Design project - SIE 2022

Urine diversion as one step towards sustainable sanitation : how can nutrient valorization be implemented ?

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Introduction

- Urine contains most of plant-needed nutrients found in human waste, especially **nitrogen.** It is a valuable resource that needs to be revalorized for sustainable sanitation.
- New **urine diverting toilets** have been designed with EOOS, Laufen and Eawag. They exist in dry and "wet" variant and are more efficient and easy to use than previous versions.
- Treatment solutions are being developped at Eawag, such as VUNA treatment based on **nitrification and distillation**, or another new **alkalinisation and evaporation**-based treatment.

Objectives

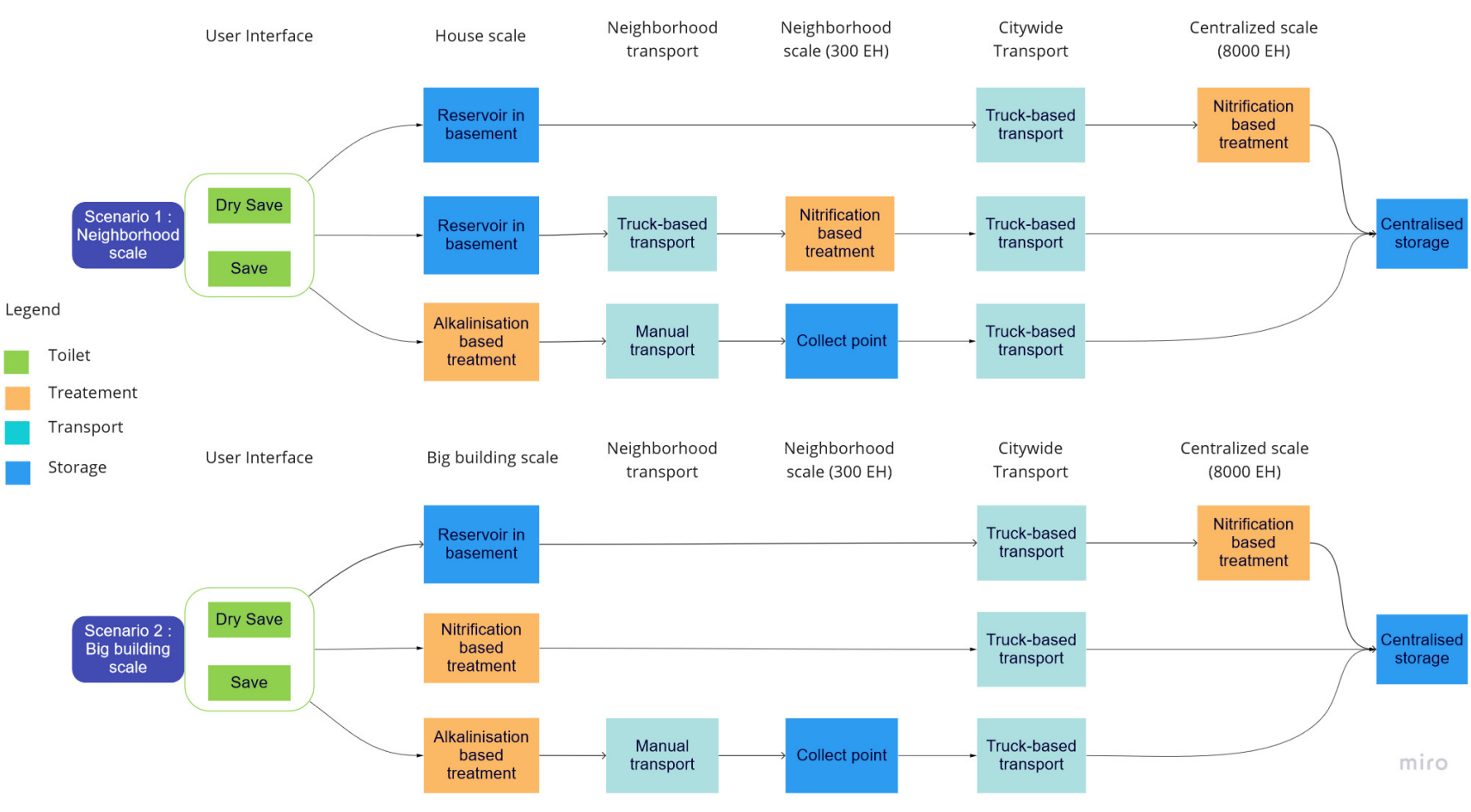
- Build **scenarios** for implementing urine separation and its treatment in the **context of an existing swiss city**
- **Compare** and **rank** these scenarios using pertinent criteria and aggregation method

Scenarios

- Two scenarios : **neighborhood** (300 EH, noted S1) and **building** (70 EH, noted S2) equiped with urine diverting toilets
- Three variants for each :

→ Small- scale (**decentralized**) Nitrification treatment, noted V1
→ Big-scale (**centralized**) Nitrifcation treatment, noted V2
→Direct **Alkalinisation** treatment, noted V3

Visualization



Criteria

Criteria are based on :
• *Quantitative criteria* :

Treatments costs

that include
→ Installation costs
→ Energy costs
→ Maintenance costs

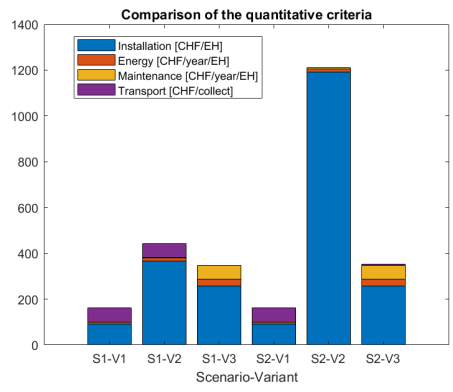
Transport costs

→ truck-based transport
→ manual transport

• *Qualitative criteria* :
→ Simplicity of installation
→ Odours
→ Simplicity of maintenance

They are compared **for each variant.**

Results



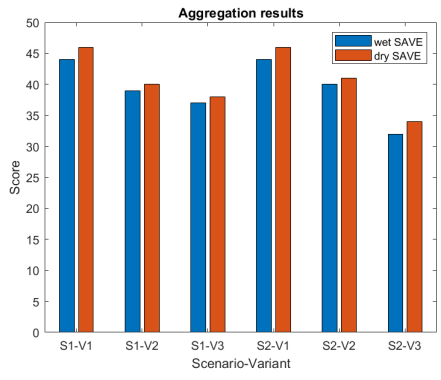
- **Installation costs** are the highest for each scenarios
- **Transportation** is another major factor of costs
- **Energy costs** are high for alkalinisation treatments
- **Odour occurence** is particularly challenging in the alkalinisation-based process due to the proximity of the treatment to the user
- **Installation and start-up** is more complex in the case of the nitrification-based process

→ Several assumptions have been made and results should be considered with caution.

Aggregation

METHOD

• Aggregation using **MCDA** (Multi-criteria decision analysis) : scoring using a distribution of the values into ranges
• Quantitative criteria : scores from **1 to 6** for each, 6 being the best score
• Qualitative criteria : **malus** substracted for each inconvenient



→ Sum up the scores and obtain a **global score** for each variant

RESULTS

• Highest score reached by the **centralized variants** in both scenarios : high transport costs compensated by reduced installation, maintenance and energy costs
• Followed by the decentralized nitrification building scenario and the decentralized nitrification neighborhood scenario
• Lowest score reached by the **alkalinisation variants** because of too high maintenance and energy costs

Conclusion

By combining :
• *2 processes* : alkalinisation and nitrification
• *2 scales* : neighborhood and building
• *2 SAVE toilet types* : dry and wet toilets

We were able to rank 12 variants and found that the **centralized variant** reaches the highest score and the **alkalinisation variant** reaches the lowest score. Dry toilets have the advantage of diverting a big proportion of urine, therefore allowing less losses. Their widespread use could be a step towards **more sustainable sanitation.**