Case study of a sustainable suburb to the City Aarhus

RAINWATER HARVESTING STRATEGIES IN CITIES

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Introduction

Aarhus Vand is a public limited company owned by the City of Aarhus

Our aim is to create health through clean water

- for humans and the planet

Key figures

230
competent and dedicated employees

15
mio. m^3 of drinking water a year

30
mio. m^3 of purified wastewater a year

1,500
kilometres of pipeline network

2,800
kilometres of mains network

350,000
citizens in Aarhus Municipality

We adopt water knowledge by:

- A holistic approach to the entire water cycle
- Forming innovation partnerships
- Forming international alliances that support knowledge exchange around intelligent, sustainable and efficient water solutions
- Operating and developing state of the art resource recovery plants that recover resources and produce energy from wastewater
- Protecting groundwater to ensure future high quality and safe water supplies
- Automating and digitalizing in order to achieve an intelligent efficient water system
- Separating storm water from wastewater

Looking into another decrease in drinking water use?

1980	2010	2040?
200 l/per/day	110 l/per/day	60 l/per/day

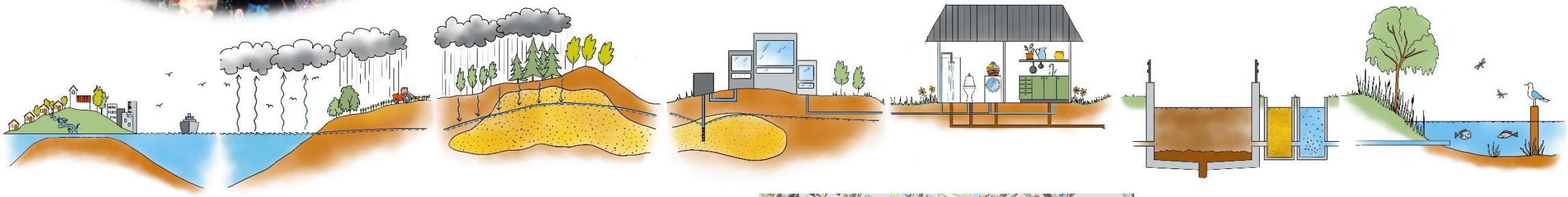
Vision (preliminary version)

Alternative water resources will provide our customers with new sustainable opportunities for responsible use of the planet's resources

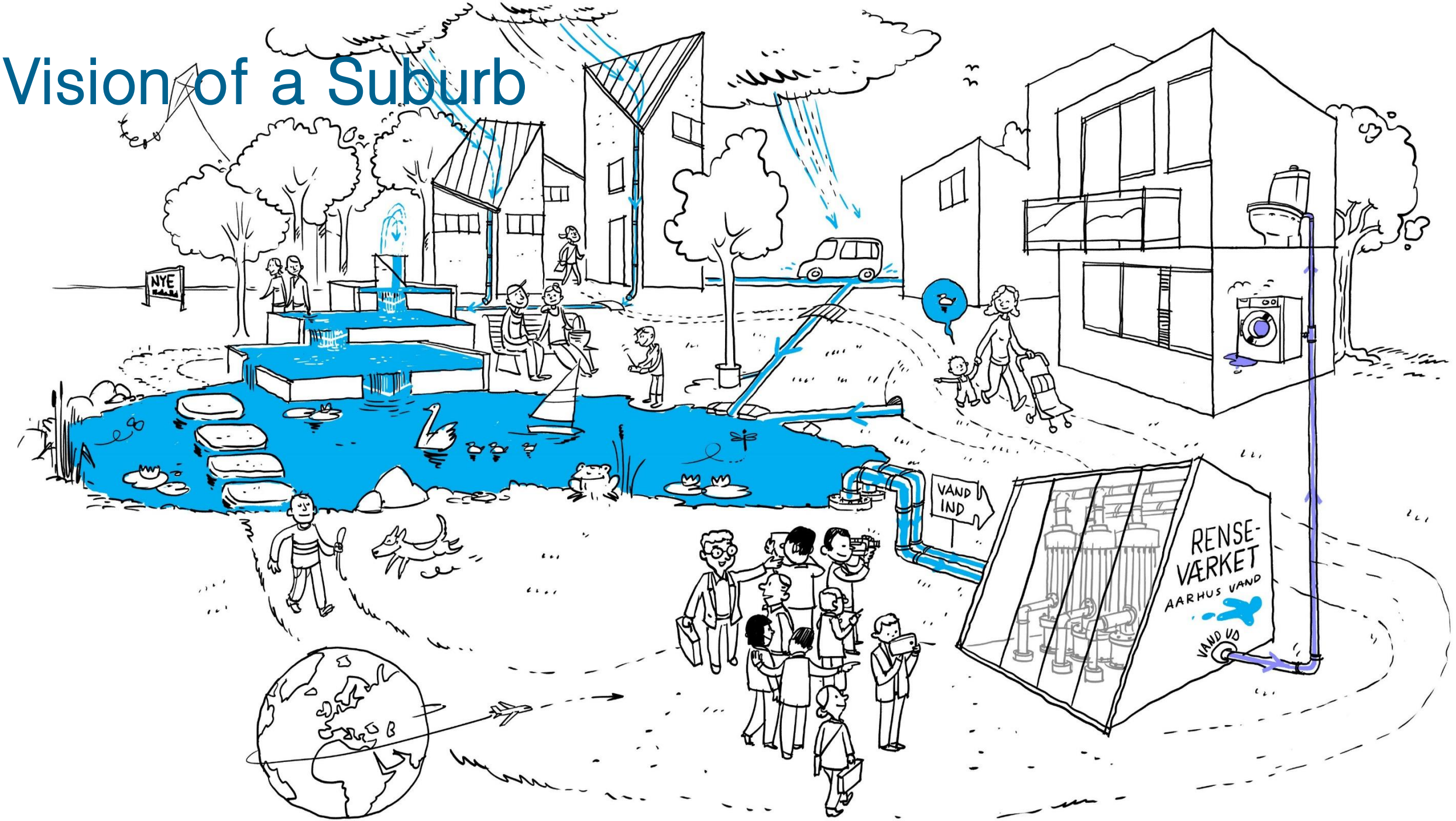
Alternative water resources will fulfill 20% of the water demand of the City of Aarhus in 2050

The price of water will reflect the value of water to the customer

Why?



Vision of a Suburb



Realising UN's sustainable development goals

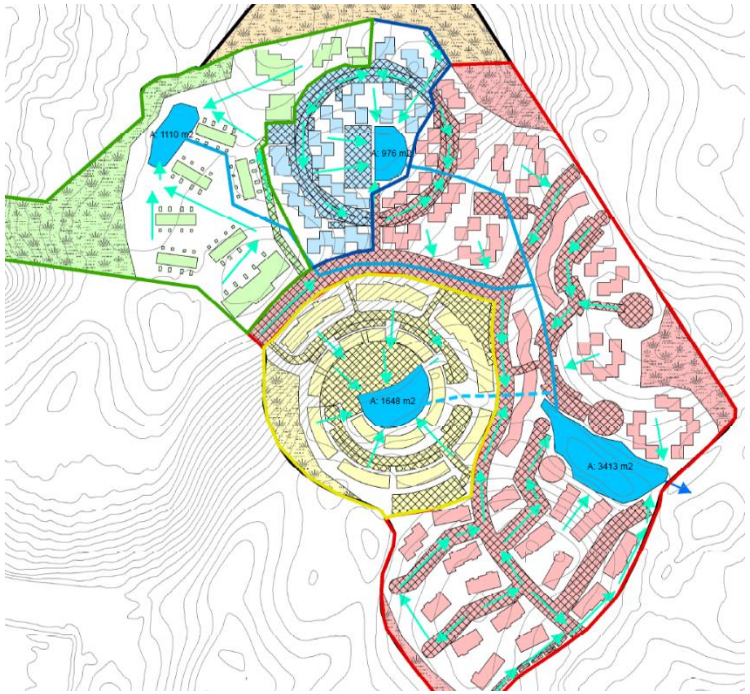
Visions / ambitions	Realising
Rainwater adds value	Water in open channels, drains, dams and lakes – a system that creates value for recreational purposes
Holistic water management	Water, roads, open areas and buildings are planned in close cooperation between stakeholders
Climate change adaption	A 100 year cloudburst can be handled without damaging floods
Environment and sustainability	Water quality and quantity that meets demands for the water cycle - ground water, streams and lakes
Rainwater is a resource	Collection and reuse of rainwater for toilets and laundry (save 40% of groundwater resources)

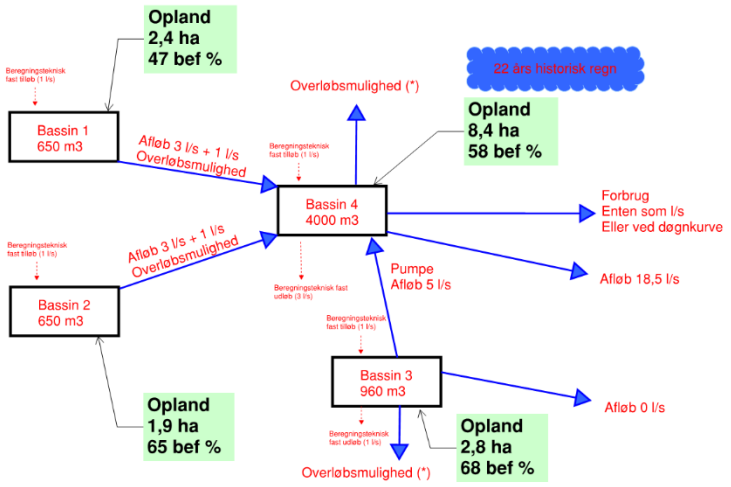
13 CLIMATE ACTION

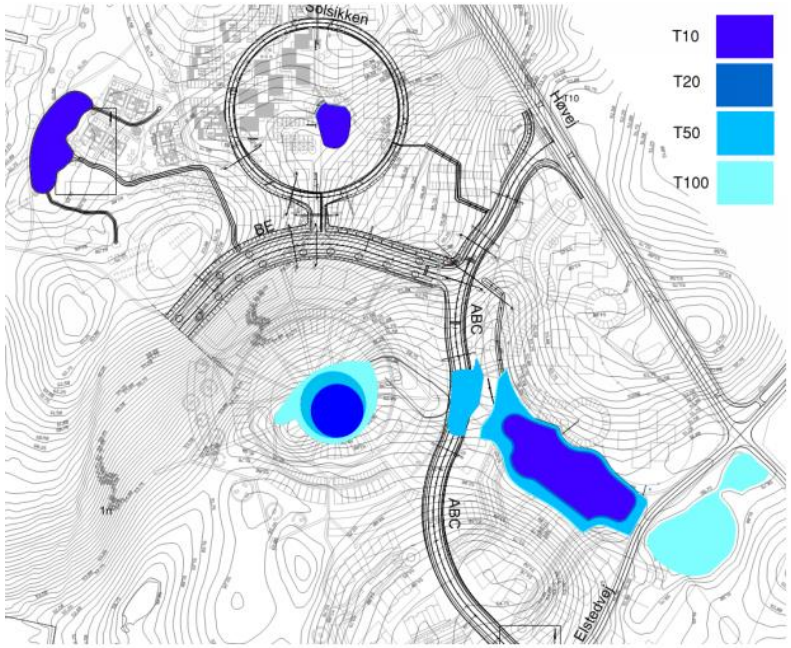
6 CLEAN WATER AND SANITATION



Protection from storm water



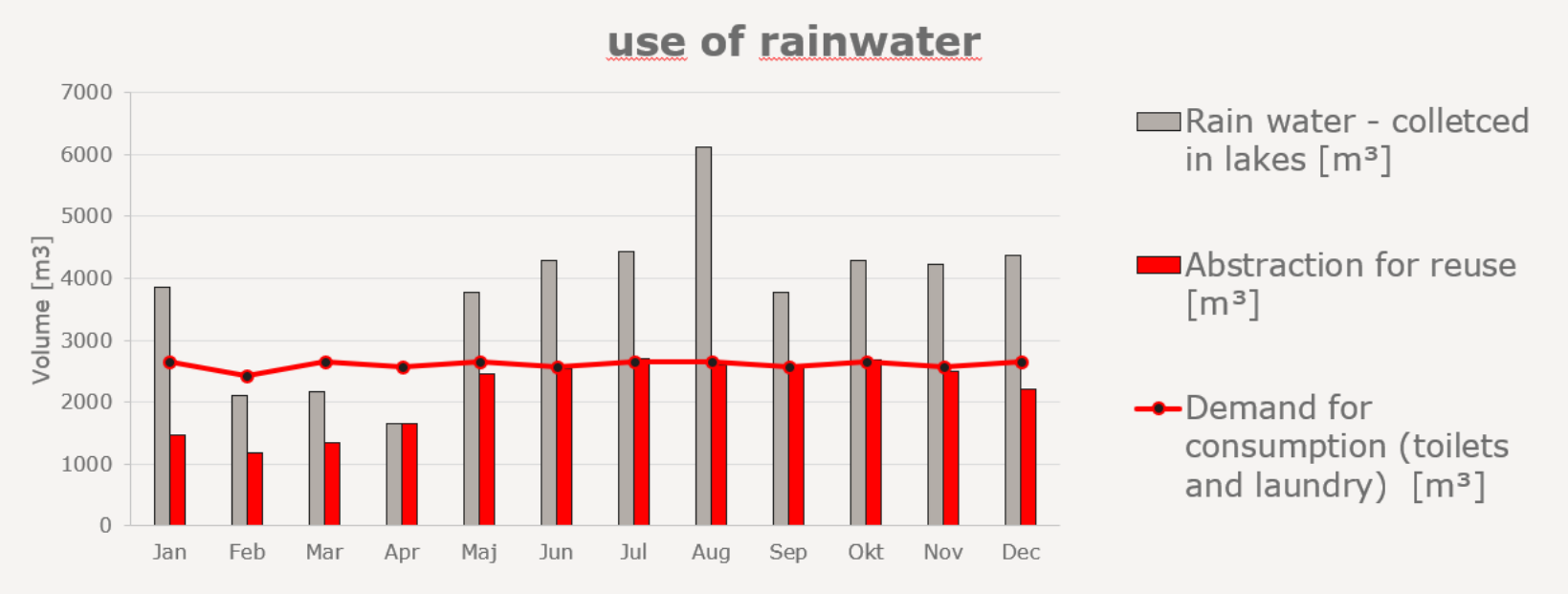




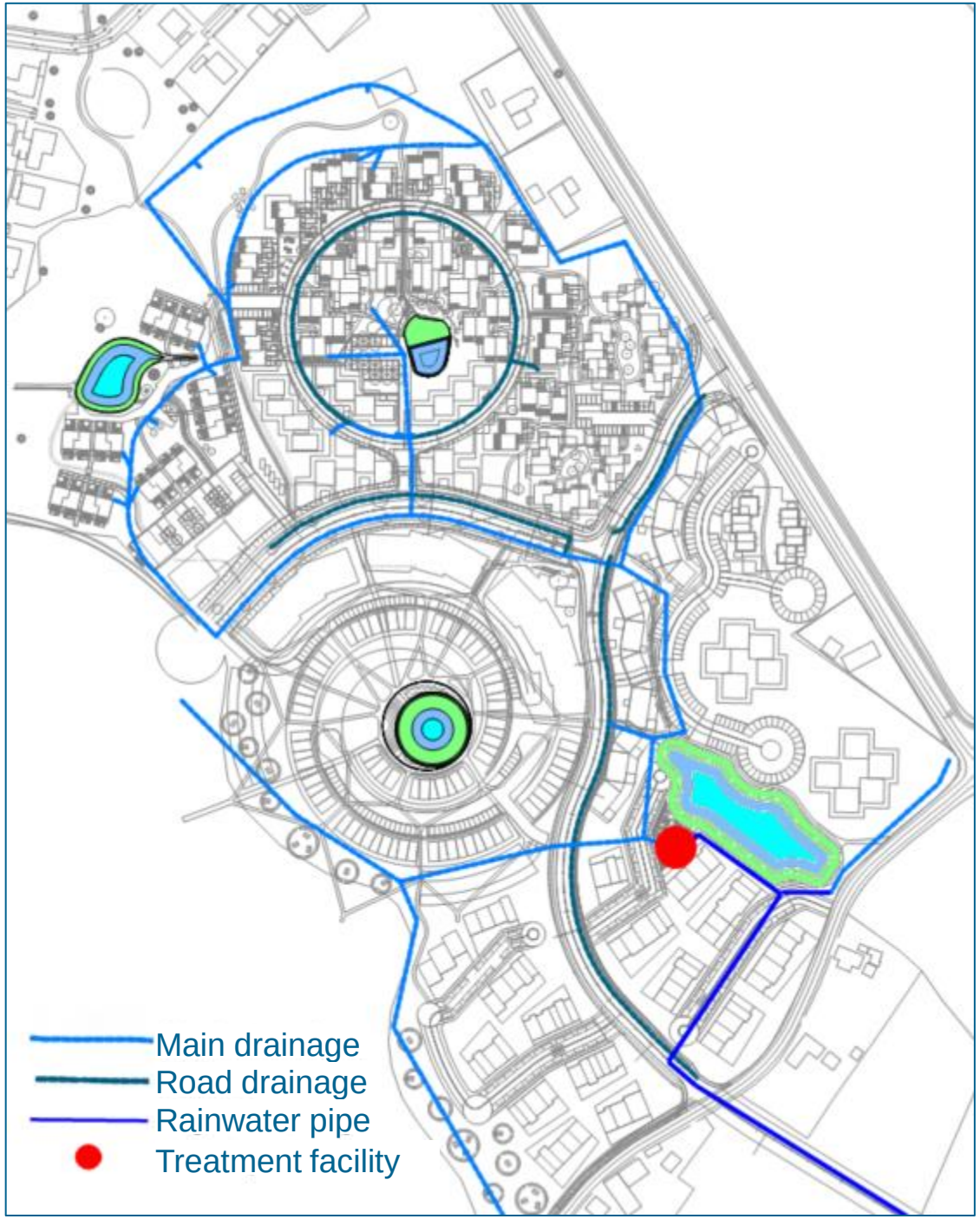
Ensuring water supply

Will the collected rainwater meet the demand?

Numer of households:	650
Number of people:	2000
Use of rainwater:	31.000 m^3/year 85 m^3/day



Rainwater collection system



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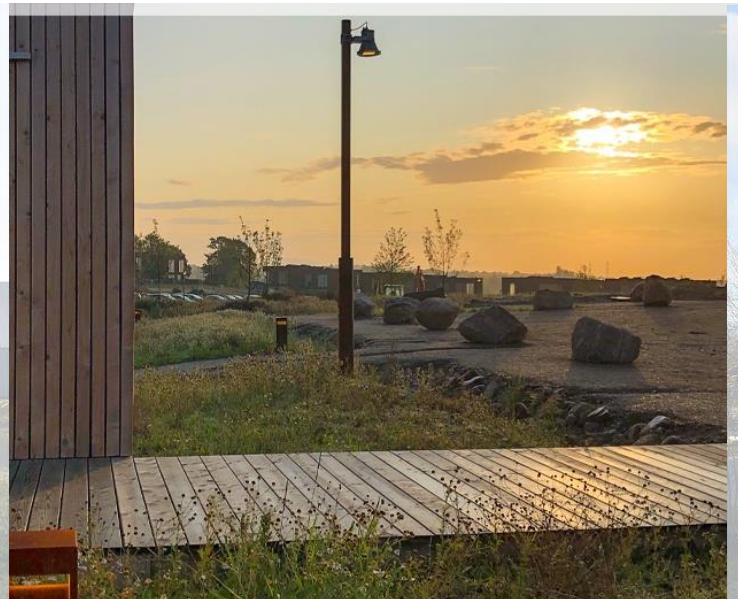
Water on the surface



Quality of non potable water

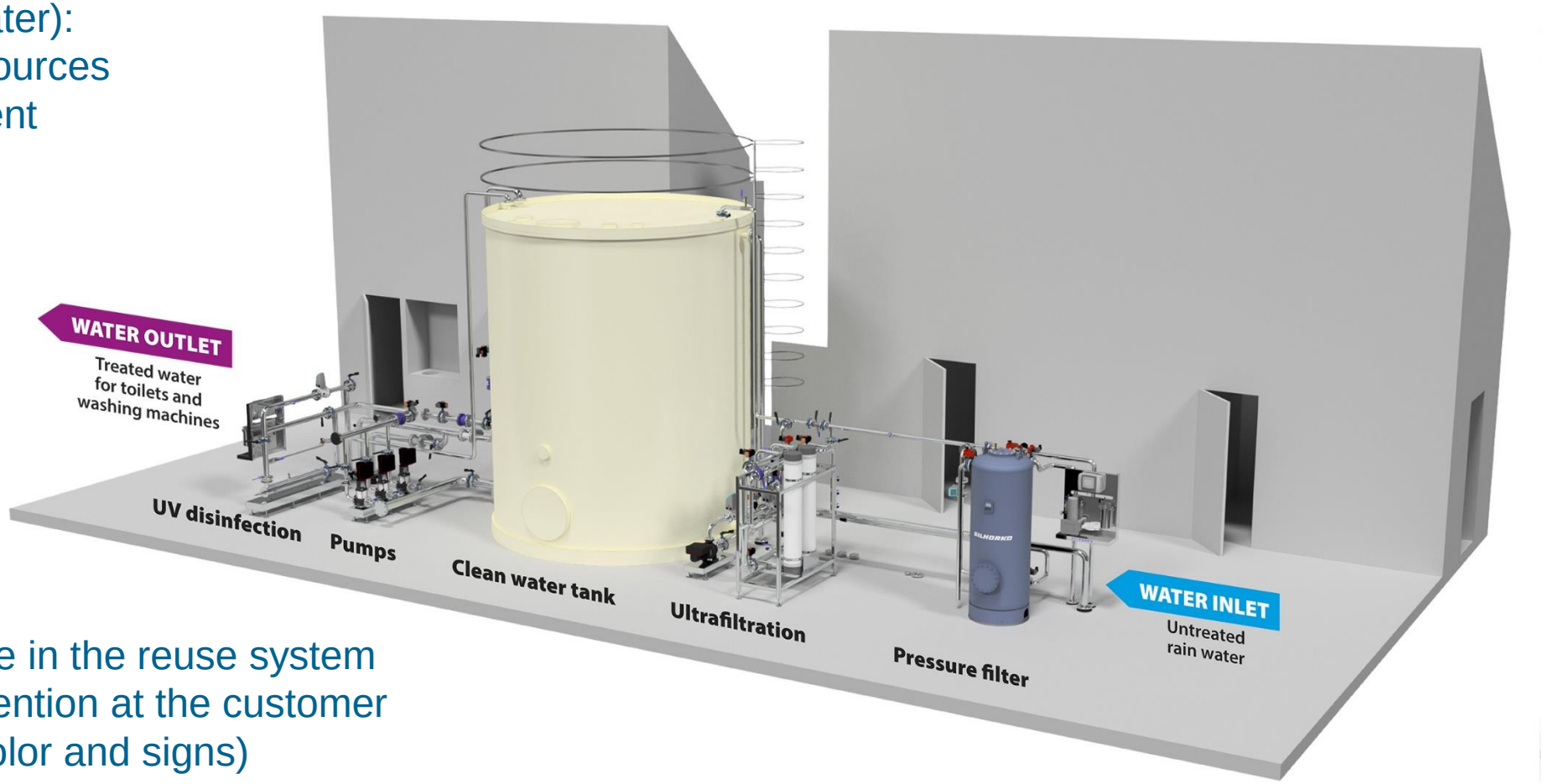
Parameters:

- Basis (temp., pH, O2, tubidity..)
- Metals
- Pollutants
- Microbiology

	Parameter	Problem	Eksempler på kilder	Toiletskyl	Tøjvask
Basisparametre	Temperatur	Bakterievækst	-	18 °C	18 °C
	pH	Korrosion	Atmosfæren Overflader (cement)	7,5-9	7,5-9
	Turbiditet	Bakterievækst Misfarvning	Partikler	2 NTU	2 NTU
	Oxygen	Lugt (Bakterievækst)	-	> 0,5 mg/L[1]	> 0,5 mg/L[1]
	NVOC	Misfarvning, bakterievækst	Organisk materiale	4 mg/L	4 mg/L
	Aggressiv CO_2	Korrosion	-	2 mg/L	2 mg/L
Metaller og ioner	Jern	Udfældning og misfarvning	-	0,3 mg/L	0,3 mg/L
	Mangan	Udfældning og misfarvning	-	-	0,05 mg/L
	Aluminium	Udfældning	Byggematerialer	0,2 mg/L	0,2 mg/L
	Klorid	Korrosion Skjolder på tøj	Vejsalt	250 mg/L	250 mg/L
	Zink	Udfældning (høj temperatur og pH)	Bremser og dæk Byggematerialer (f.eks. zinktage)	-	5 mg/L
	Sulfat	Korrosion	-	$\frac{Cl^- + 2SO_4^{2-}}{HCO_3^-}$ <1 (målt i mmol/L)	$\frac{Cl^- + 2SO_4^{2-}}{HCO_3^-}$ <1 (målt i mmol/L)
	Tungmetaller	Sundhedsrisiko	Bremser og dæk	-	As: 15 µg/L, Pb: 15 µg/L, Cd: 7,5 µg/L, Cr: 75 µg/L, Ni: 75 µg/L, Hg: 1,5 µg/L
Miljøfremmede stoffer	PAHer[2]	Sundhedsrisiko	Asfalt, tjære og tagpap	-	Enkelte: 38 µg/L Total: 375 µg/L
	Pesticider (total)	Sundhedsrisiko	Bekæmpelsesmidler Byggematerialer	-	38 µg/L
	Flammehæmmere	Sundhedsrisiko	Byggematerialer	-	Ikke målbar
	Phenoler	Sundhedsrisiko	Byggematerialer Atmosfærisk deposition	-	Penta- (PCP) og tetrachlorphenol: 3,8 µg/L, Trichlorphenol: 15 µg/L, Di- og monochlorphenol: 38 µg/L
Mikro-biologi	*E. coli*	Sundhedsrisiko	Fæces	1 CFU/100 mL[3]	1 CFU/100 mL[3]
	Enterococci	Sundhedsrisiko	Fæces	1 CFU/100 mL[4]	1 CFU/100 mL[4]
	Legionella pneumophila	Sundhedsrisiko	Miljø (varmt vand)	Ikke påvist	Ikke påvist

Ensuring a secure water supply

Reuse (purple water):
- Two water resources
- Water Treatment
- Backup Water



Drinking Water:
- Lower pressure in the reuse system
- Backflow prevention at the customer
- Information (color and signs)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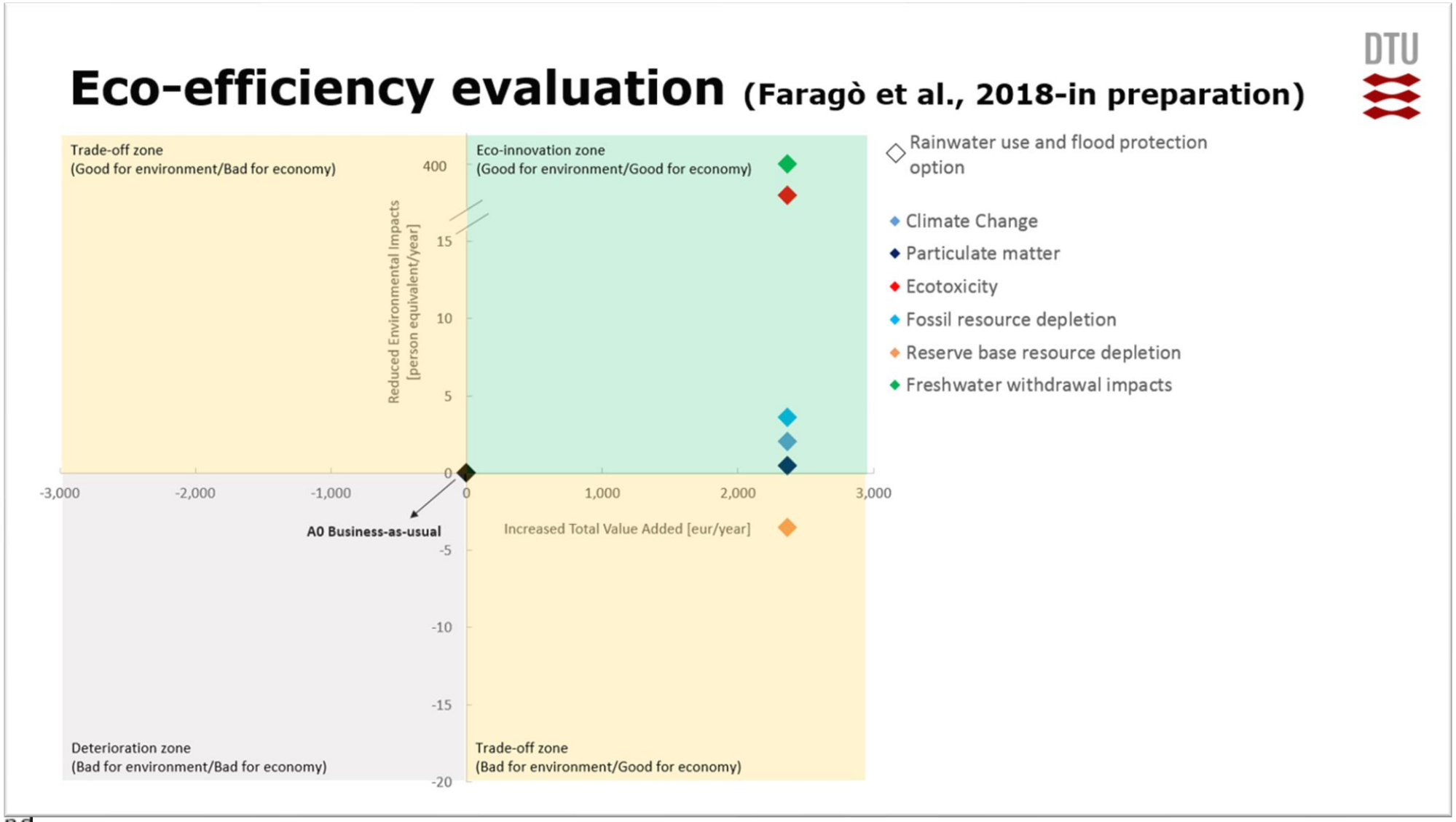
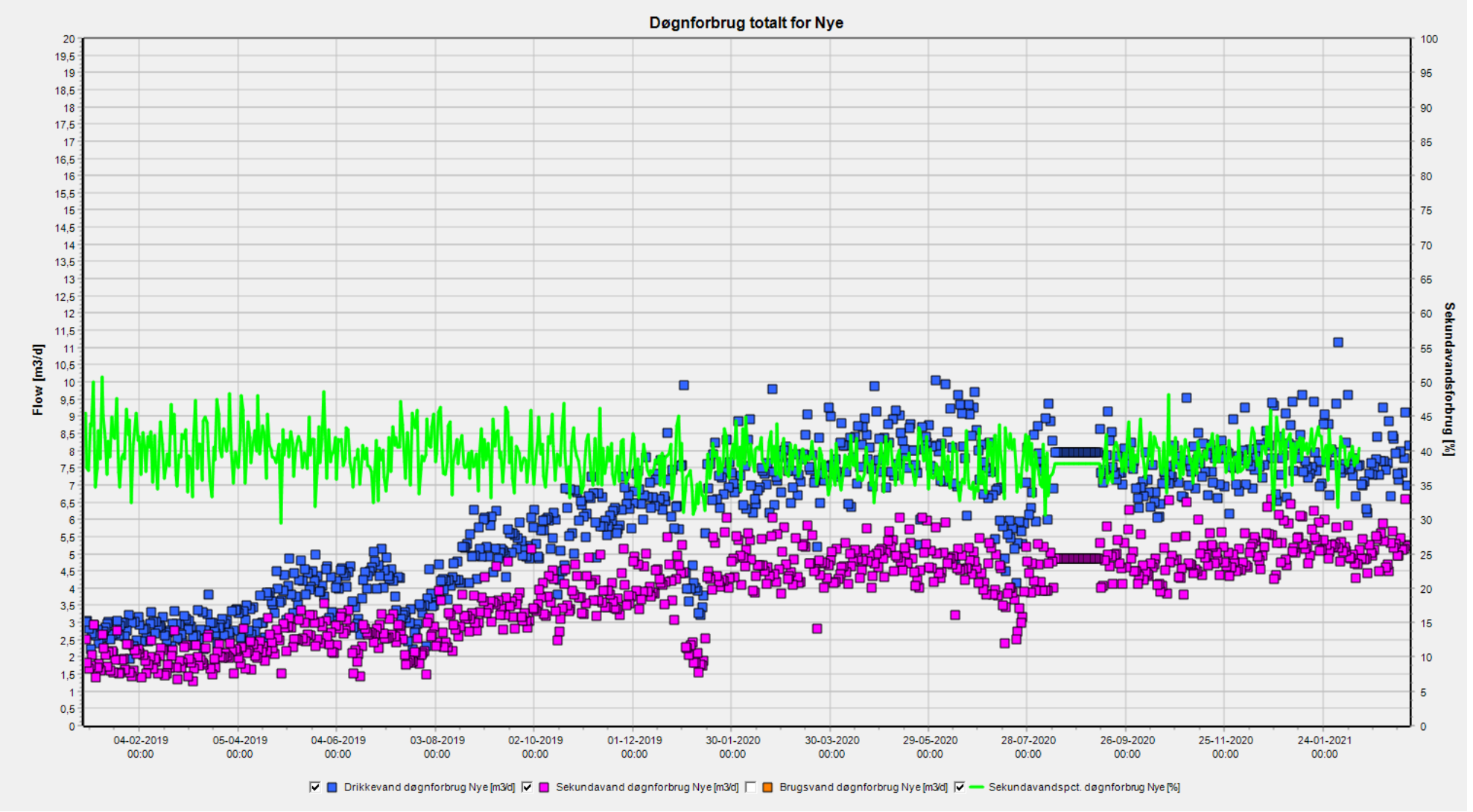
Evaluation


Eco-efficiency evaluation (Faragò et al., 2018-in preparation)
DTU
Trade-off zone
(Good for environment/Bad for economy)
Eco-innovation zone
(Good for environment/Good for economy)
Deterioration zone
(Bad for environment/Bad for economy)
Trade-off zone
(Bad for environment/Good for economy)
Reduced Environmental Impacts [person equivalent/year]
Increased Total Value Added [eur/year]
A0 Business-as-usual
400
15
10
5
0
-5
-10
-15
-20
-3,000
-2,000
-1,000
0
1,000
2,000
3,000
Rainwater use and flood protection option
Climate Change
Particulate matter
Ecotoxicity
Fossil resource depletion
Reserve base resource depletion
Freshwater withdrawal impacts

Water consumption per household



- Drinking water
- Rainwater use
- Rainwater % of total use

Thank you