Assessing the sustainability of innovative alternative water supply

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Abstract: In this project a water utility and two of their water customers (cases), a textile laundry service and a social housing association, wish to incorporate alternative water supply in their operations. The cooperation also covers a technical university and private water technology companies. We developed innovative scenarios for reclamation of water from the city for treatment and reuse in the operations thereby reducing the freshwater impacts. The sustainability of the scenarios are assessed by use of the eco-efficiency tool. The learnings so far are that 2-3 innovative scenarios are developed for each case and the carbon footprint results show that for the textile laundry service reclamation of rain and stormwater from the upstream basins has the lowest impact and for the housing association, the rainwater tanks have a lower carbon footprint compared to the greywater system.

Keywords: Industry recycling; Non-potable reuse; Alternative water supply;

Pressure on water resources in urban water systems is an increasingly urgent issue, driven by e.g. local shortages and pollution with pesticides and metabolites, toxic substances, etc. The political and public demand for efficient water use is growing. Alternative water supply for non-potable applications and reclamation are considered promising as they not only satisfy a wish from end-users (water customers) but also require less freshwater to meet the water demand, and influence freshwater uptake on both upstream water supply and downstream wastewater treatment processes. In this cooperation between a utility, a private water technology company, two end-users, or cases (a textile laundry service and a social housing association), and a university, we developed two to three scenarios per case for reusing water in the urban water system. To evaluate the sustainability of the developed water reclamation scenarios, we assess their eco-efficiency.

Largely unpolluted fresh- and groundwater are often the main sources for drinking water. Polluted groundwater, saline water, wastewater and rain- and stormwater are alternative sources for water supply. Numerous systems using these different sources are implemented worldwide, often providing water for non-potable applications like toilet flushing, laundry or cooling. While treatment up to drinking water quality requires significant resources, simple treatment, e.g. filtration and disinfection, is often sufficient for non-potable uses. Rain- and stormwater and grey wastewater are usually only lightly polluted, allowing reuse even at household level after simple treatment.

Fors A/S is a multi-utility company that covers the supply of water, district heating, waste and wastewater management in three municipalities, serving about 200,000 customers. Today, the general water supply is based on the natural process of groundwater recharge followed by aeration and sandfiltration at waterworks. However, looking into a future with a changing climate and a growing numbers of contaminated groundwater resources, alternative water sources might be part of a resilient solution seen in a perspective, where drinking water supply is ensured. Therefore, as part of the vision of a triple helix partnership, the partners are looking for new water solutions, where the reuse of water in industrial processes, urban garden and toilet flushing can be tested and evaluated. A purpose is also to develop a more general business model on how and when a utility company can play an active role, upscaling alternative water supply as part of a strategic action reducing risk of flooding and saving groundwater for the supply of drinking water.

The scope of the study is based on two cases (fig. 1.1). Berendsen (a textile laundry service) and Boligselskabet Sjælland (a housing association of 12,500 households). Berendsen has already developed a secondary water supply, where wastewater from the washing process and roof runoff is reclaimed for reuse, saving municipal water and use of chemicals. This project investigates whether alternative water supply by reclamation of stormwater from the city, transport and treatment can cover all water demands, increasing the sustainability of the textile laundry service even further.

In the case of the Boligselskabet Sjælland, water is part of a strategy to increase liveability in the housing association and adapt to climate change by introducing green and blue landscape elements. . We developed scenarios for using rainwater runoff and reclaiming greywater for toilet flushing and laundry. A central element of the green areas surrounding the houses is an infiltration basin of 1,500m^3, where water is collected, percolated and retained, protecting the residential areas against risk of flooding. Three scenarios for providing non-potable water are assessed: 1) use of rainwater collected in the green basin after simple filtration treatment, 2) use of runoff from roofs and 3) use of grey wastewater after treatment

Eco-efficiency is evaluating the environmental performance of a product or system to its value (ISO, 2012) meaning that a change to a system is more eco-efficient if it generates more value whilst reducing environmental impacts including resource consumption. In our work we used life cycle assessment (LCA) to evaluate the scenarios environmentally. The economic performance of the scenarios is evaluated by assessing the scenarios impact on relevant stakeholders' economy. Subsequently, the environmental and economic assessment results are combined in an eco-efficiency matrix in order to provide decision support covering both dimensions. Eco-efficiency has previously been shown to be a useful tool evaluating and comparing non-potable reuse system (Farago et al., 2019).

The sustainable development goals addressed in this work are primarily to protect water-related ecosystems (SDG 6.6) and achievement of sustainable management through efficient use of natural resources (SDG 12.2) (UN, 2015).

At the conference, we will present the scenarios developed in the cooperation and the eco-efficiency results. As an intermediate result, the carbon footprint results show that reclamation of rain and stormwater from the upstream basins has the lowest impact in the carbon fooprint category and for the housing association the rainwater tanks have a lower carbon footprint compared to the greywater system (fig.1.2). Other environmental impact categories and the influence on stakeholders' economy will be ready for presentation at the conference. A major outcome of this project is that a utility together with their customers succeeded in developing new scenarios for water supply which in Denmark is novel and innovative.

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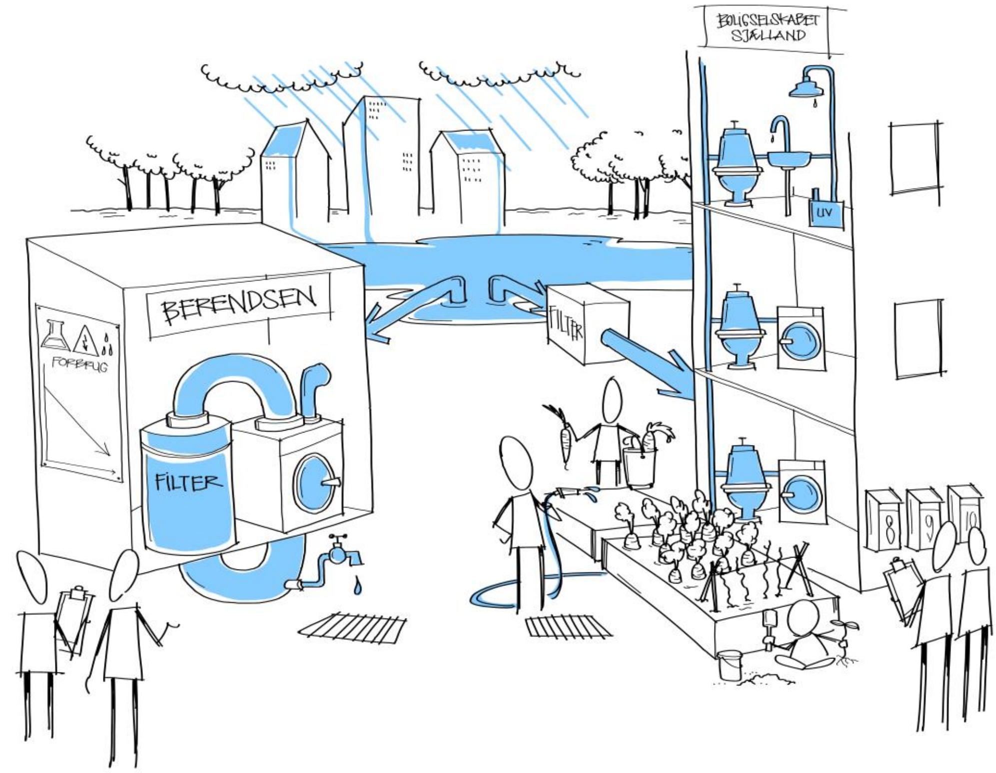

Figure 1.1 Illustration of the two cases generated in the project: a) The Berendsen case where rainwater is stored, transported and treated for reuse and b) The housing association where rain or grey water is reclaimed and used for toilet flushing and laundry.

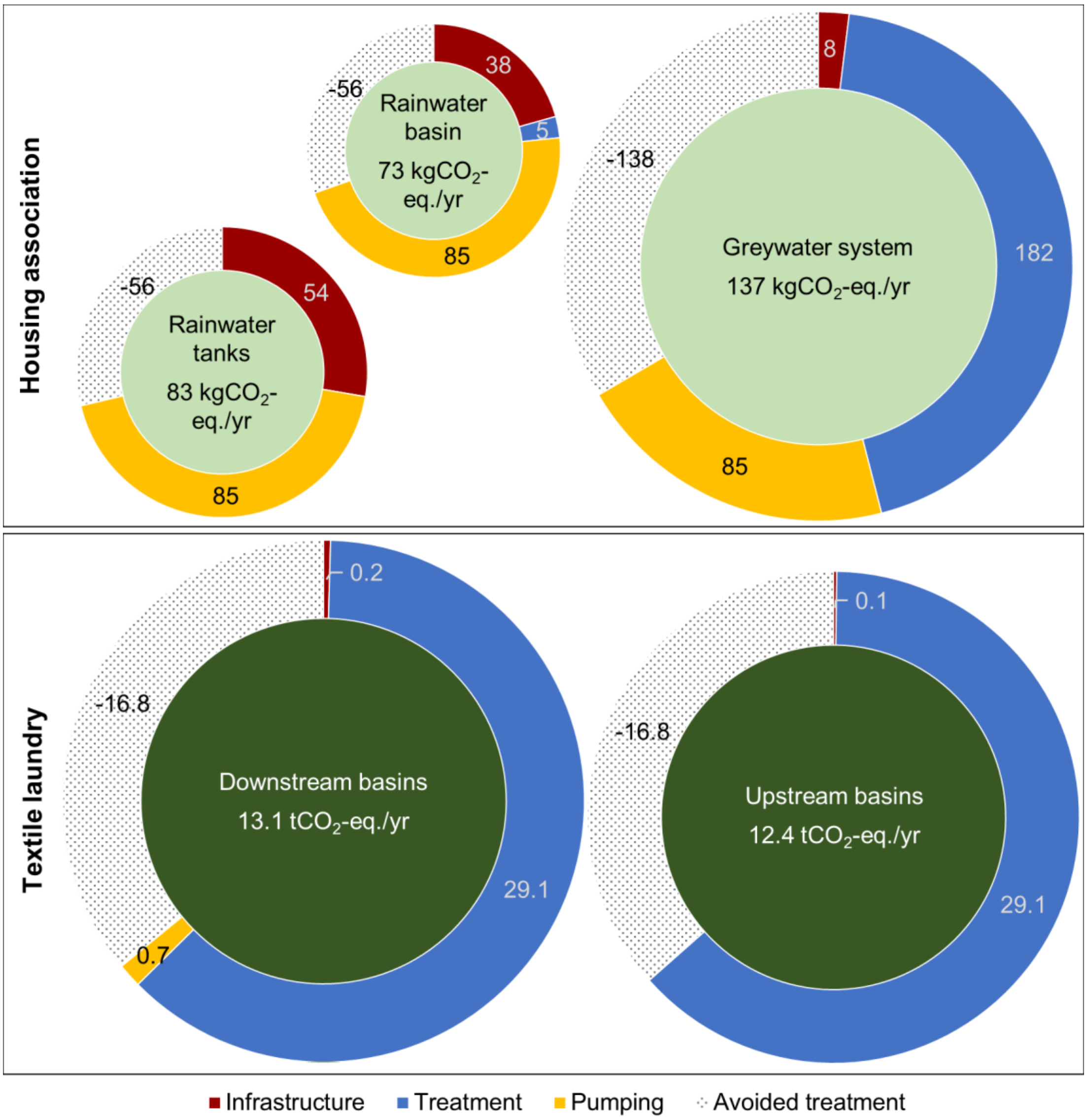

Figure 1.2 Carbon footprint of different alternative water supply scenarios for the housing association (top) and the textile laundry (bottom). The outer circles show the contribution of the different elements of the alternative water supply systems (infrastructure, treatment, pumping and avoided treatment).

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