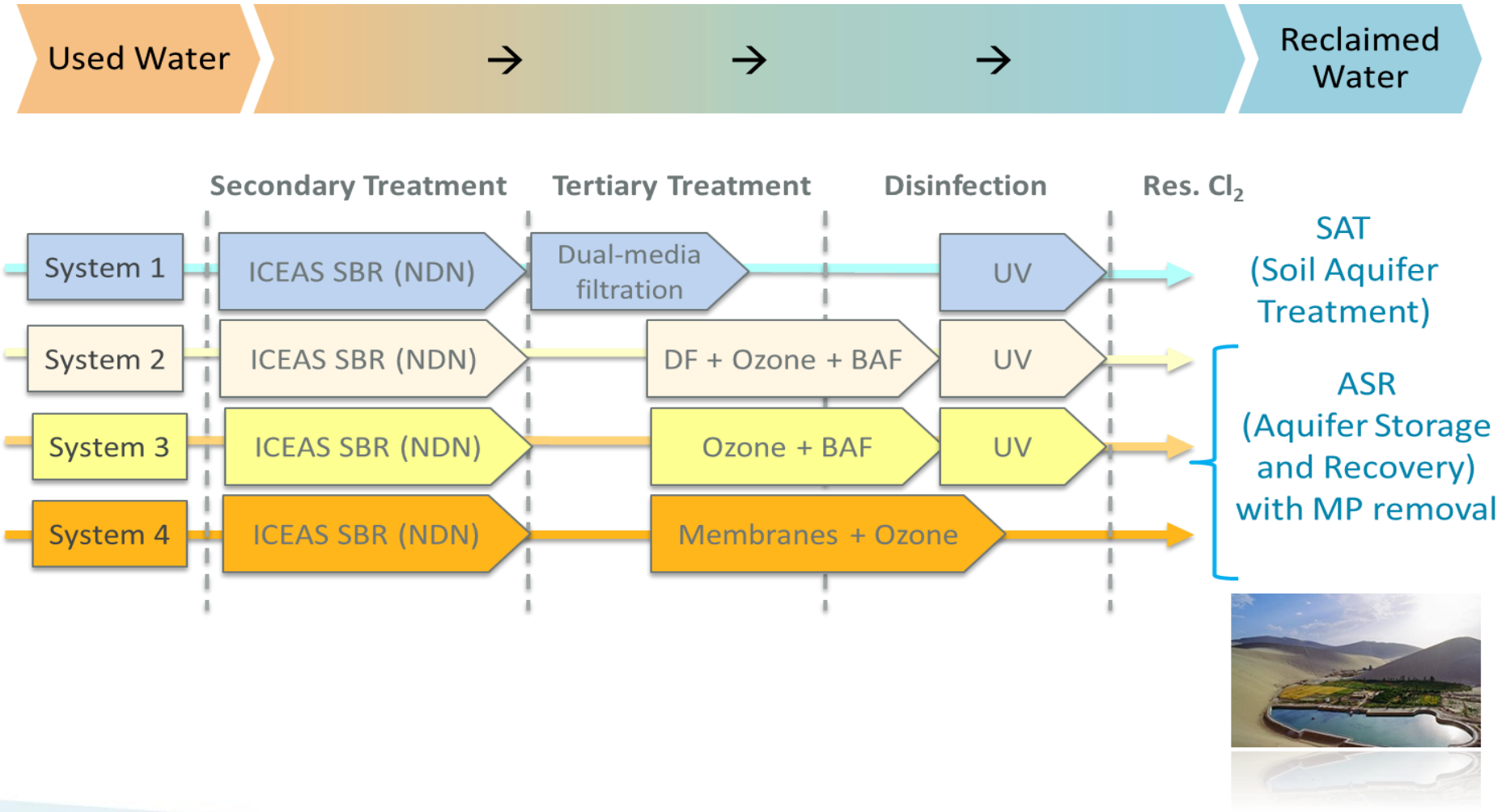




Hammarby Sjöstadsverk – R&D facility

- Ambition: To facilitate long-term cooperation between researchers, municipal wastewater treatment plants, and industry
- Partnership for faster development
- Xylem uses Hammarby Sjöstadsverk R&D platform (owned by IVL) to test technologies.
    - Operation and maintenance of the plant
    - Access to various municipal raw wastewater
    - Access to wide source of technical, fundamental, and applied knowledge
- Research on non-potable water reuse conducted here by Xylem & IVL since 2012

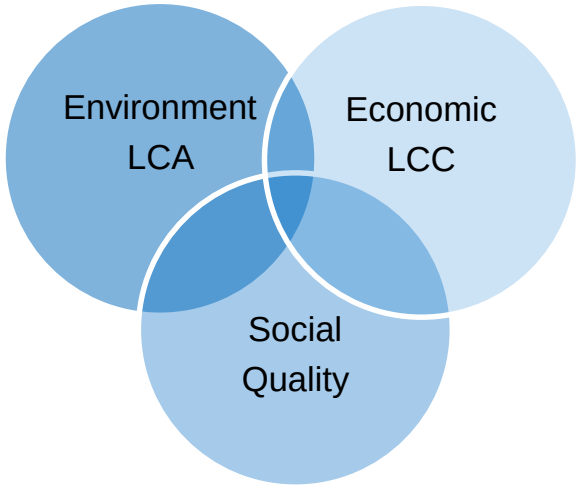
Treatment Trains for NP MAR



Sustainability Factors

Inform and influence **customers** on the **best environmental** and **financial reuse solution**

- The **Life Cycle Assessment** (LCA) informs on the environmental impact of the solution
- Full system **Life Cycle Cost** (LCC) adapts the solution to the economic limitation
- The adapted effluent **quality** leads to safety at the point of use and social acceptance



- Optimal solutions vary based on plant size, local and regional conditions, requirements, flexibility, etc.

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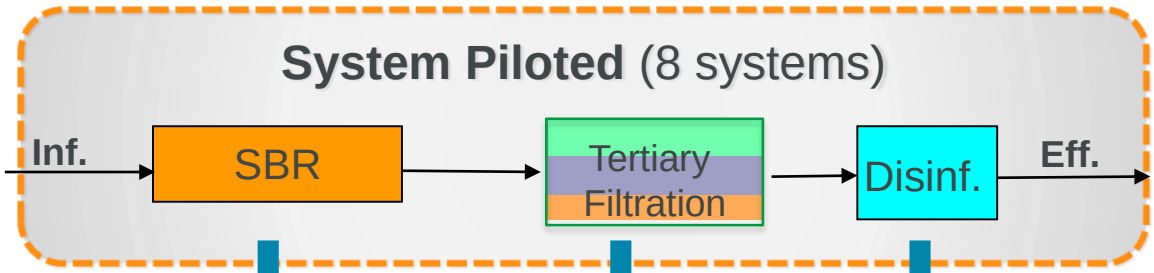
LCA / LCC modeling - approach

1. Predict Performance

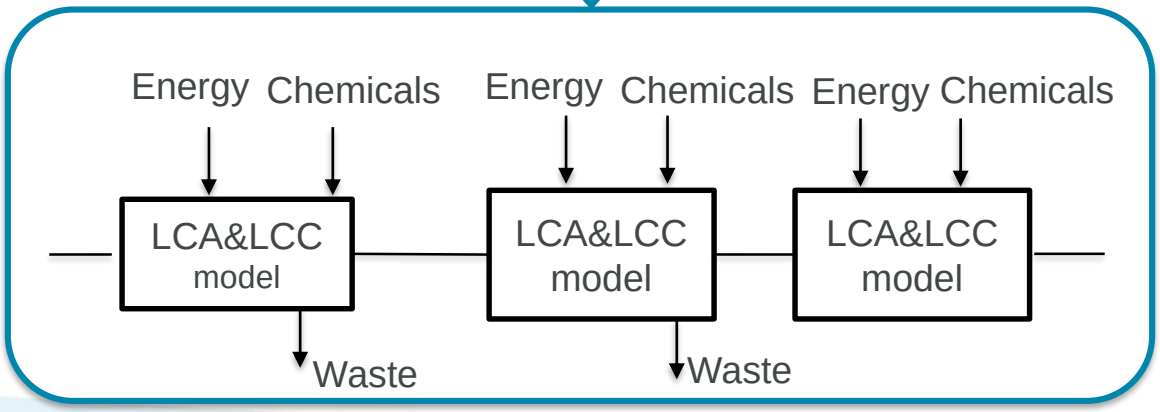


Effluent Quality (BOD, SS, N, P, MP)

2. Design Full-scale solution

Scale-up to:
20 000 PE; 100 000 PE; 500 000 PE

3. Assessment and Evaluations



LCA & LCC (10 LCA KPIs and 3 LCC KPIs)

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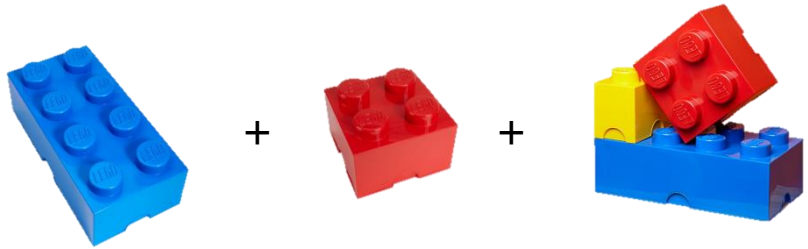
Commercial Impact



Secondary + Tertiary + Disinfection

Secondary Treatment (ICEAS)

	Goal / Actions	Commercial Impact
I	**Nitrification / denitrification capabilities**	
	Confirm nitrification and denitrification rates	Confirmation that existing designs have excess capacity
	Denitrification capacity	
	Improve understanding of ICEAS nitrog	
	Determine impact on performance durin modes, operating conditions (MLSS, SR loads	
II	**SIMS and MLSS control optimi**	
	SIMS logic optimization	
	MLSS control logic definition	
III	**DO control for nitrification**	
	Tuning of the P&ID control logic	
IV	**Ammonia control development**	
	Optimized partial nitrification in NIT mo	
V	**P removal**	
	Chemical P-removal in NIT mode	
	Luxury bio-P uptake	
	7% N and 3% P sludge composition	
VI	**Settling and SVI performance**	
	Correlation of SVI with sludge settling ch confirm	
	Correlation between plant operating mo performance	
VII	**Sludge yield evaluation**	
	Confirmation of the literature-based slud design tool	

Tertiary Treatment

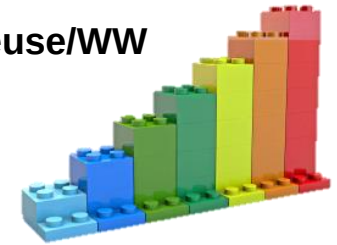
	Goal / Actions	Commercial Impact
	Rapid Gravity Media Filter	
I	**Filtration performance**	
	Reach Target effluent quality	
	Performance at high hydraulic l	
II	**Chemical-P removal opti**	
	P removal performance with sin (ICEAS & RGSF) chemical add	
III	**Helminth ova removal ef**	
	Additional work required to valid in Peru and Bahrain	
	Disk Filter (18µ and 10µ)	
	Filtration performance	
	Suction UF (0.4µ) and Pressurize	
I	**Design flux and operatin verification**	
	Impact of influent quality on flux	
	Impact of NH4 load	
II	**Chemical-P removal opti**	
	P removal performance with sin (ICEAS & UF) chemical additio	

Disinfection / Emerging Contaminants

	Goal / Actions	Commercial Impact
	Ozone	
	Disinfection performance	
		Confirmation of dose, performance, and design tools
	COD and Color reduction	
		Quantified dose required for color performance and COD reduction
	UV	
	Disinfection dose	
	Characterization of wastewater	Confirmed wastewater microbial dose response
		Validated UV disinfection design dose and tools
		Cost / performance comparison of UV vs. Chlorination for disinfection
	UV + Chlorine	
	Residual hypochlorite dose reduction	
		Minimal impact of UV disinfection on hypochlorite dose needed for residual
		Confirmation of impacts of ammonia on hypochlorite dose
	Ozone + Biologic Active Filter (BAF)	
I	**Micropollutant reduction**	
	Establish effective design for Swiss (FOEN) micropollutant regulation	• Confirm design (media, O_3 dose, contact time) required for reduction • Understand reduction in each process • Demonstrate harmful byproducts not created
II	**Differentiate adsorption and biological degradation**	
	Performance of bio active GAC to fresh GAC without ozone	Prepare sales arguments on GAC vs. AOP performance
III	**Disinfection credit**	
		0.5 log - 2 log disinfection credit
IV	**COD and NH4 reduction**	
		Confirm design required - linked to R-BAF (Wastewater) VBPD project

Improved Offers

- **Denitirfication Capacity**
- **Advanced Process Control**
- **Total P effluent add on**
- **Ozone + BAF for reuse/WW**



Optimized Reuse Solutions

- **Systems adapted to local and regional requirements**
- **Lowest possible life cycle costs**
- **Best micropollutant reduction**
- **Most environmental and financial sustainable solution**
- **Unmatched process guarantee**

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Thanks

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