

Strategy for phosphorus recovery and wastewater treatment in Amsterdam



M. V. Amosov¹, L. Zlatanovic², J. P. van der Hoek^{2,3,4}

¹ Organic Village, Amsterdam, the Netherlands (E-mail: maxim.amosov@gmail.com)

² Delft University of Technology, Delft, the Netherlands

³ Waternet, Amsterdam, the Netherlands

⁴ Amsterdam Institute for Advanced Metropolitan Solutions, Amsterdam, the Netherlands

Introduction



Figure 1: Centralized phosphorus (P) recovery in Amsterdam West.

Waternet (water board in Amsterdam) searches for a resilient and feasible strategy to expand the WW treatment plant (WWTP) West with decentralized or centralized solutions and phosphorus (P) recovery. The study compared systemic impacts of six solutions on the WW system. As a result, two generic strategies and specific recommendations were identified to increase resilience, with evaluation of costs and benefits for WWTP expansion over 15 years - an average life-span of a WW infrastructure.

Methodology

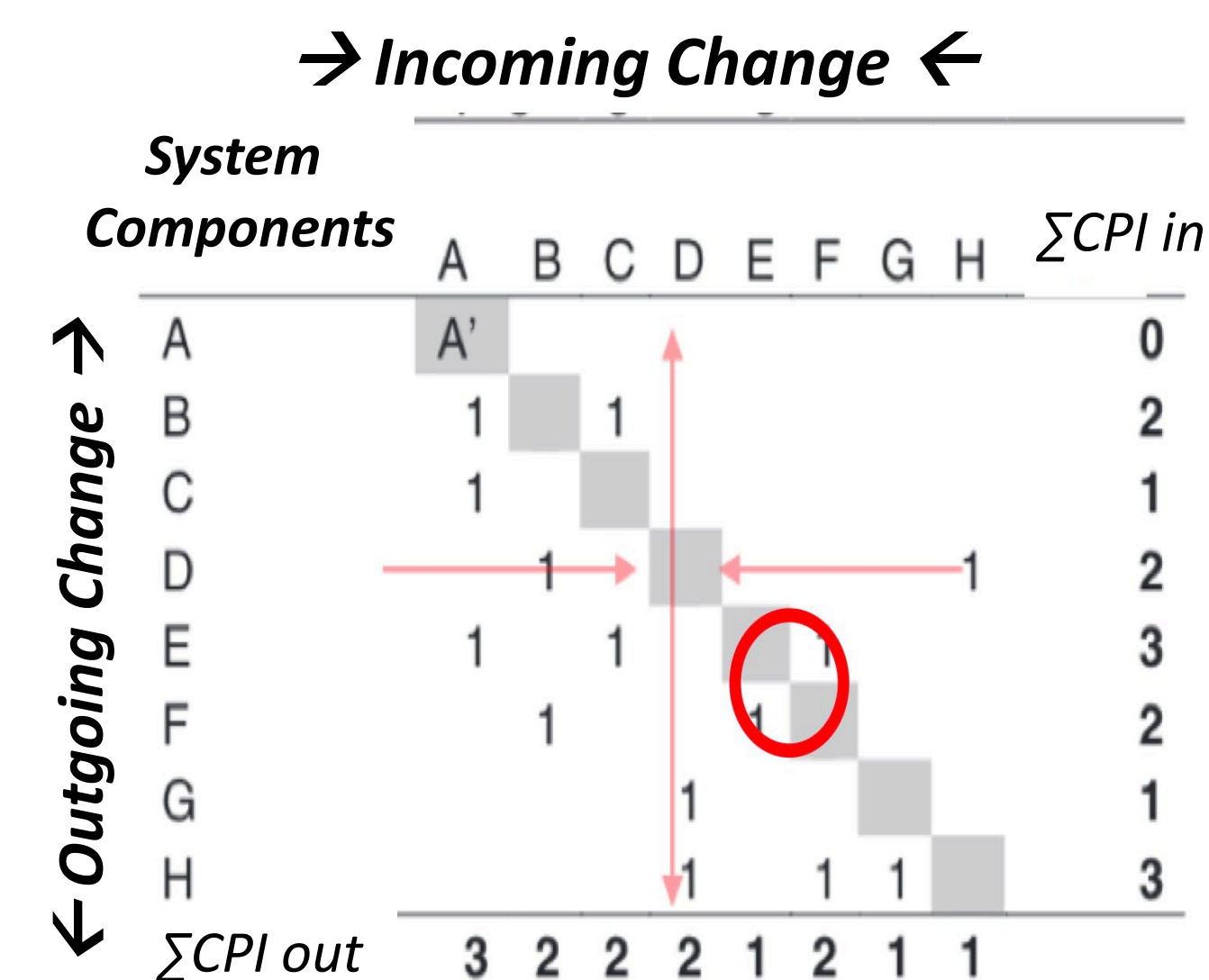


Figure 2: the DSM, where 1 shows a dependency e.g. A provides to B, C, E.

The Design Structure Matrix (DSM) was combined with the Cost-Benefit Analysis (CBA). The DSM is a square matrix describing elements and dependencies. The Change Propagation Indicator (ΣCPI) quantifies dependencies: incoming and outgoing. The ΔCPI shows if an element Multiplies, Carries or Absorbs change. ΣCPI and ΔCPI unriddle generic behaviour of a system and specific improvements that increase resilience i.e. WW system. The CBA quantified CAPEX and OPEX for WW management e.g. energy, materials.

Results & Discussion

STRATEGY 1: solutions are linked by sewers to the centralized WWTP West and Waternet.

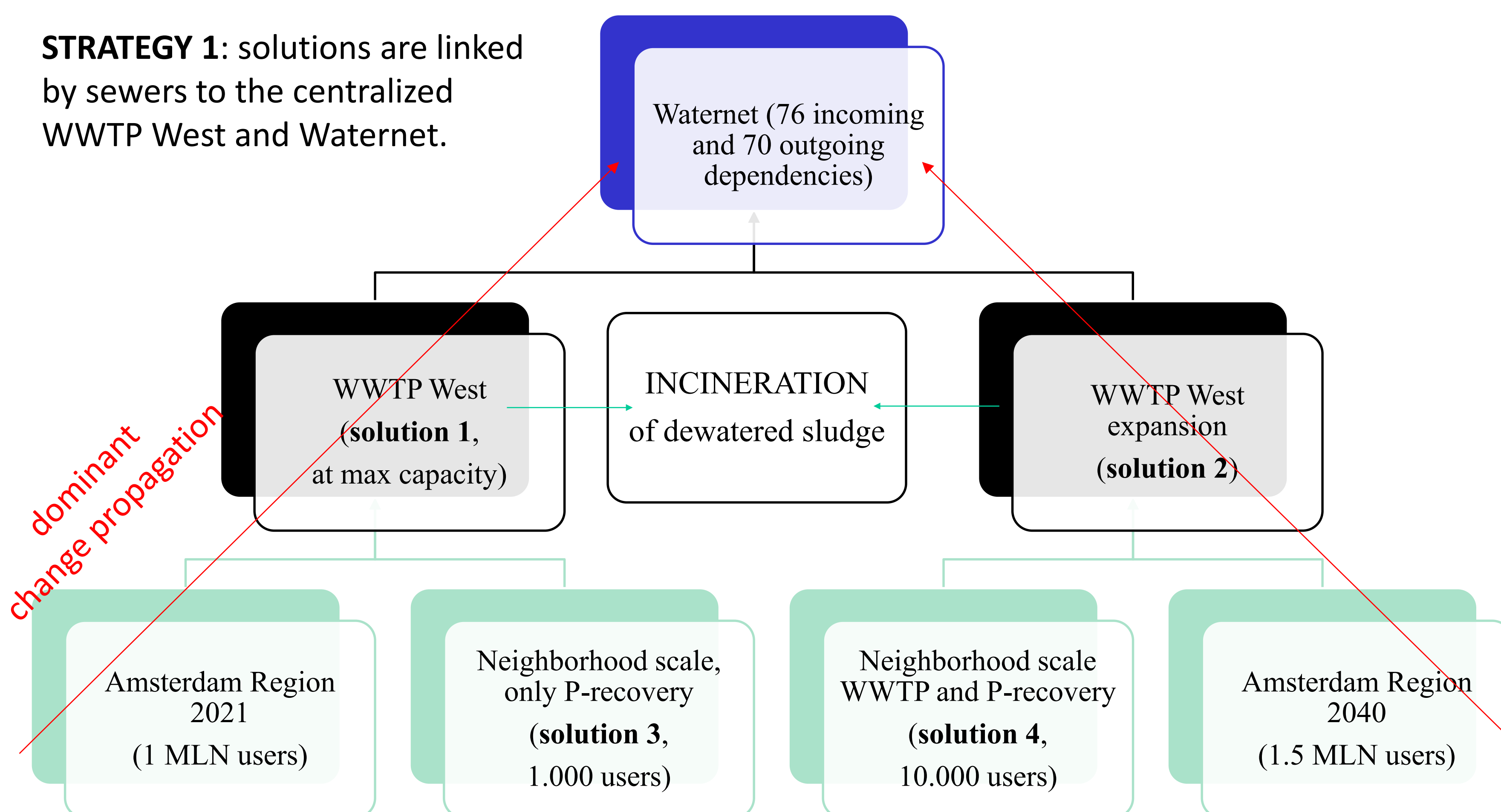


Figure 3: conceptual overview of solutions implemented in Amsterdam i.e. 1, 3; and envisioned i.e. 2, 4.

GENERIC BEHAVIOUR: Waternet is Absorber (owner) of changes propagated by the users, the solutions and the sewers towards the water and the sludge infrastructure at WWTP West and the sludge incineration afterwards, which is the only utilization chain.

SPECIFIC IMPROVEMENTS

I> **Users:** top-multipliers of negative change

RISK: growth in users will increase amount of WW and sludge ;
COST: replace 11 technologies in buildings with water efficient;
BENEFIT: reduce costs for energy, materials and transportation.

II> **Digested sludge:** top carrier of change at WWTP

RISK: growth in users/ incineration break will overflow WWTP;
COST: develop buffering capacity, or circular sludge value chain;
BENEFIT: delay overflow/ reduce costs for sludge management.

Due to a limited space, not all improvements are presented.

STRATEGY 2: solutions are disconnected from the centralized WWTP West via living machines (biofiltration) on site.

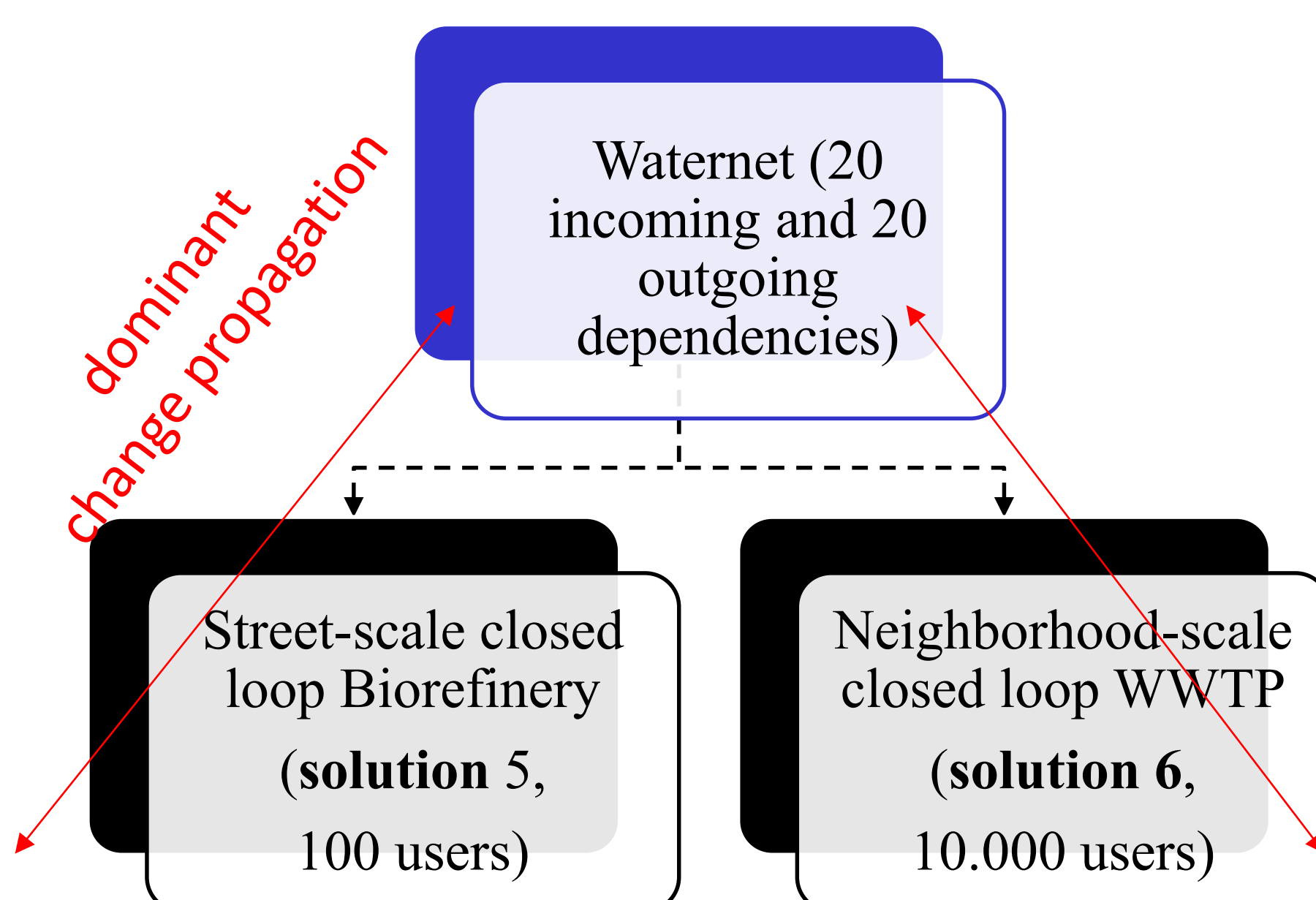


Figure 4: conceptual overview of solutions implemented (5) and envisioned (6) in Amsterdam.

GENERIC BEHAVIOUR: Waternet is Carrier (distributor) of changes propagated by the users to stakeholders i.e. waste utility, real estate, tech. providers and a P-valorisation company.

SPECIFIC IMPROVEMENTS

I> **Users:** multipliers of positive change

RISK: quality of discharged WW effluent / produced resources;
COST: online monitoring; incentives for users and stakeholders;
BENEFIT: increase sales of resources; reduce costs for WWTP.

II> **Biofilter:** absorber of changes

RISK: changes in quantity of WW → overflow/ dry-out;
COST: double the size, install rain water collection;
BENEFIT: robust technology; low maintenance.

Due to a limited space, not all improvements are presented.

COST-BENEFIT ANALYSIS

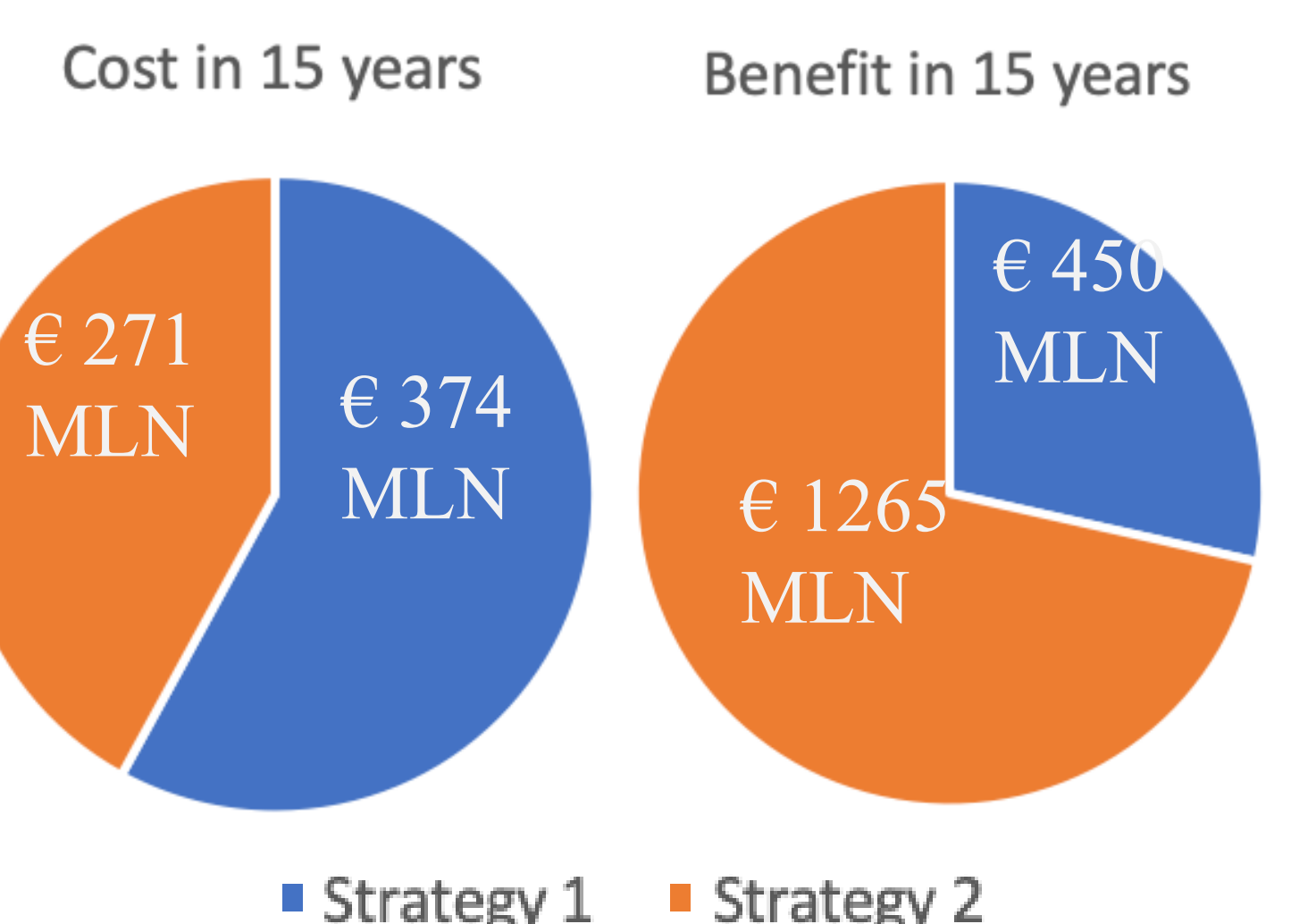


Figure 5: costs and benefits for the competing strategies, including WW tax. Strategy 2 only possible if Strategy 1 is phased out over 15 years (average end of technology life cycle i.e. WWTP).

Conclusions

- The strategy 1 is less resilient and cost-beneficial.** To increase resilience, Waternet has to reduce change propagation from up the WW chain i.e. Users, or buffer it; which will only increase costs i.e. awareness campaigns for the users, building silos for sludge storage or a mono-incineration or composting at the WWTP West site.
- The strategy 2 is more resilient and cost-beneficial.** To increase resilience, online monitoring of technology and business performance can be provided by actors other than Waternet. To increase benefits, the closed-loop solutions can be upgraded with technologies for production of water, energy and proteins sold to market.

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