B-WaterSmart
Living Lab Bodø

b-watersmart.eu

bodø KOMMUNE

NTNU
Norwegian University of Science and Technology

SINTEF

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TECHNI

ICCS
ΕΠΙΣΕΥ

Introduksjon

- **Living lab Bodø**

Oversikt over LL Bodøs oppgaver

- Lover og regler
- The water-smartness assessment framework
- Teknologier
- Programvare

Konklusjon

- Sammendrag

B-WaterSmart LIVING LABS

1 Alicante

Challenges
Water scarcity, limitations to water reuse due to high salinity/nitrates, limitations to water reuse due to low acceptance.

Innovation & Demonstration
Improve water-smartness in the municipality of Alicante by incrementing water reuse and boosting circular economy opportunities.

2 Bodø

Challenges
Growing resident population and economy, increased pollution, untapped efficiency potential.

Innovation & Demonstration
Zero emission urban development, improved management of the wastewater stream, improved air quality.

3 East Frisia

Challenges
Increasing water demand in supply area by growing sectors (households, industry, agriculture), limited groundwater resources, locally untapped water reuse potential.

Innovation & Demonstration
Increasing the carrying capacity of water supply: Identification of alternative resources, intelligent protection strategies for groundwater bodies and improved treatment of process water for reuse in milk production.

4 Flanders

Challenges
High drinking water demand due to dense population, high water demand for agriculture, groundwater overexploitation, water quality deterioration, water scarcity due to droughts, climate change and urbanisation.

Innovation & Demonstration
Development of regional concept for improving and monitoring water-smartness and a more robust water system, with a focus on safe water reuse.

5 Lisbon

Challenges
Growing population and economy depend on distant freshwater resources with increasing climate challenges (e.g. droughts and floods). This demand must be balanced with the need to increase urban green areas to ensure the quality of life of citizens and the sustainability of urban life.

Innovation & Demonstration
Development of tools & processes to facilitate safe water reuse, improvment of water-energy-phosphorous efficiency in municipal non-potable water uses, improvement of households and buildings' climate readiness regarding water and energy with an assessment/certification tool developed locally but with an ambition for national/European adoption.

6 Venice

Challenges
Need for reuse and recovery schemes for wastewater & sludge, limitations to reuse and recovery due to low acceptance, water scarcity, untapped efficiency potential (water and resources valorisation).

Innovation & Demonstration
Enable and complete the water reuse (industrial, agricultural and urban) goal of a regional/national plan for lagoon protection, apply nutrient recovery technologies to waste water treatment plants (WWTPs) and develop shared evaluation model-tools for the sustainability of WWTP effluents and sludge valorisation.

https://b-watersmart.eu/

Climate and energy ambitions

- Moving the current civilian airport gives us the opportunity to plan and develop the new areas of Bodø with particular focus on sustainability, climate, energy, environment and circularity

- High goals and ambitions both for Bodø Municipality and the New City – New Airport project
  - 70 % reduction in direct GHG-emissions (cf. 2009-levels) by 2030
  - 70 % recycling of materials (household and industry waste) by 2030
  - Bodø as a Low Emission Society in 2050
  - First developments as a ZEN-area

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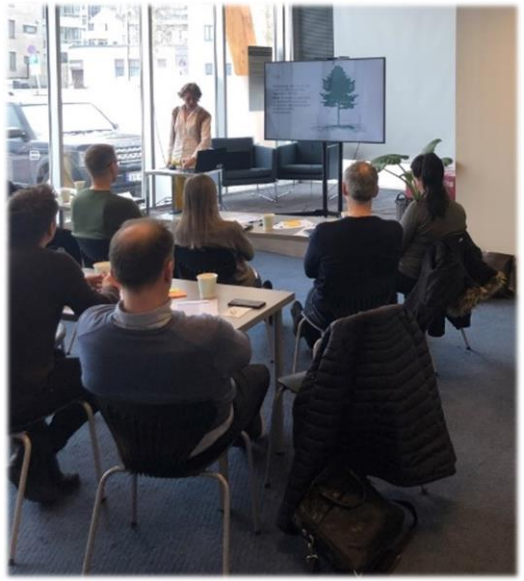
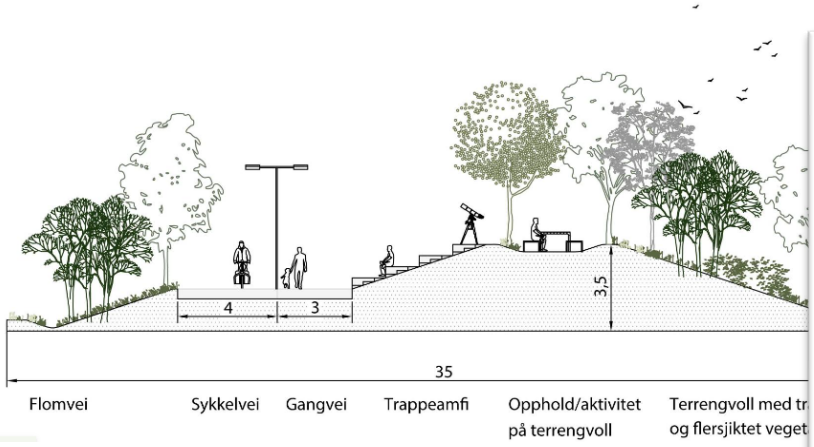
Society, governance and policy concepts

Local Communities of Practice in six Living Labs

Water-smartness assessment framework



Feasibility study of blue green structure



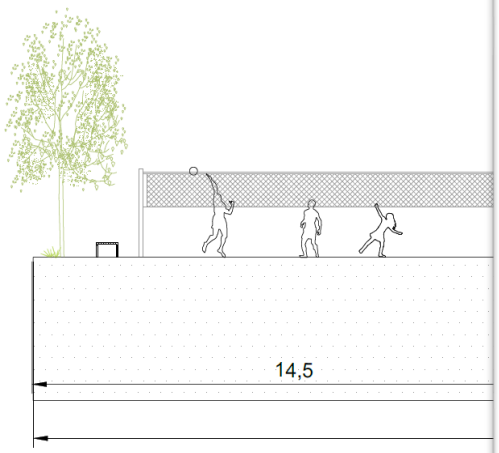
bodø KOMMUNE

TEMAPLAN OVERVANN 2022 - 2026

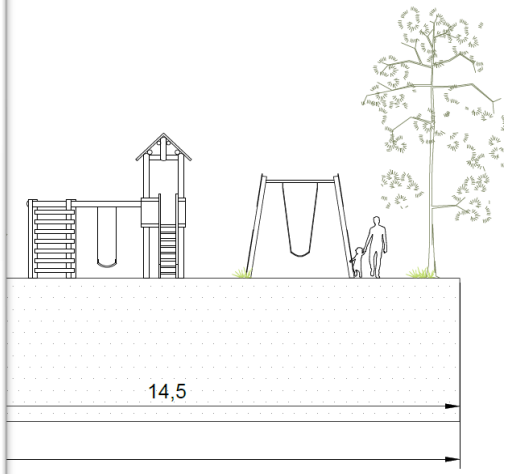
KLIMATILPASNING OG OVERVANNSHÅNDTERING

10.5.2022

www.bodokommune.no



Idrett/aktivitet



Sykkelvei Gangvei/svevesti Flomvei

Lekeplass

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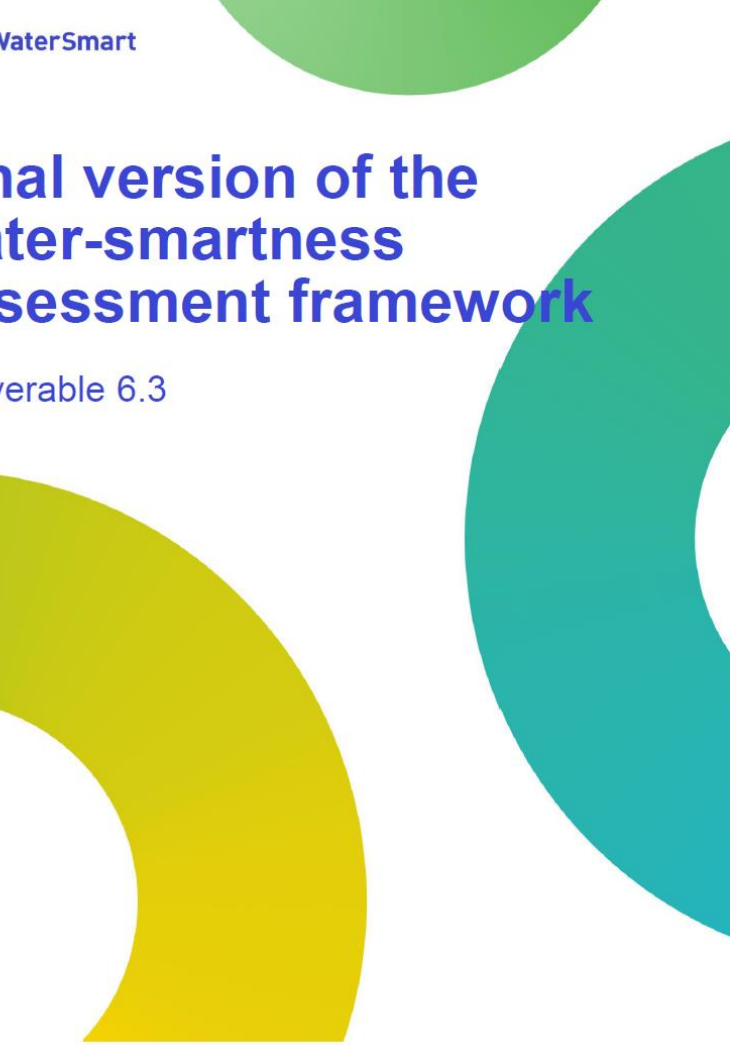
The Water-Smartness Assessment Framework

Objective A Ensuring water for all relevant uses	A.1 Safe and secure fit-for-purpose water provision	Safe drinking water (Heggmoen)		X	
		Safe drinking water All treatment facilities	X		
	A.3 Financial viability	Consumer willingness to pay		X	
		Affordability			X
		Financial continuation		X	



https://b-watersmart.eu/results-downloads/water-smartness-assessment-framework/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 869171. The publication reflects only the authors' views and the European Union is not liable for any use that may be made of the information contained therein.

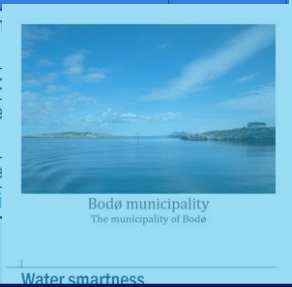
A – Ensuring water for all relevant uses

B – Safeguarding ecosystems and their services to society

C – Boosting value creation around water

D - Promoting adaptive change towards resilient infrastructure

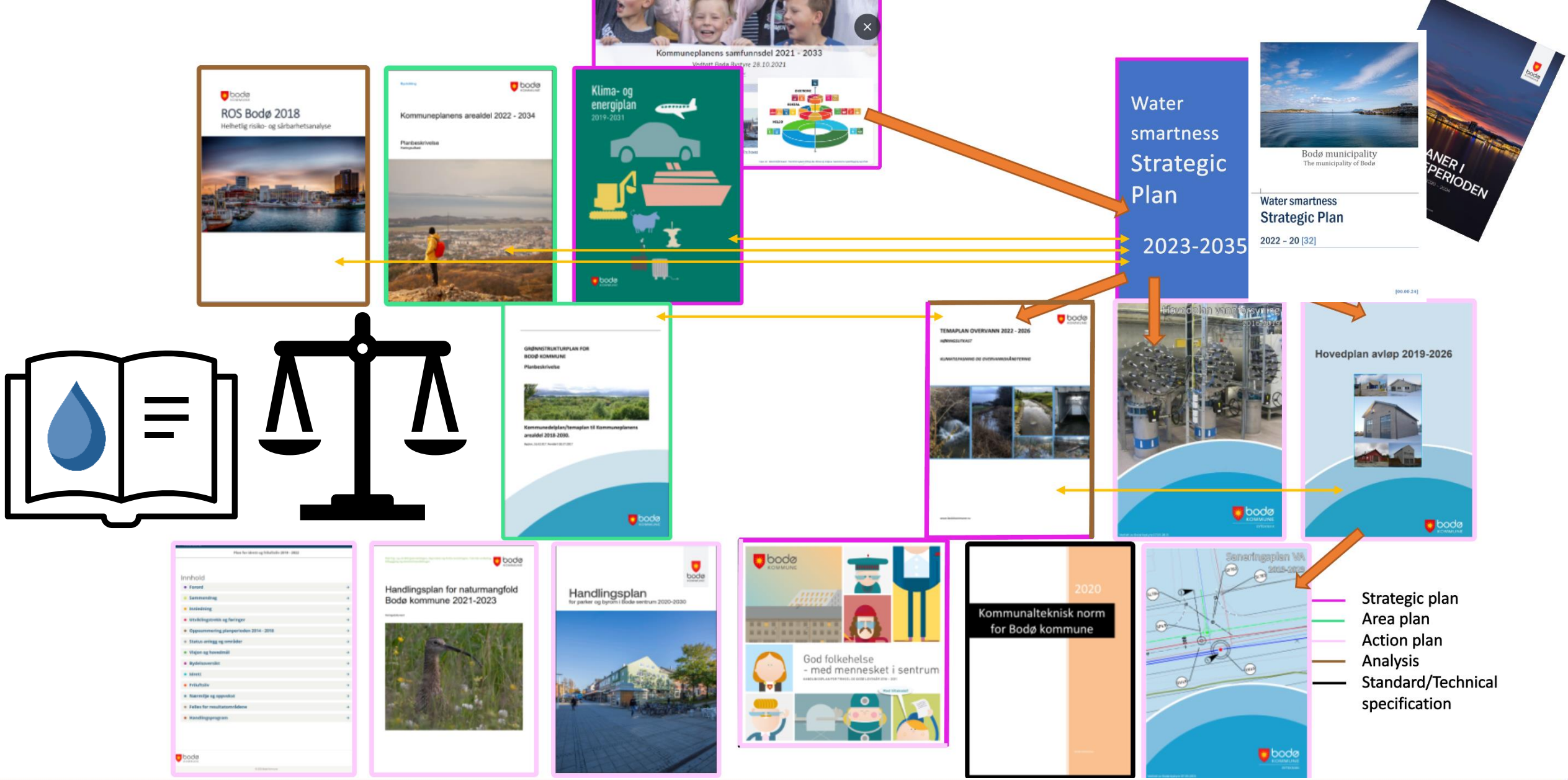
E – Engaging citizens and actors across sectors in continuous co-learning and innovation



Criteria	Metric	Unit
Safe and secure fit-for-	A.1.1 Water exploitation index +	%
	A.1.2 Safe drinking water	%
(for any user)	A.2.3 Physical access to water supply for industrial use	%
	A.2.4 Physical access to water for	%
	E.2.3 Room to maneuver	5-point Likert scales
	E.3.4 Metric "E.3.4" Collaborative agents	5-point Likert scales
AC: 15	Metrics: 58 + 2 context	

Criteria	Metric	Unit
	A.3.1 Consumer willingness to pay	5-point Likert scales
	Affordability	5-point Likert scales
	Financial continuation	5-point Likert scales
	Cost coverage ratio	
B.1 Safeguarded water ecosystems	Environmental flow re compliance rate	
	B.1.2 Effective stormwater	
	B.1.3 Effective wastewater	
	Water body self-purifi	
	Maintaining nursery p and habitats	
	Flood damage preven	
	Water provision by the ecosystem	%
	People enjoying cultural ecosystem services	%
	Water footprint	
B.3 Resource efficiency	Carbon footprint	
	B.3.3 Energy consumption	
	B.3.4 Drinking water consu	
	Statutory compliance	
	Preparedness	5-point Likert scales
	Policy instruments	5-point Likert scales
	C.1.4 Green public procurement	%
	C.1.5 Level of ambition	5-point Likert scales
C.2 Circular economy growth	C.2.1 Resource recovery revenues	%
	C.2.2 Green jobs	%
	C.2.3 Circular economy business models in practice	%

Criteria	Metric	Unit
C.3 Resource recovery and use	C.3.1 Water-related m recovery	
	C.3.2 Fertilizer produc	
	C.3.3 Reclaimed wate uses	
	C.3.4 Reclaimed wate	
	C.3.5 Energy producti	
Enabling planning to		
infrastructure		
Effectiveness	D.3.1 Linear water losses	m^3/(year. km)
	D.3.2 Water storage capacity	days
E.1 Awareness and knowledge	E.1.1 Knowledge and education	5-point Likert scales
	E.1.2 Information availability and use	5-point Likert scales
	E.1.3 Local sense of urgency	5-point Likert scales
	E.1.4 Water smart culture	5-point Likert scales
	E.1.5 Smart monitoring	5-point Likert scales


ROS Bodø 2018
Helhetlig risiko- og sårbarhetsanalyse
Kommuneplanens arealdel 2022 - 2034
Planbeskrivelse
Kommuneplanens samfunnsdel 2021 - 2033
Klima- og energiplan
2019-2031
Water smartness Strategic Plan 2023-2035
Bodø municipality
The municipality of Bodø
Water smartness
Strategic Plan
2022 - 20 [32]
GRØNNSTRUKTURPLAN FOR BODØ KOMMUNE
Planbeskrivelse
TEMAPLAN OVERVANN 2022 - 2026
Hovedplan avløp 2019-2026
Innhold
Handlingsplan for naturmangfold Bodø kommune 2021-2023
Handlingsplan
for parker og byrom i Bodø sentrum 2020-2030
God folkehelse
- med mennesket i sentrum
2020
Kommunalteknisk norm for Bodø kommune
Strategic plan
Area plan
Action plan
Analysis
Standard/Technical specification

The Water-Smartness Assessment Framework

Equation

$$C_{totalDW} = \left(1 - \frac{n_{e\ totalDW}}{n_{totalDW}}\right) \times 100$$

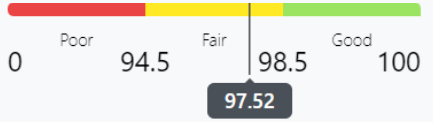
Please fill the option(s) below.

Total number of samples of drinking water with exceedance, i.e., sum of samples with microbial, chemical and indicator parameter exceedance

$n_{e\ totalDW}$ 10.00 No./year

$n_{totalDW}$ 404.00 No./year

97.52 %



Total number of drinking water samples analyzed in assessment period [10,Infinity]

Table 6.1– Metric results and targets of Objective A

Objectives	Assessment criteria	Metrics	Reference values			Results (t0) (2022)	Comment	Targets		
			Poor 🔴	Fair 🟡	Good 🟢			t1 (2030)	t2 (2040)	t3 (2050)
Objective A Ensuring water for all relevant uses	A.1 Safe and secure fit-for-purpose water provision	Safe drinking water Heggmon &	0-94.5	94.5-98.5	98.5-100	97,5 🟡	Total: 440 Total failed: 10 Majority of failed tests were turbidity. Heggmoen vannverk supplies approximately 95% of population	96.5-98.5 🟡	98.5-100 🟢	98.5-100 🟢
	A.3 Financial viability	Consumer willingness to pay	-- or -	0	+ or ++	0 🟡	We should give more information about the costs of water and quality of water, raise awareness	0 🟡	+ 🟢	+ 🟢
		Affordability	-- or -	0	+ or ++	++ 🟢		++ 🟢	++ 🟢	++ 🟢
		Financial continuation	-- or -	0	+ or ++	0 🟡	Political willingness, public willingness	0 🟡	0 🟡	+ 🟢

Objectives	Assessment criteria	Metrics	Reference values for...		
			Poor performance	Fair performance	Good performance
Objective A Ensuring water for all relevant uses	A.1 Safe and secure fit-for-purpose water provision	Safe drinking water (Heggmoen)		X	
		Safe drinking water All treatment facilities	X		
	A.3 Financial viability	Consumer willingness to pay		X	
		Affordability			X
		Financial continuation		X	
Objective B: Safeguarding ecosystems and their services to society	B.1 Safeguarded water ecosystems	Effective wastewater/stormwater treatment			
		Carbon footprint for drinking water			
	E.2 Multi-sector network potential E.3	Authority			X
		Room to maneuver			X
	E.3 Stakeholder Engagement processes	Stakeholder inclusiveness			X
		Protection of core values			X
		Cross-stakeholder learning			X
		Collaborative agents			X
	B.3 Resource efficiency	Carbon footprint for wastewater			
		Energy consumption (Total)			X
		Drinking water consumption			
Objective C Boosting value creation around water	C.1 Circular policy making	Statutory Compliance		X	
		Preparedness	X		
		Policy instruments		X	
		Level of ambition			X
Objective D Promoting adaptive change towards resilient infrastructure	D.1 Enabling planning to promote adaptive change towards circularity and resilience	Infrastructure Planning Index for Adaptive Change		X	
	D.2 Implementing adaptive change towards resilient infrastructure	Infrastructure Implementation Index for Adaptive Change	X		
	D.3 Effectiveness of the adaptive change towards resilient infrastructure (Diagnosis)	Linear water losses	X		
		Incident occurrences in the system (Water pipe burst)			X
		Incident occurrences in the system (Sewer stops)		X	
		Combined Sewer Overflows	X		
		Time for restoration (Sewer system facilities)			X
		Treatment capacity utilization	X		
Objective E Engaging citizens and actors across sectors in continuous co-learning and innovation	E.1 Awareness	Knowledge and education	X		
		Information availability and use	X		
		Local sense of urgency		X	
		Smart monitoring		X	
		Clear division of responsibility			X

Outcomes of completing the assessment:

Many within the water and waste department knows of these challenges, this document **helps other objectively understand the challenges** and why investments are needed

Gives a clear view of **strengths and weaknesses**

Highlights what data is missing

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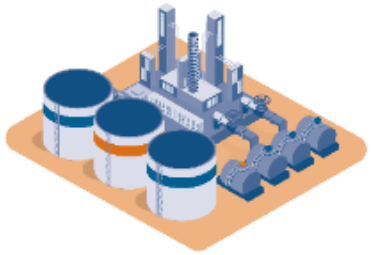
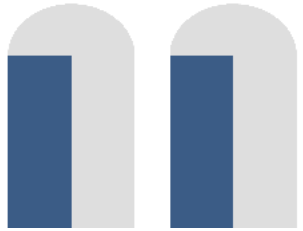
Sludge to Energy

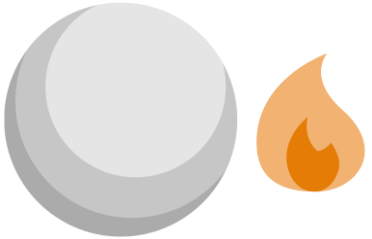


WWTP

Sludge

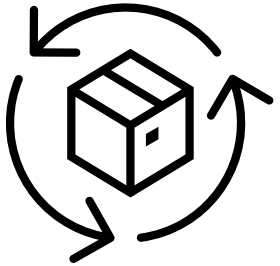


Sludge digestion



Energy generation

Biogas, Heat, Electricity



Residuals

Biosolids → Biopellets Biochar Composted

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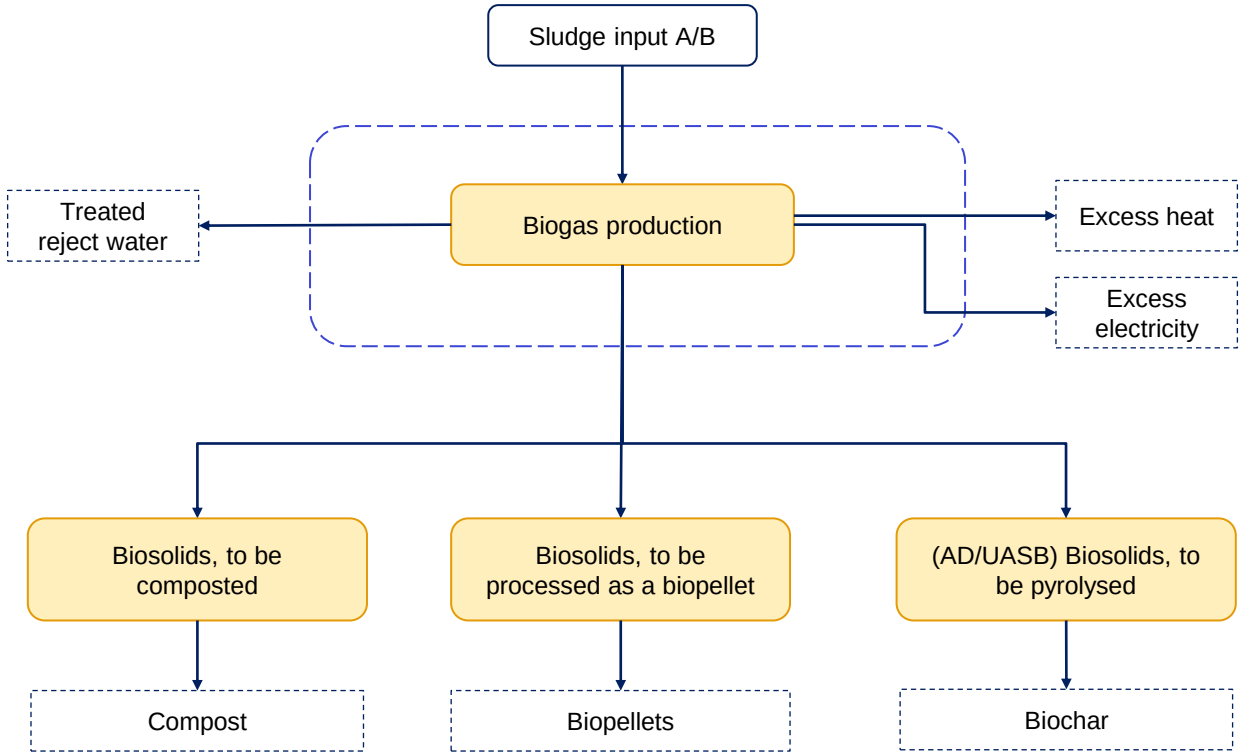
Alternatives: Biogas with different biosolids treatments



MENGDER 2022

- Kloakkslam: 3000 tonn
  - 45% fra Bodø kommune
- Septik til avvanning: 4300 tonn
  - 80% fra Bodø kommune

Slam fra hele Salten, inkl. alle renseanlegg i Bodø kommune.

Annet organisk avfall:

- Matavfall: 9000 tonn
- Hageavfall: 6000 tonn
- Fiskeslam: 200 tonn (+++)

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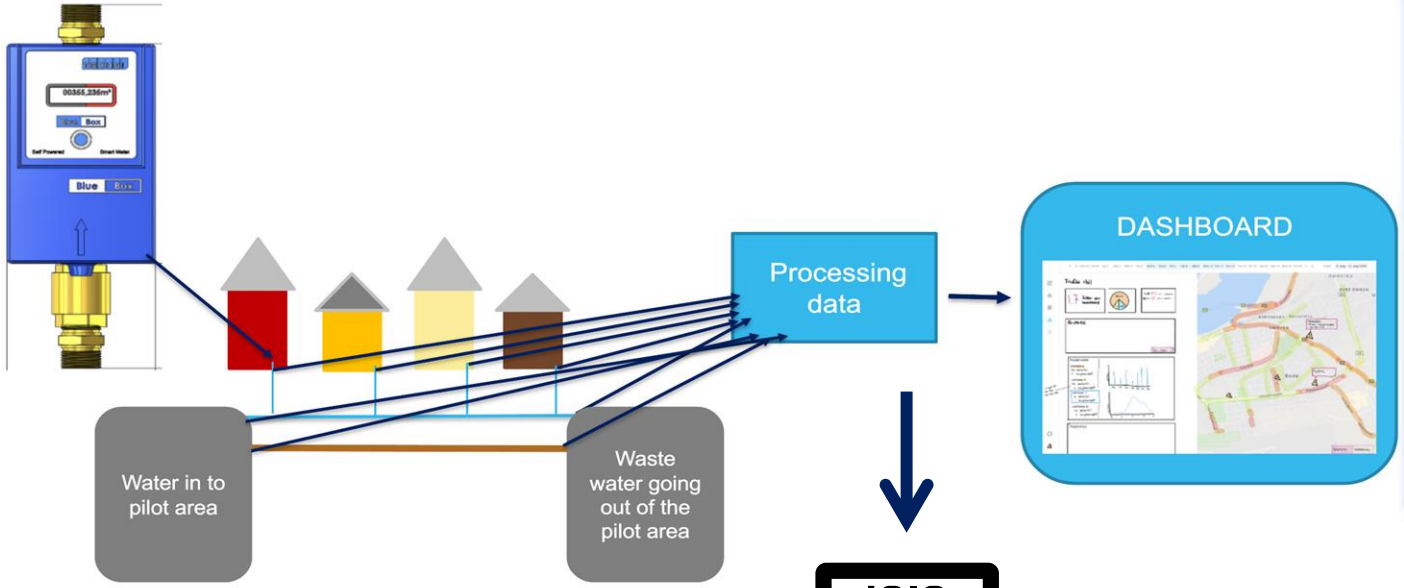
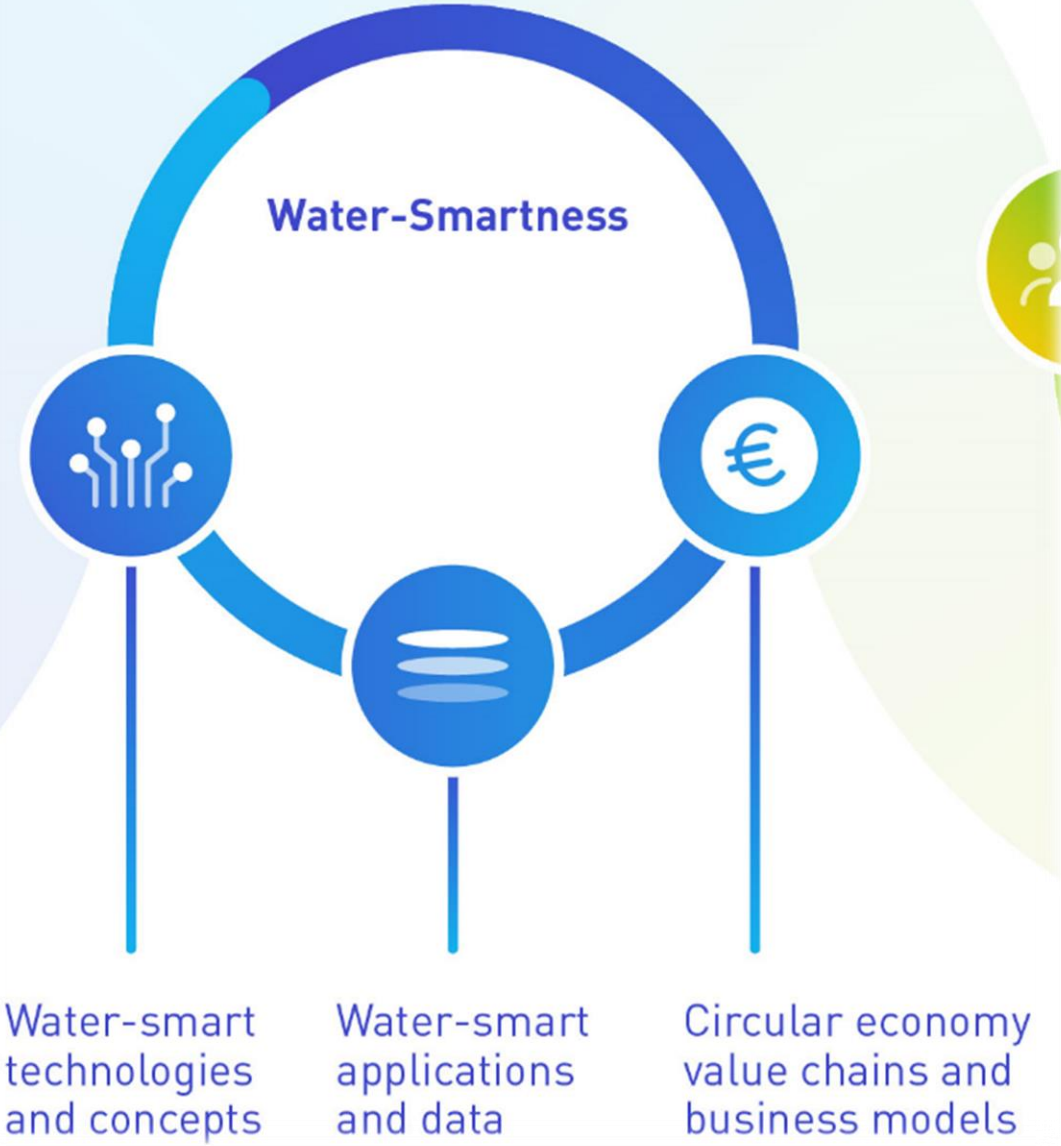
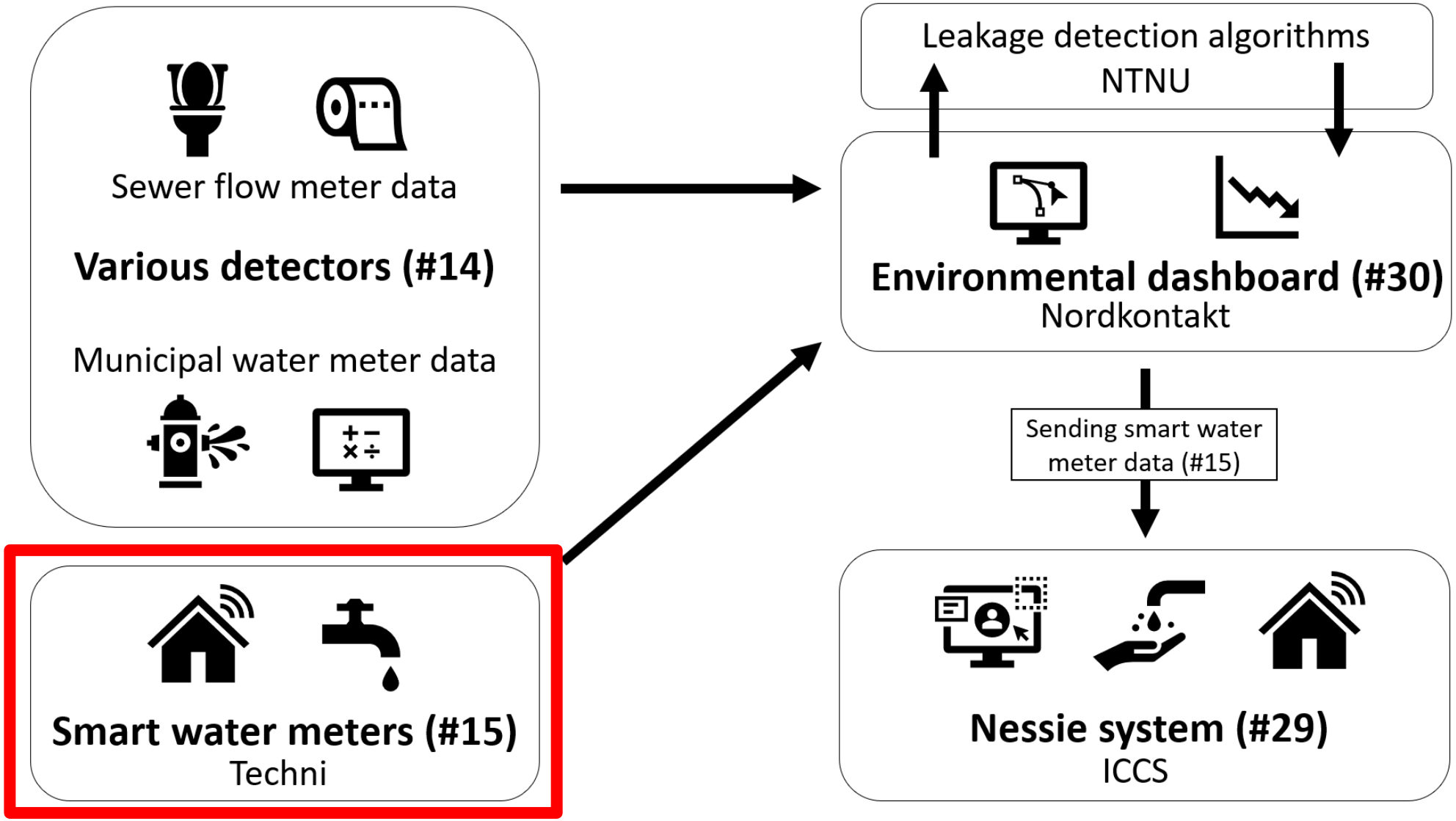
LL Bodø Smart Water Meter Pilot

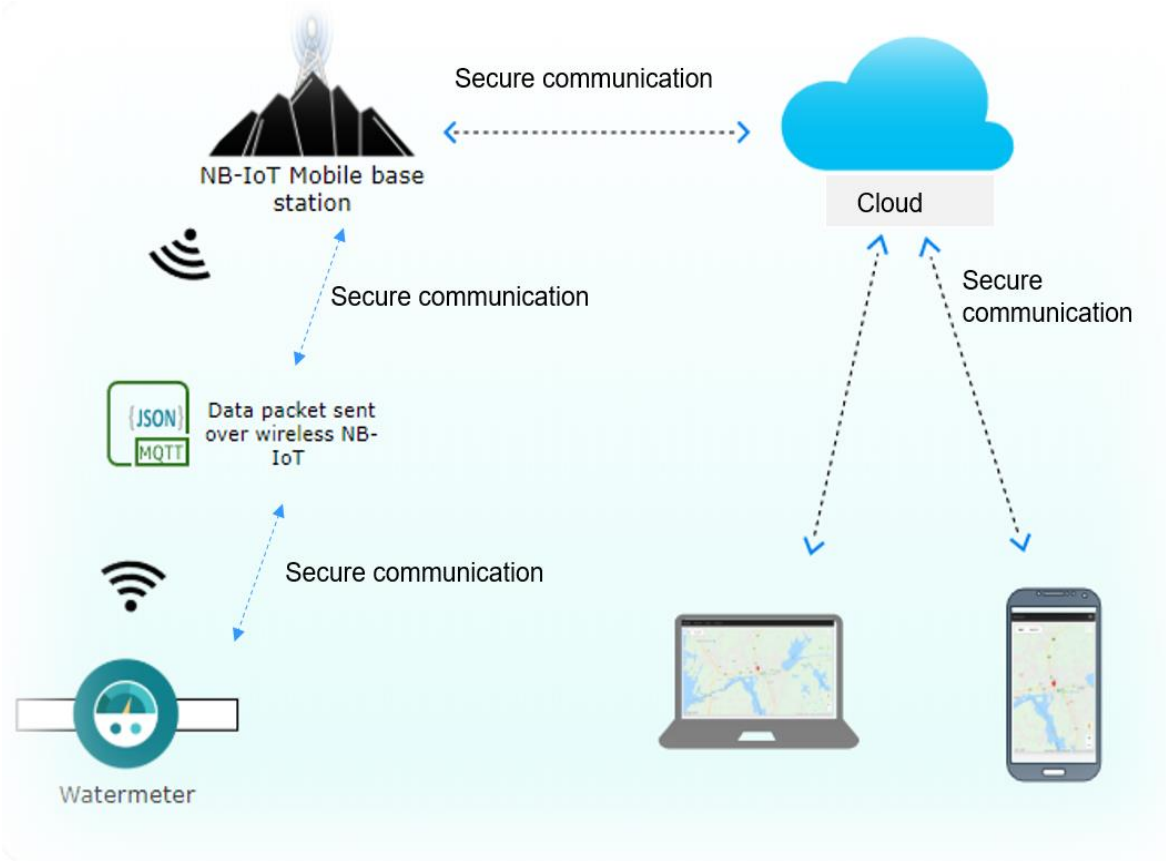




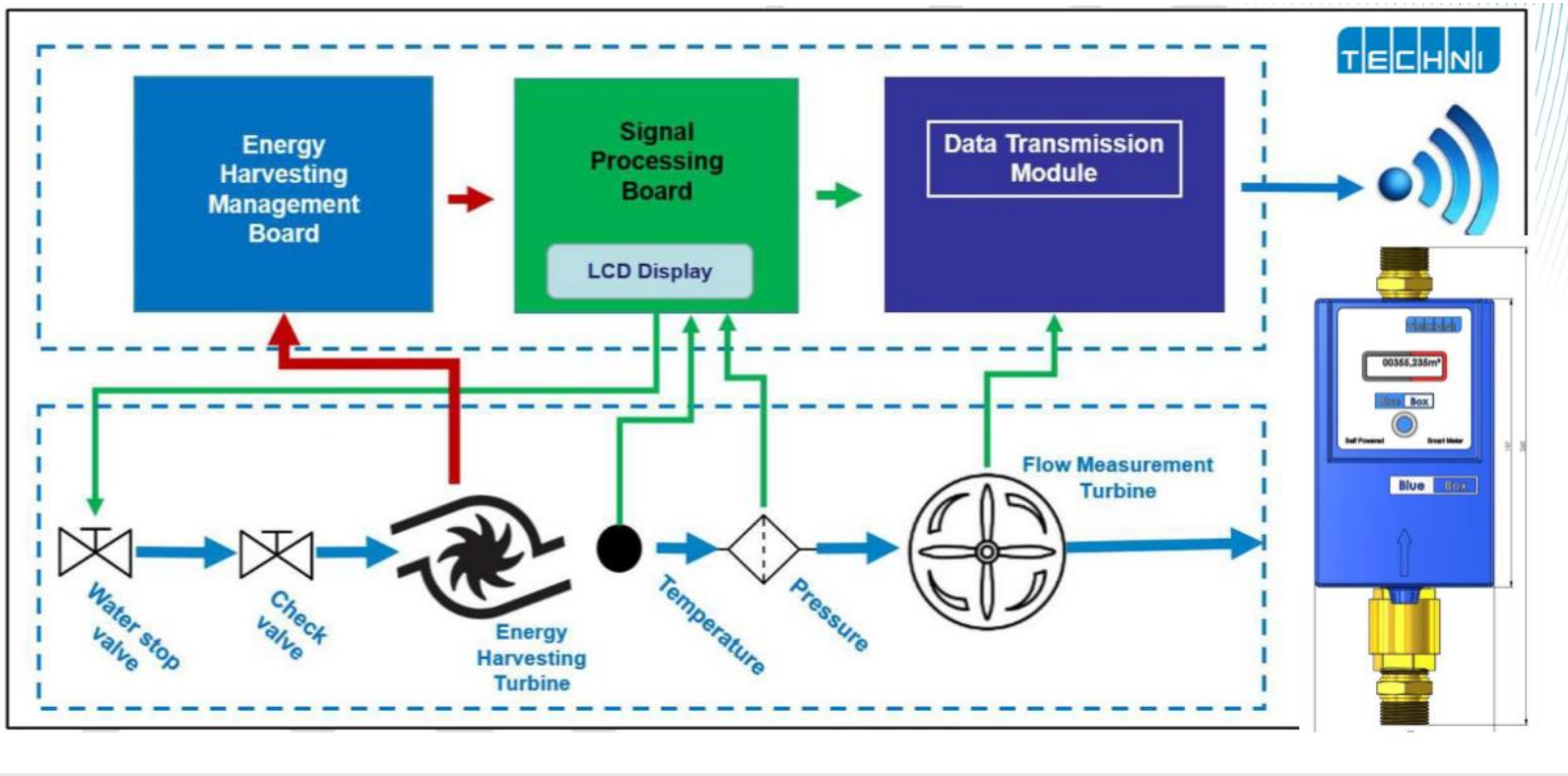

Sewer flow meter data
Various detectors (#14)
Municipal water meter data
Smart water meters (#15)
Techni
Leakage detection algorithms
NTNU
Environmental dashboard (#30)
Nordkontakt
Sending smart water meter data (#15)
Nessie system (#29)
ICCS

The goal is a water meter providing «real-time» granular data throughout its life made possible by energy from the water flow

- Generate and store energy for its own use and capability
- Provide online data to suppliers/municipalities
- Provide online data to the end user
- Measure flow, water temperature and pressure
- Two-way communication
- Household microleakage detection – (valve & pressure)



The energy from the water is harvested optimally by a combination of pressure-controlled flow-by and a turbine optimized for low-flow volumes



Meters were assembled, calibrated and rolled-out, showing a strong energy balance and the data stream this far is good

Parameter	Frequency	Resolution
Water Volume	Consumption the last 60 s, in L	8 ml per step
Pressure	Every 60 s	0,1 bar
Temperature	1/h	0,1 degree
Battery	1/h	0,01 Volt

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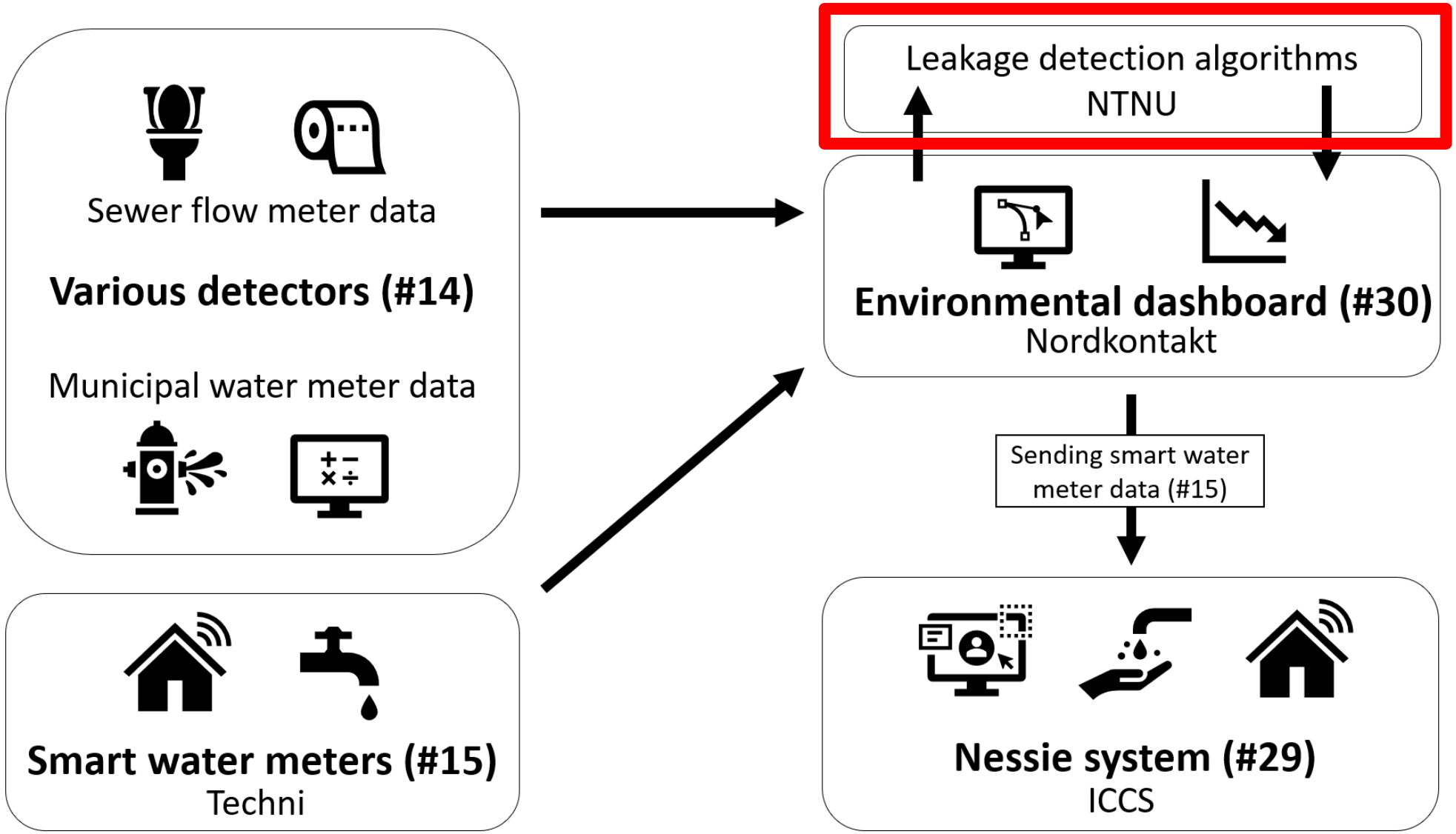
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Smart water meters (#15)
Techni
Nessie system (#29)
ICCS

Leakage detection algorithms

Prioritization of DMAs for leak reduction measures (Arendal)

- Jesper A. O. Vimme (MSc thesis, 2021), Water loss management and Data Quality assessment in Medium Sized Water Distribution Systems in Norway, https://hdl.handle.net/11250/2830171

Pressure reduction and pressure burst relationship (Bergen)

- Sam Alaya (MSc thesis, 2022), Assessment of Pressure-Pipe Life Expectancy and Pressure-Leakage Relationships in the Water Distribution System in Bergen, Norway. A Case Study, https://hdl.handle.net/11250/3028251

Autoencoders (AE) and variable Autoencoders (VAE) using artificial data (L-Town)

- Magnus Totland (MSc thesis, 2022), Detection of leakages in a water distribution network using an autoencoder, https://hdl.handle.net/11250/3023048

Leak localization with a dual model approach (Real world data)

- Erik Nordahl (MSc thesis, 2022), Leak Localization with the Dual Model on a Real-World Water Distribution System, https://hdl.handle.net/11250/3021069

Benchmarking of approaches (Gjøvik)

- Daniel Habenicht (MSc thesis, 2023)

Other Studies relating to developing a watersmart society

Low-cost measurement devices tested in a lab setting

- Meier, R., Tscheikner-Gratl, F., Steffelbauer, D.B., Makropoulos, C., 2022. Flow Measurements Derived from Camera Footage Using an Open-Source Ecosystem. Water 14, 424. https://doi.org/10.3390/w14030424

Quantifying Infiltration and Inflow in Data-Scarce Environments

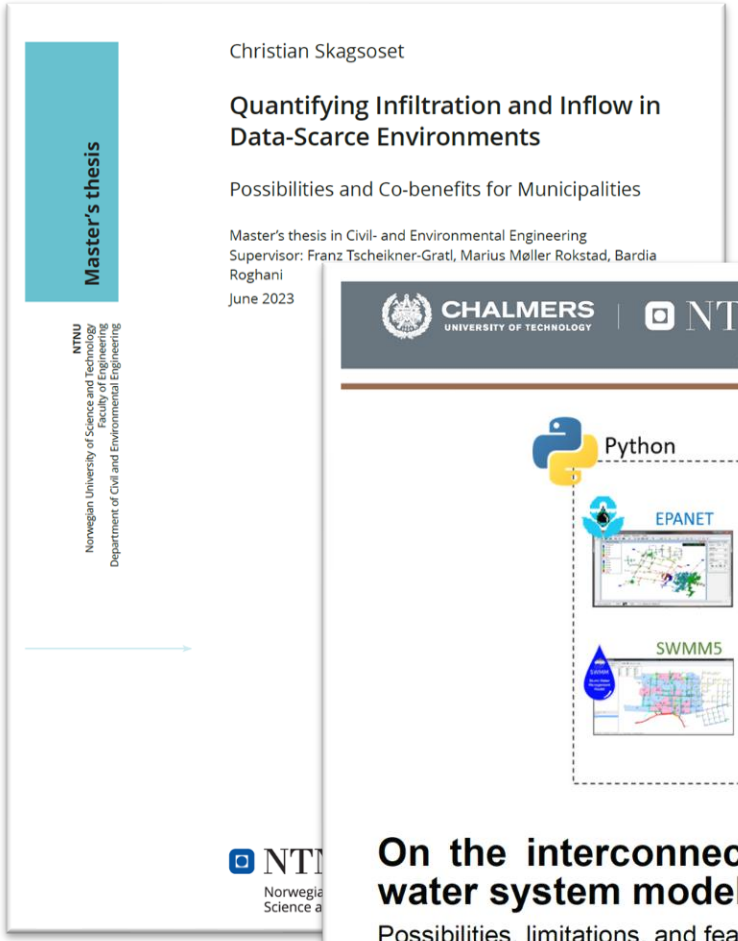
- Christian Skagsoset (MSc thesis, 2023): Quantifying Infiltration and Inflow in Data-Scarce Environments - Possibilities and Co-benefits for Municipalities

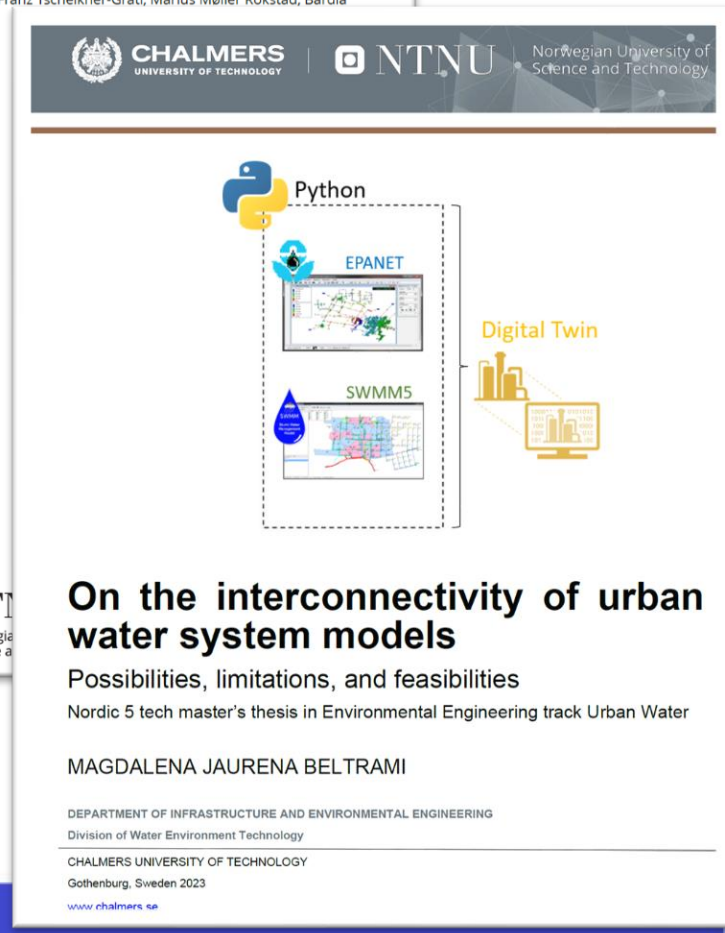
Usage of camera footage to find wrong connection in a system

- Anders N. Løfald (MSc thesis, 2023): Using Optical Velocimetry to Detect Illicit Inflow to Sewers: A sensor strategy

Possible combination WDS and Sewer

- Magdalena Jaurena Beltrami (MSc thesis, 2023): On the interconnectivity of urban water system models - Possibilities, limitations, and feasibilities

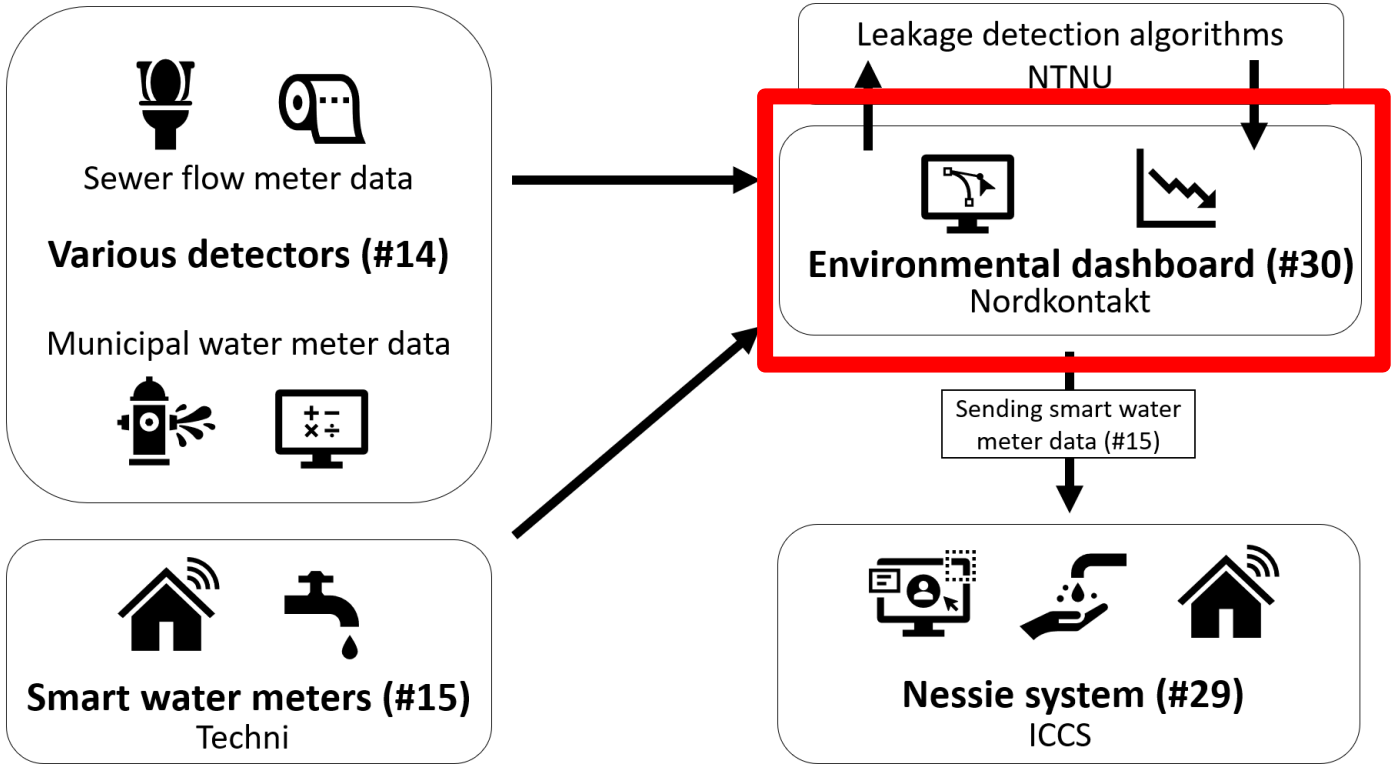





SIEMENS


HONDA
bodø

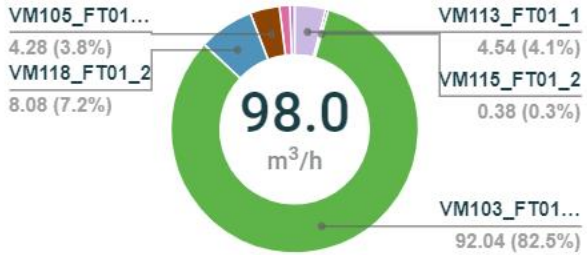
Smart Water Meters
Leakage detection algorithms
Dashboards

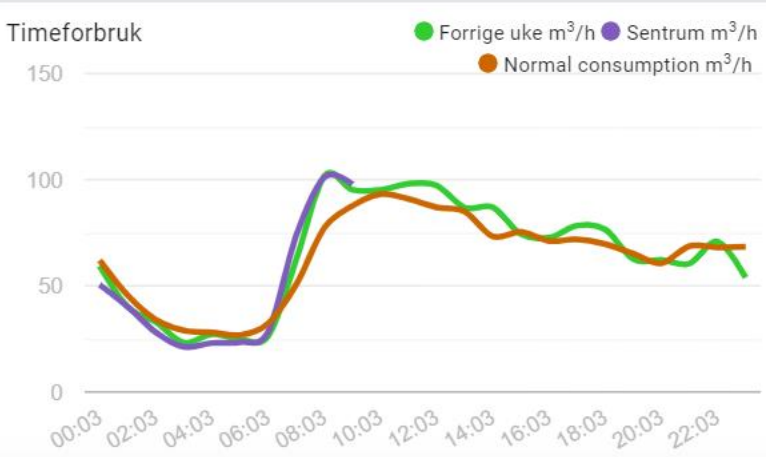


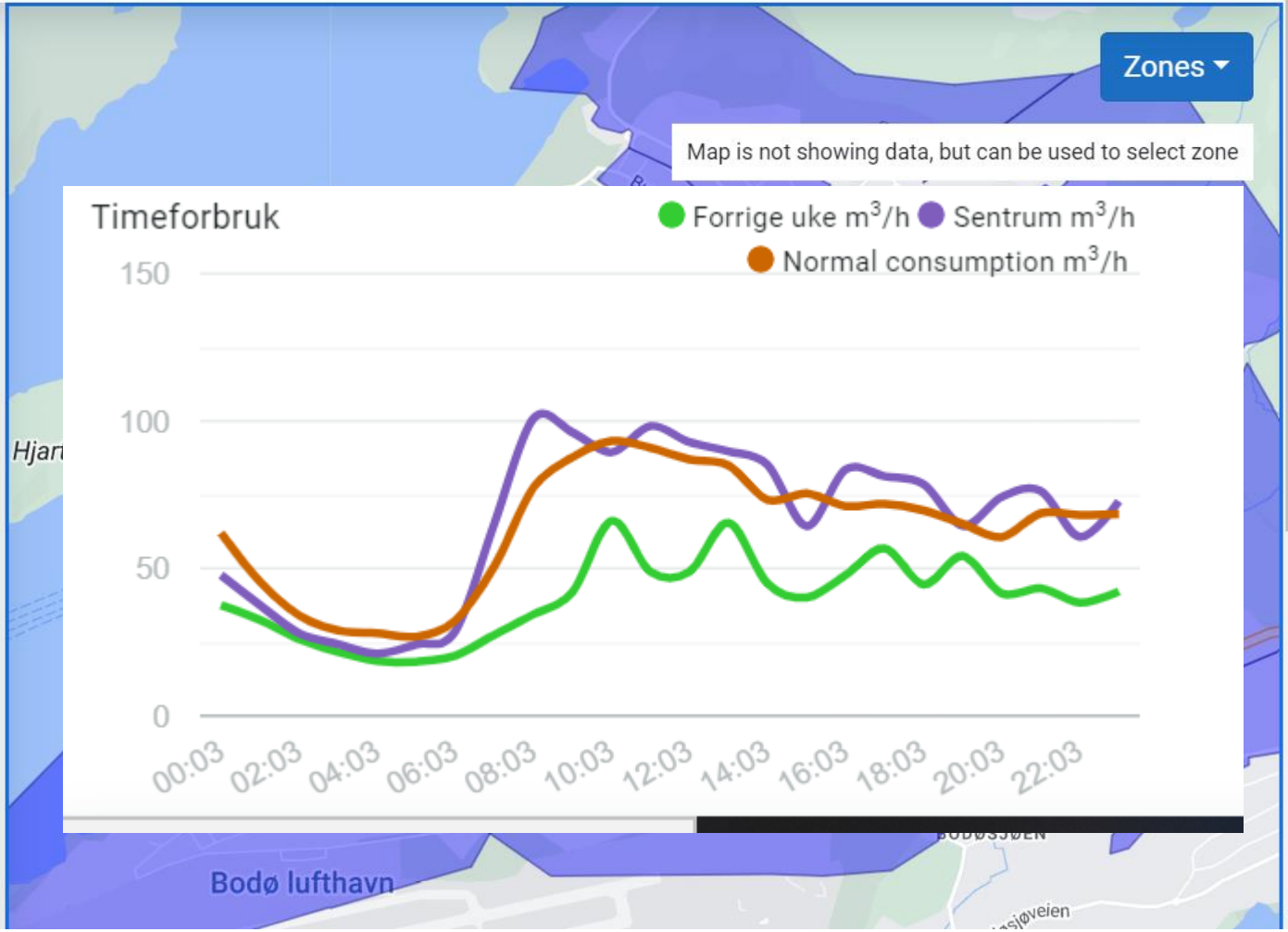
Torsdag | Uke 16 | 2024 | Sentrum | Bodø Kommune | Nordland | Norge

rachelle.collette@bodo.kommune.no

Forbruk detaljert Sentrum fra 08:00 til 09:00 Thu Apr 18 2024



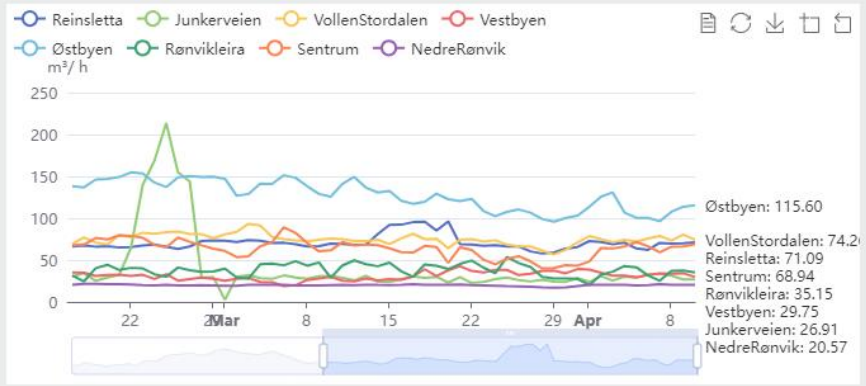


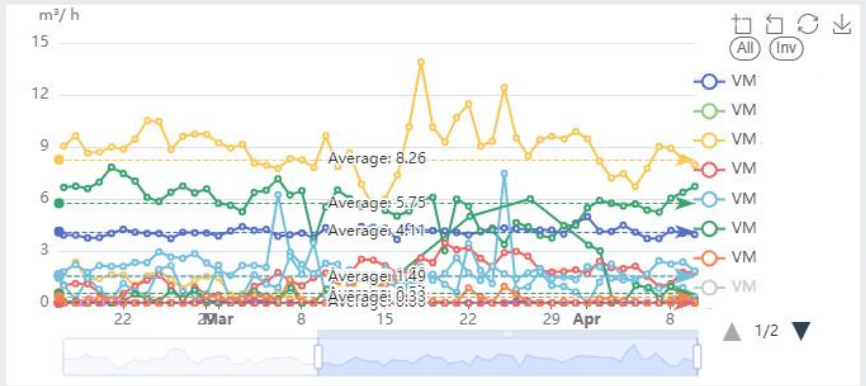


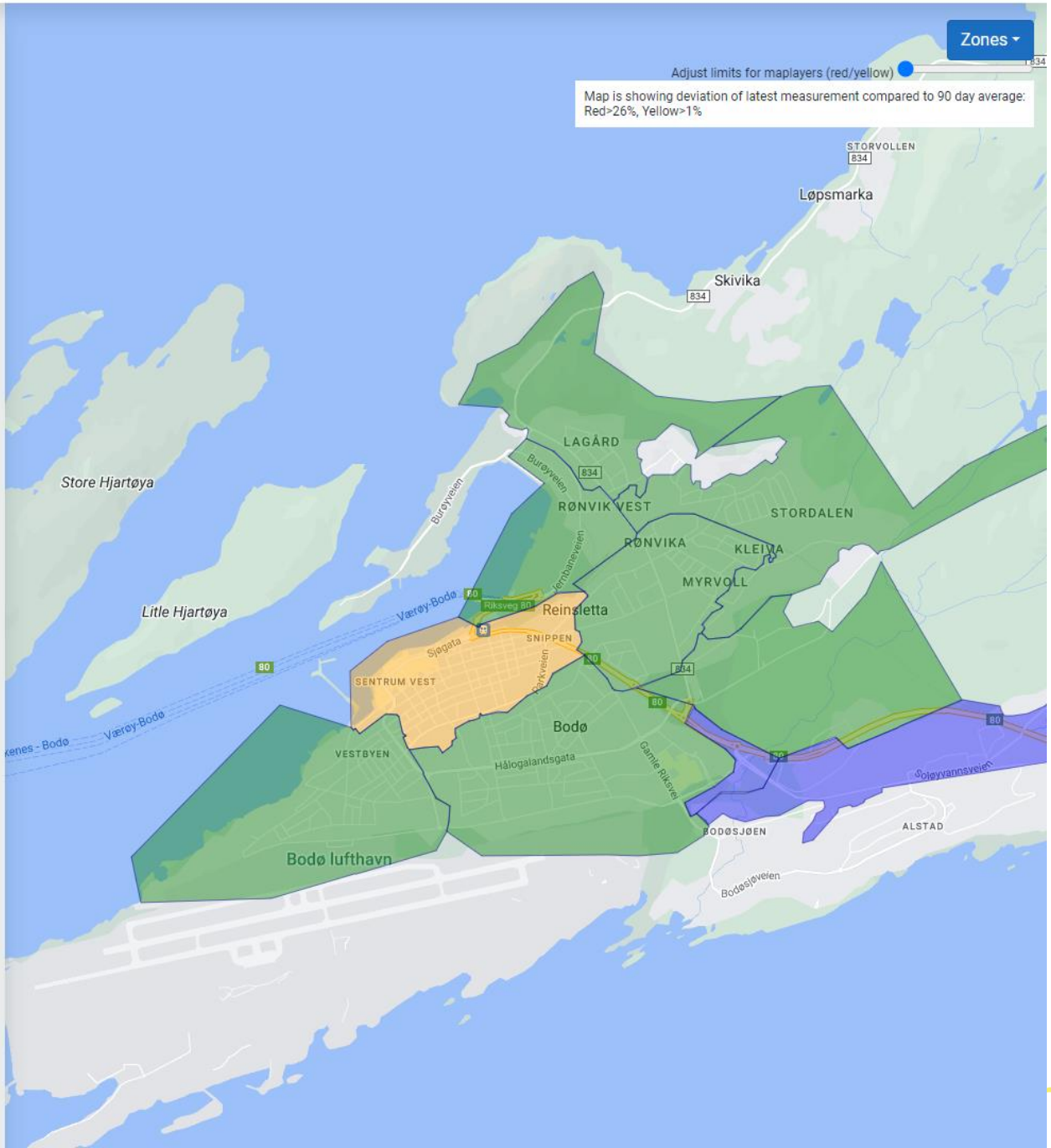
nordkontakt®

Torsdag | Uke 15 | 2024 | Sentrum | Consumption avg

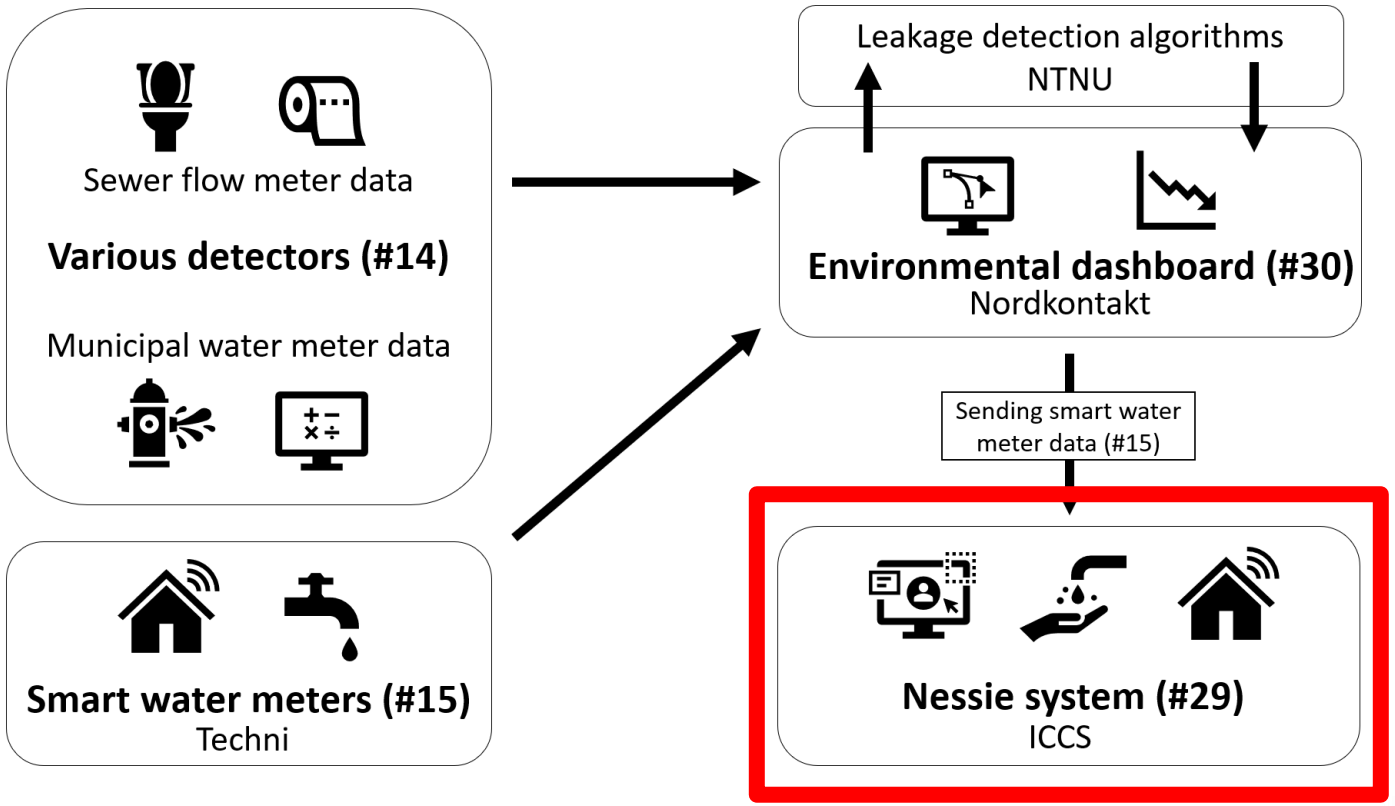
History





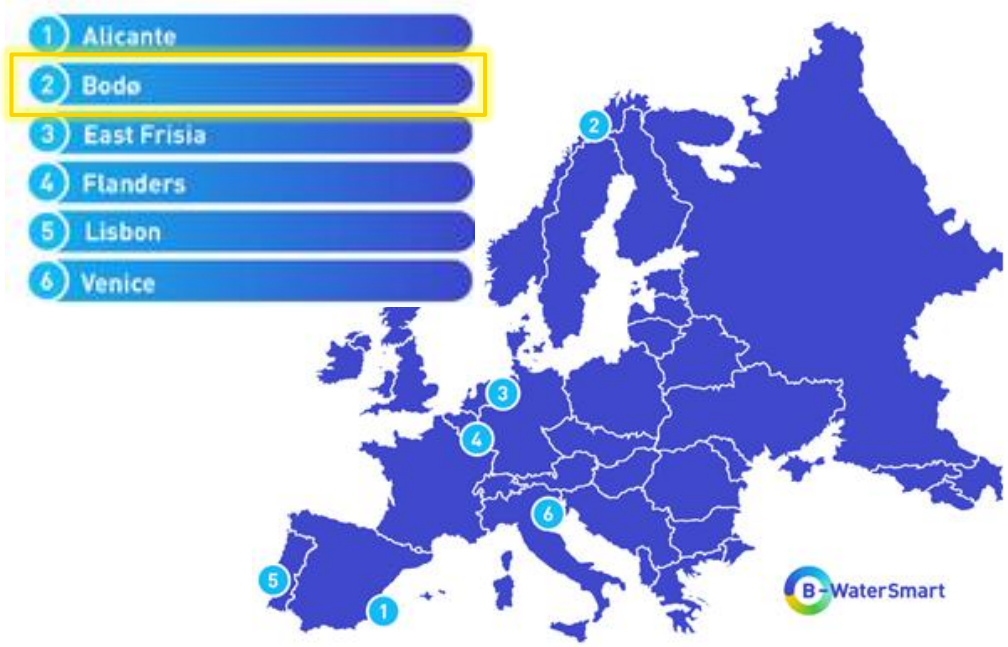


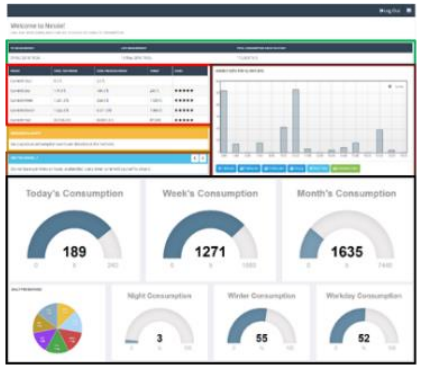
Smart Water Meters
Leakage detection algorithms
Dashboards



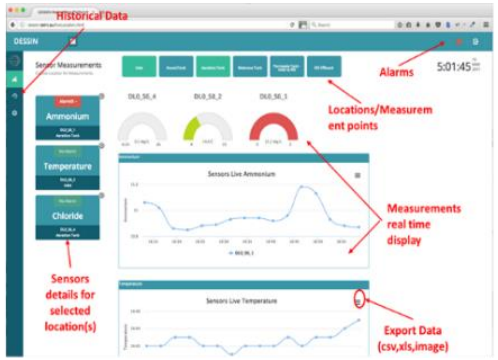
Nessie system (#29)

- Nessie is **visualization and analytic platform** able to **acquire, process and store** high-resolution data from IoT (incl. sensors and smart meters), developed in ICCS/NTUA.
- Currently, it is a **FIWARE-enabled platform,** which has been **built and evolved through different EU-funded projects (starting in iWidget project; 2012-2015).**

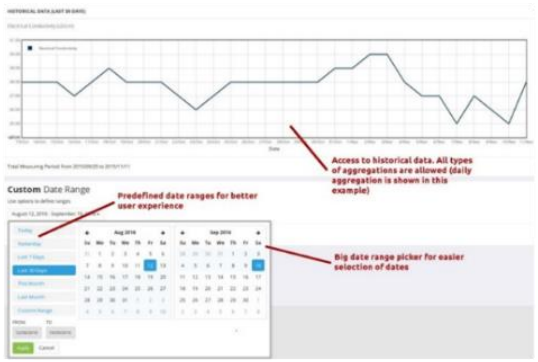




Monitor, analyse and get advice on **water consumption**, using smart meters

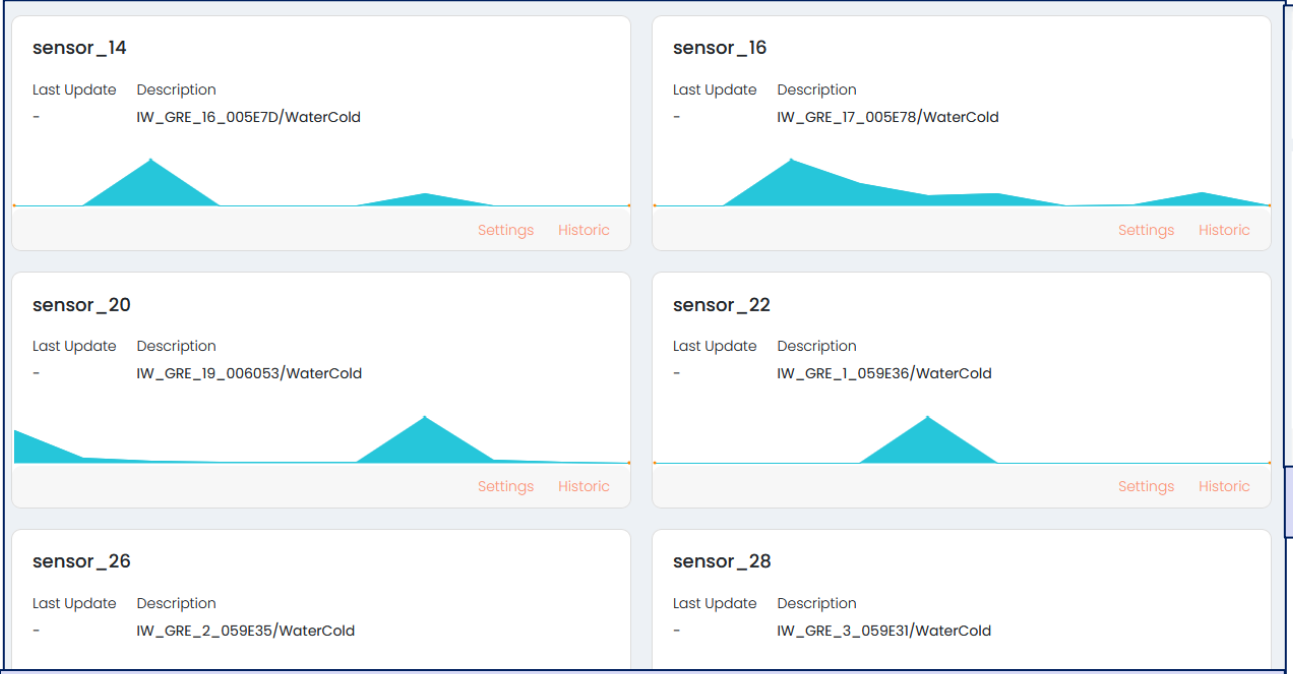


Monitoring and control of **Sewer Mining** Unit



Monitoring and control of a **Managed Aquifer Recharge and Recovery** installation

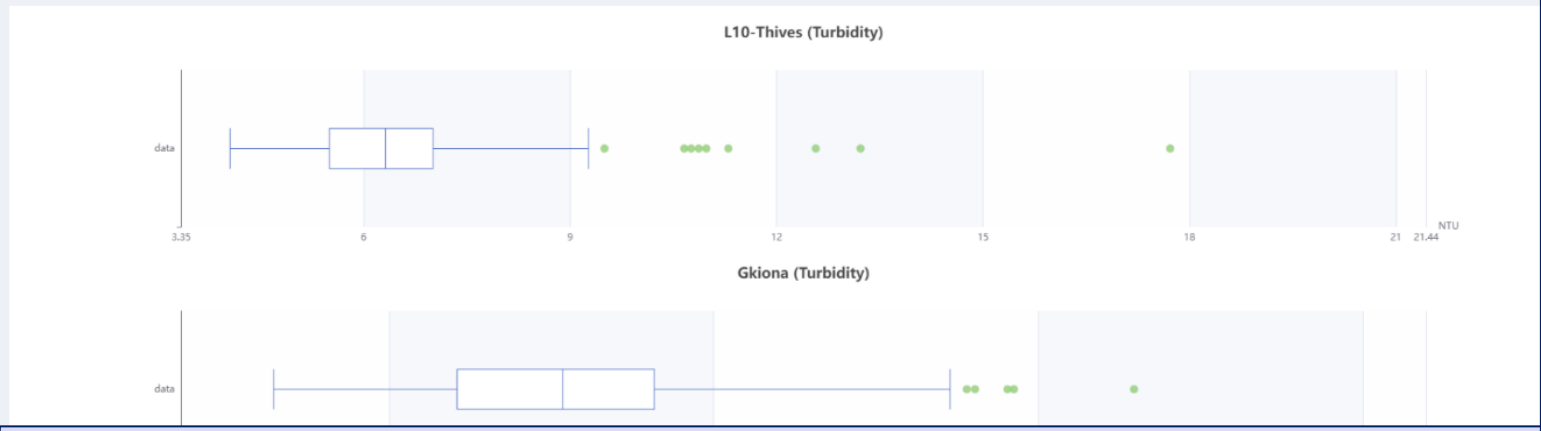
- For the Bodø case, it aims to assist in water efficiency **at the household level by delivering information** (e.g., water volume, pressure, temperature) **from smart-meters**, available for leak detection of water supply networks as well as demand management at a household level.



Overview of latest measurements from sensors.

Comparison of measurements on the basis of common axis graphs.

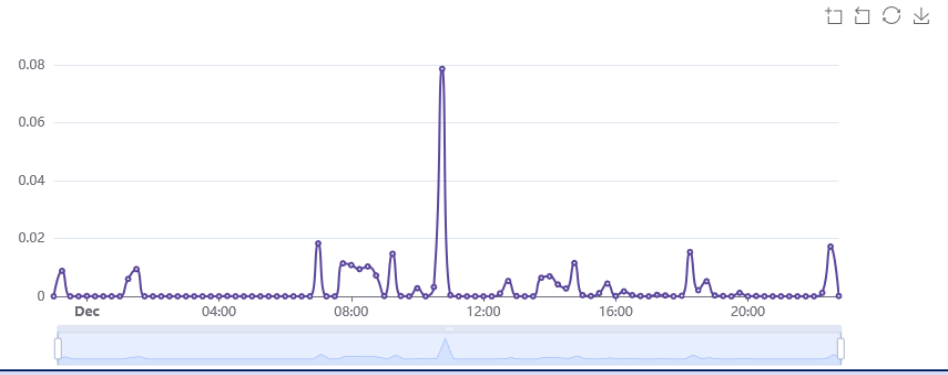
Measurement	Minimum	Maximum	Average	Deviation	Q 5	Q 25	Q 50	Q 75	Q 95
L10-Thives (Turbidity)	4.06	17.72	6.59	2.01	4.48	5.51	6.32	7.01	10.79
Gkiona (Turbidity)	3.29	8.59	5.15	0.97	3.87	4.42	5.07	5.63	6.66



Comparison of statistical characteristics of selected properties, along with boxplots.

Sensor	Value	Timestamp
IW_GRE_18_005E4F/WaterCold	0.0001	2015-12-01 22:45
IW_GRE_19_006053/WaterCold	0.0003	2015-12-01 22:45
IW_GRE_19_006053/Electricity	0	2015-12-01 22:45
IW_GRE_7_059E14/WaterCold	0	2015-12-01 22:45

sensor_18 (IW_GRE_18_005E4F/WaterCold)



Most recent measurements and an interactive graph.

Introduksjon

- Living lab Bodø

Oversikt over LL Bodøs oppgaver

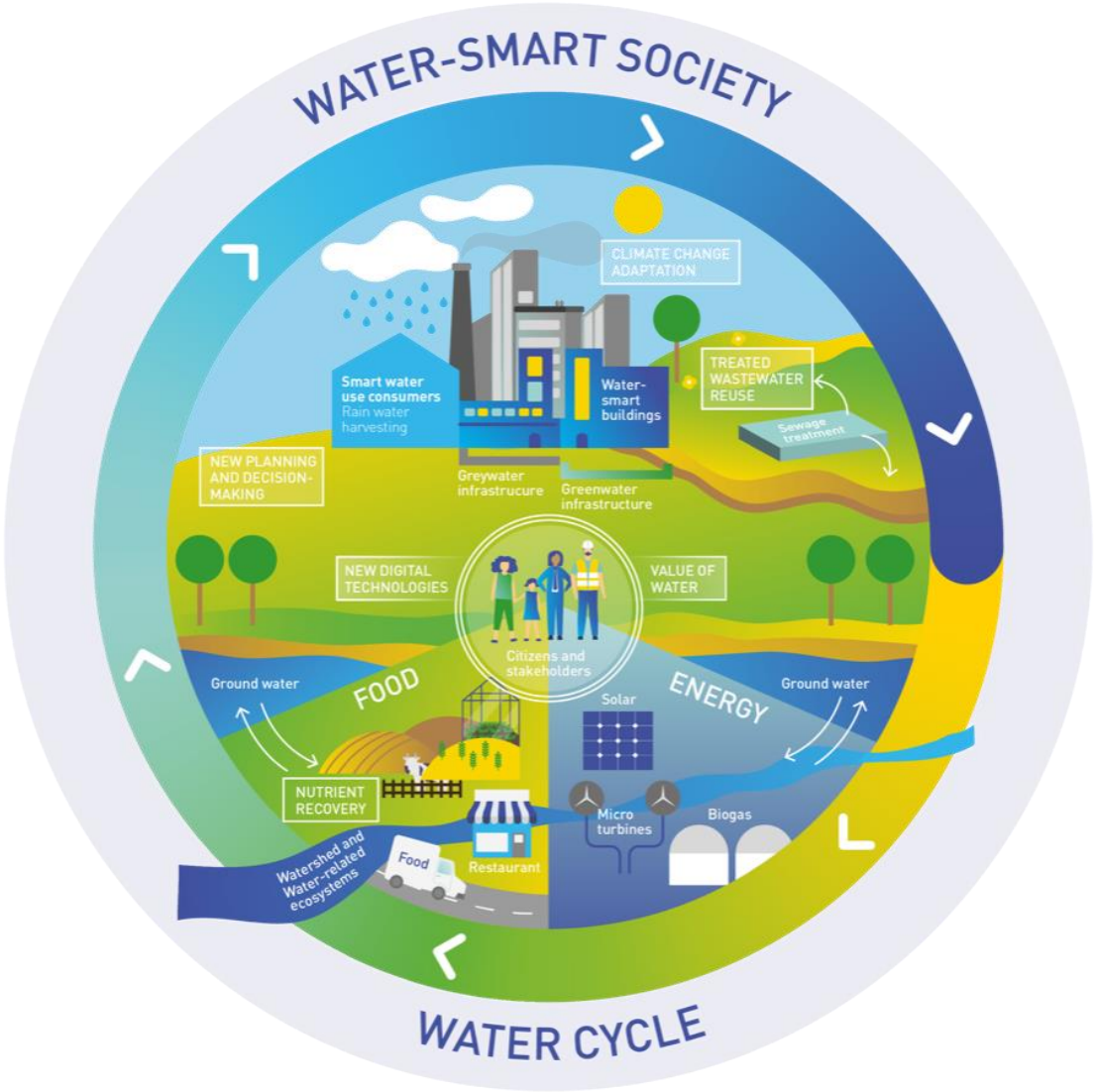
- Lover og regler
- The water-smart assessment framework
- Teknologier
- Programvare

Konklusjon

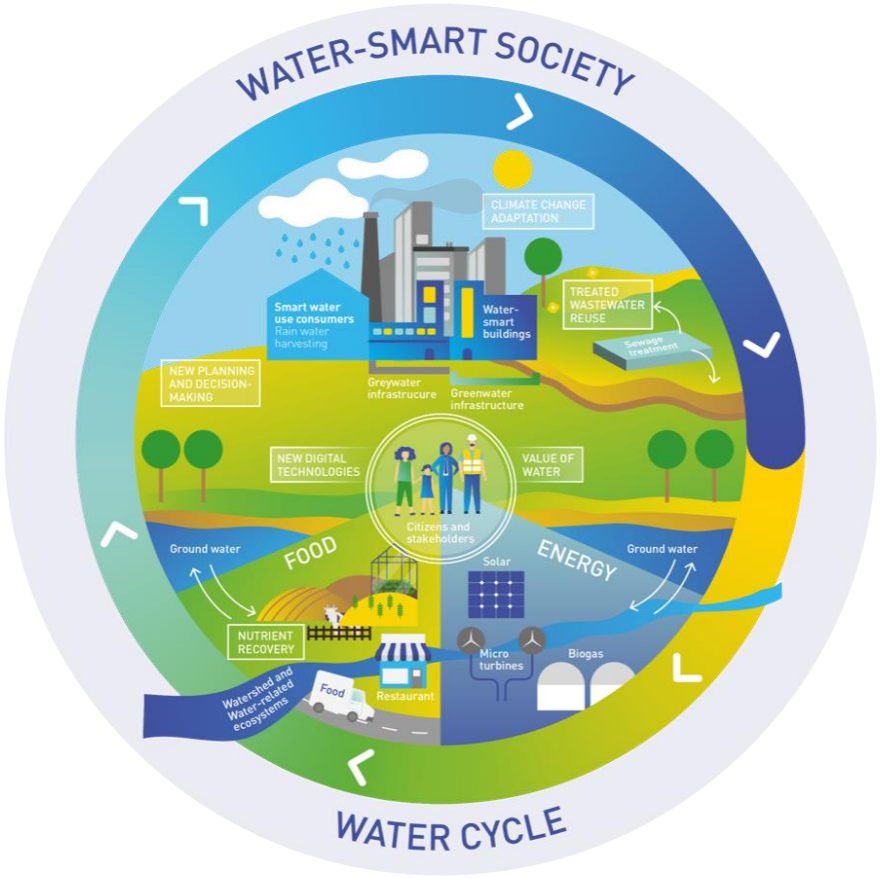
- **Sammendrag**

Outcomes

- New insights: SWOT analysis, GDPR, UWWTD, Nature based solutions
- Contributing to innovation
- Strengthened connections with local, national and international partners


WATER-SMART SOCIETY
CLIMATE CHANGE ADAPTATION
Smart water use consumers
Rain water harvesting
Water-smart buildings
TREATED WASTEWATER REUSE
Sewage treatment
NEW PLANNING AND DECISION-MAKING
Greywater infrastrucure
Greenwater infrastructure
NEW DIGITAL TECHNOLOGIES
VALUE OF WATER
Citizens and stakeholders
Ground water
FOOD
ENERGY
Ground water
Solar
NUTRIENT RECOVERY
Micro turbines
Biogas
Watershed and Water-related ecosystems
Food
Restaurant
WATER CYCLE

Tusen takk



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