Digitized Water Leakage Management - Costs and Benefits for the Utility

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Introduction

At NORDIWA 2018 in Oslo Bronderslev Water Company (BWC) presented the first results of a new digital strategy for water leakage management (WLM). The aim was to gain full control over the infrastructure and the water losses. A new target for the annual water loss of less than 5% was decided. In parallel, an already ongoing sectioning-scheme (finalizing DMA-structure) concerning the distribution system was accelerated.

The technical and organizational outcomes of the strategy were again presented at the IWA Water Loss Conference in Prague 2022. The present paper goes a step further and examines the costs and benefits from the Smart Meter-investment. *Does it pay off?* This is an important question to answer, as water utilities around the world increasingly are looking into the digital future with Smart Meter-Technology as a strategic backbone.

Smart Meter-data as the backbone for Digitalization

Installation of Smart Meters of different kinds at the consumers is rising. In Denmark the proportion of Smart Meters exceeds ¾ of all meters (DANVA 2023). However, the succeeding intelligent use of the meter-data is unfortunately often lacking behind. Many utilities find great comfort in the fact that the meter reading process has become almost effortless. They should be more ambitious. Smart metering *and* the strategic use of meter data may be considered as the most important link in the new digital value chain in the water industry. Furthermore, future government mandates and standards for the adoption of intelligent water meters will boost the outlook. Indeed, promoting and pushing forward new digital solutions based on Smart Meters should be a high priority for the top management of the utility.

Average water losses (Non-Revenue Water – NRW) in Danish water companies are on average around 8% (DANVA 2023). If the annual NRW exceeds 10%, it triggers an economic penalty from the national authorities. BWC has been one of the forerunners in Denmark with the full installation of Static (Smart) Meters. The complete roll-out was finalized 2015. The subsequent active use of the data for optimizing the network, reducing losses from new and old background leaks and hence obtaining better control of the distribution system has improved the WLM-performance of the company profoundly. At the same time the company has improved the costumer-experience while pushing out crucial information regarding leaks at the consumer-side of the meter. The Digitized Leak Management Strategy at BWC is on a large scale based on Smart Meter-Technology. Since 2019 the annual water loss at BWC has been oscillating around 5% (see figure 1) and in 2024 the future target was lowered to 4%.

Surely, acquiring assets as Static Meters and Fixed Networks etc. cost a lot of money. But, when also the benefits of the data-driven new benefits are added, the bottom line eventually could turn from red to black. The saying goes that “the gold is in the data” but without digging after the gold, many valuable opportunities will remain undiscovered.

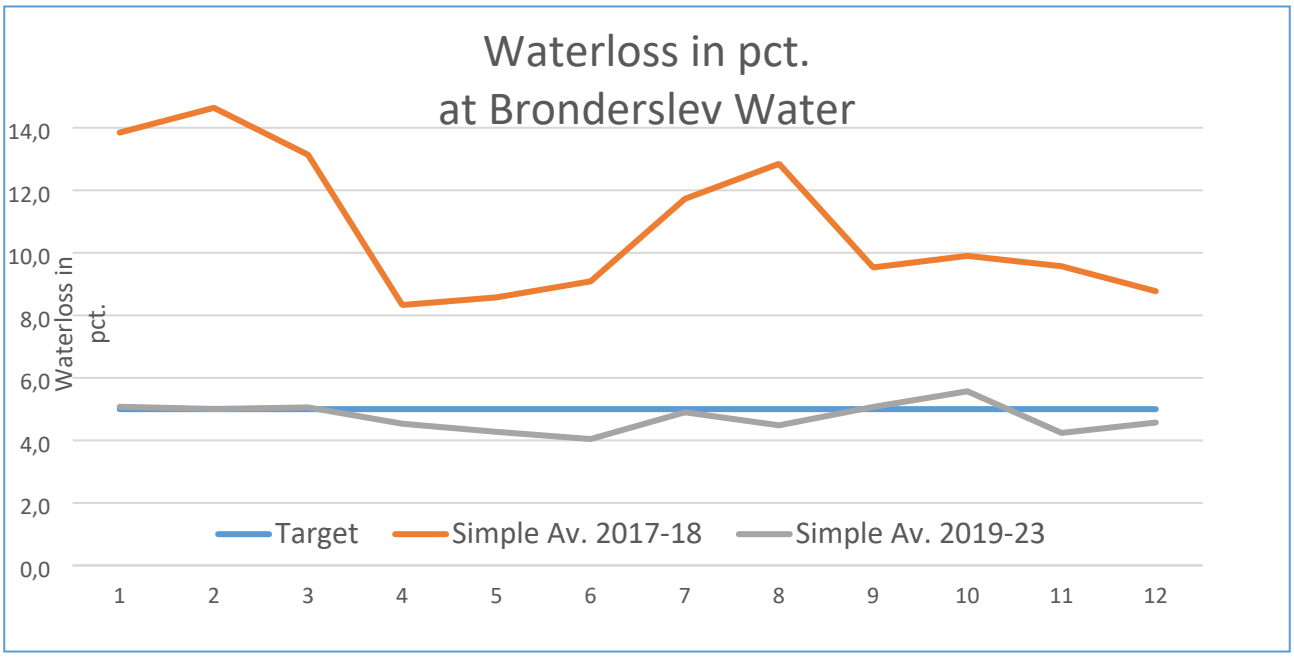

Figure 1: Water losses per month at Bronderslev Water Company before and after the implementation of the data-driven leakage management. The figure shows the water losses in two periods before and after start of the WLM-system: 2017-19 versus 2020-23. Losses are defined as differences between water flow from waterworks and billed water. The Target for 2024 is lowered to 4 pct. NRW.

The Water Leakage Management System

What have BWC done to be able to deploy and benefit from the new data-driven management approach?:

1 At first, 6.500 Static Smart Meters are installed in the entire distribution system at every household.

2 A Data collection system with fixed antennas and extenders secures hourly meter readings from min. 98% of installations.

3 The entire water distribution network is subdivided into 22 unique and well-defined DMA's, see figure 2.

4 Each DMA is equipped with an online inlet Bulk Meter.

5 The pipe recording database and the DMA's are digitized.

Efforts to minimize water losses were intensified due to unacceptable levels of water losses in the period from 2017 to 2019. Since 2022, a new fully integrated digitized WLM-management platform continuously monitors the current leakage situation at the DMA-level. New anomalies in the water distributions system (e.g. new upcoming leaks) are noticed from day to day, and the team can react accordingly. The online GIS-based application combines the household meter-data with DMA Inlet-data from the SCADA-system 24/7/365. From 2023 the new platform has been in full operation after final calibration.

The outcome of the WLM-strategy and the data-driven solutions – the benefits – are:

1. Company gets lower OPEX and improved Asset Management through rapid identification of new leakages, reducing unsustainable losses in terms of water, machine time, energy, downtime, repair costs.

2. Besides recognizing new leaks quickly and much more easily the use of the WLM-system makes it possible - step by step to - identify, localize and repair many old sources of hidden *background leaks*. That may be small - but infuriating - leaks that have been running for even years. Obviously, over time the sum of many minor background leaks is becoming expensive. And every water distribution system all over the world has a lot of such small hard-to-identify background leaks. A daily loss of 24 m^3 running for e.g. 180 days could cost BWC approx. 2.000 €. Due to the data driven approach, BWC

has for example eliminated four such small sized background leaks during 2023 and 2024 saving the company for approx. 8.-10.000 € if we only count for a 180-day leaking period. Hence comes the future savings because these background leaks are now eliminated.

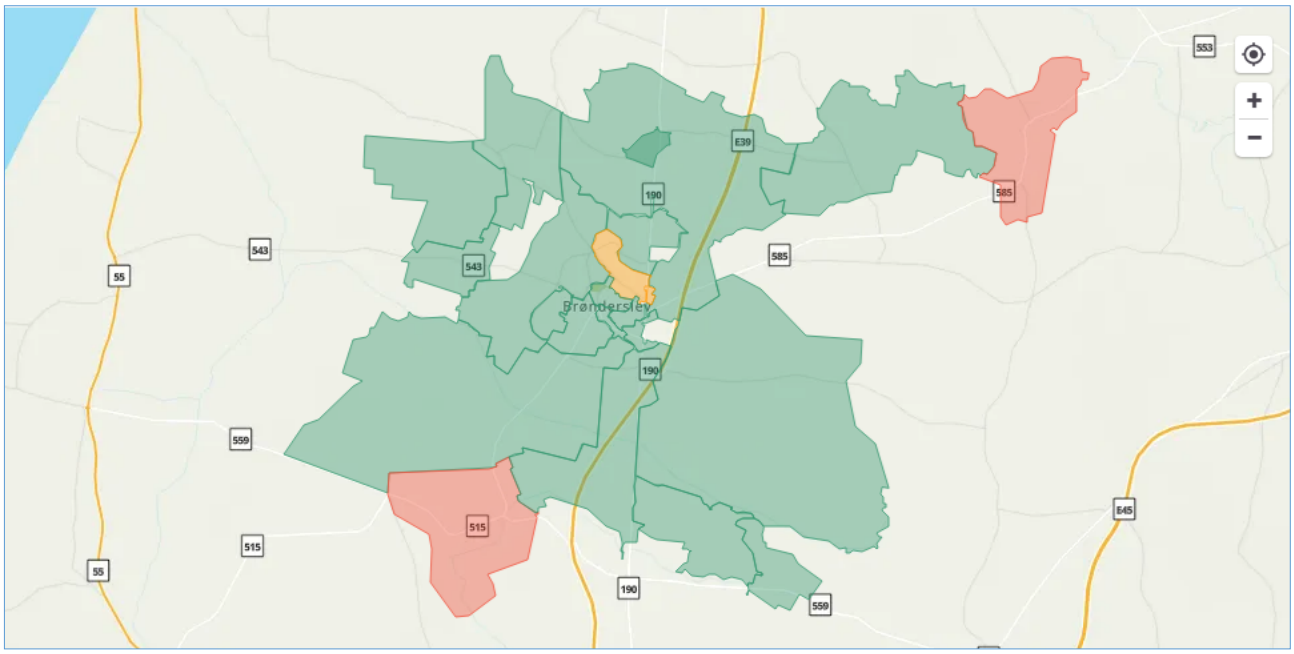

Figure 2: The WLM-Management Platform keeps track on the water losses 24 hour a day in all 22 individual DMAs.

3. Company revenues can be increased. Firstly, most companies can raise the annual fixed-price paid by the consumer for having installed a Smart Meter because of the (new) benefits the costumers will experience (e.g. instant leak-warnings). Secondly, utilities - in countries like e.g. Denmark - will in some cases even be able to reclaim back the revenues from water lost in the household-connection pipe *after* the connection valve because the loss can be documented through data-analysis in the WLM-platform before and after the private pipe is fixed.
4. Customers face less severe breakdowns in the distribution system and obtain quicker repair also of leaks in their own domestic installations. On top, costs for water losses, repair and insurance costs for covering ruined floors and spoiled household effects etc. are diminished and customer satisfaction increases.
5. Community gains as new leaks are more rapidly identified leading to diminished complications on infrastructure and reduction of external costs for repairing streets, boardwalks, pipes etc.; traffic is bothered less. Water consumption is diminished, and natural water resources saved.

The new WLM-strategy combined with new organizational procedures has resulted in a significant and permanent reduction of the water losses. The permanent reduction is on average at 5 pct.-point which corresponds to an improvement from an annual NRW-average at 9-10 pct. in the period 2017-2018 to a new average at 4-5 pct. in the three years from 2019 to 2023 as shown in figure 1.

A generic for model for a business case

The total costs for setting up a fully digitized metering system with Smart Meters at all costumers and antennas or other kinds of technology for automized daily meter readings are indeed considerable.

Furthermore comes the costs for separating the complete distribution network into many unique District Metered Zones (DMAs) and equip these with online bulk meters at the inlet. However, at many water utilities

this DMA-set up may have - if at all possible - been done already at full scale or partly for supply-security reasons and for improving water age and pressure conditions.

In the following we shall examine a "3-step" generic model for a describing the business case for the investment in Smart Meters. The Business Case is based partly on the findings at BWC and partly on genuine data from an offer from a meter-supplier for a Smart Meter-solution (statis meters) tendered by another Danish water utility in 2023. In this case study we presume that the DMA-division is already in place and that every DMA has its own bulk meter at the inlet being online with the SCADA-system. See Annex 1 for more details.

Disclaimer: These estimates will of course differ from utility to utility. But the calculation underscores the fact that the utilities (read: the top management) really should be ambitious and focus heavily on pursuing the many valuable data-driven opportunities from the pool of data.

In this case the total investment in the "medium scenario" in Annex 1 is totaling 1.540.000 € for a utility with 7.500 meters and an annual sale of 1.5 million m³. But, since the water utility under all circumstances must replace the water meters in an ordinary replacement schedule, we reduce the total investment to 1.240.000 €. This corresponds to a 40 € reduction of the cost price for each meter [1)].

Step 1. At a first glance the bottom-line 1 in the business case in table 1 is red, as the annual costs exceed the annual savings. The annual money loss is estimated to 40.000 €.

Step 2. When the utility enters the new era of data-driven leakages management with dedication and actively uses the data to obtain better overview over the losses at the DMA levels, then the next bottom-line 2 will turn into a more promising figure. In this situation the bottom-line is reduced to - 10.000 € per year.

Step 3. In addition, a new business opportunity arises for the water company with the Smart Meters: It is possible to raise the fixed element of the costumers' water-bill by adding – in this case let's say – just 6 € to the annual bill[2]. This addendum to the bill is justified by the fact that the consumers due to the new meters will be facing new opportunities to discover leaks at the household installations 24 hour after the leaks start to run. An alarm could be prompted from App alerts or from automized SMS/text-warnings. In this case it will raise the following bottom-line 3 revenue to a positive figure at 35.000 € per year.

Table 1: A generic three step model for a business case for Smart Meters

See more details in Annex 1.

	EUR
Annual costs (depreciations, interests, software, hosting, support etc.)	145.000
Annual savings and benefits (Administrative reliefs, better technical performance, improved control, new staff competencies etc.)	105.000
Bottom-line 1	- **40.000**
Estimated annual Savings from data-driven leakage management (lowered annual water losses)	30.000
Bottom-line 2	- **10.000**
Estimated new company income from adding a new fixed annual "Smart Meter-fee" (here: 6 € per meter)	**45.000**
Bottom-line 3	**35.000**

[1] A new premium quality smart static meter costs today (2024) approx. 90 €; A new, reliable mechanical meter approx. 40 €).

[2] In many countries the water bill has two components: A fixed annual "meter rent-fee" and a variable fee depending on the amount of metered water in m³.

But it doesn't stop here. The business case can be improved further.

- First, there is an extra possible financial bonus that can be derived from the Smart Meter set up: In some circumstances it is possible to reclaim costs from specific NRW-losses from a costumer when the utility can prove that at leakage at the private part of the connection pipe after the valve (i.e. the interface between the company owned and the private pipes) has caused this leak.[3]
- Second, there are some noteworthy extra Smart Meter-benefits at the consumer-side. Instant alerts from App-services or automatized text-messages can be pushed to the consumer as soon as the household meter detects an internal leak. This will save them for otherwise severe upcoming damages such as ruined floors, furniture and other inventory and the inhabitants can avoid mold that is hazardous to health. Eventually the insurance bill can be lowered.[4]
- Instant alerts and rapid fixing of a leaks inside the house will also directly save the costumer for the costs of the saved water lost. And if the water meter-reading at the same time – as in Denmark - is used also to bill for the discharge of sewage water this combined bill will be 5-fold higher.

Additional info: In the first quarter of 2024 the meter-department has warned 235 unique costumers about in-house problems:

- 160 costumers had leaks with a flow between 5 and 30 liters/hour.
- 25 costumers had a leak-flow between 30 and 100 l/h.
- 20 costumers had leaks between 100 and 500 l/h.
- 12 costumers were above 500 l/h.
- 18 customers were warned because frozen water had ruined the meter.

As a supplementary step 4, in the Annex 1 we use these benefits to calculate an additional bottom-line 4, even though we hereby enlarge the scope of the business case a little.

Conclusion

Smart Meters and the active use of the new data-pools in data-driven management solutions must be considered as an inevitable part of a modern water company. The new technology brings more clarity and organizational control over the complete water distribution, especially when the DMA's are already in place. The active use of the data enables the staff to react focused and without long delays when new anomalies like leakages appear in the distribution net. Costs can be saved, and new services can be introduced. Besides that, the many benefits from the new meters will encourage new innovational thinking among the staff and act as a stimulus accelerating the pathway to the digital future. Exploitation of the full potential of the Smart Meters *and* the data may turn out to be the most important next step for the digital water utility to be.

To sum up: ***It is probable that many utilities around the world will be able to produce a satisfying economical bottom-line of the smart meter-investments if the management strives for the data-driven opportunities.*** The companies should *not just read meters but create value*. On the following pages we give some examples of the use of the WLM-system at BWC.

[3] At least this possibility is in place in Denmark. At BWC we have – with success – reclaimed such water spills more times in the recent years because we could prove the spills from the data.

[4] During a year BWC on average warns 800-1.000 costumers that they have an internal leak in the house installation. It could be a leaking pipe under the floor or an unnoticed running toilet – but the costumer can react quickly. Statistics from the Ass. of Danish Insurance Companies tells, that the average compensation-payout for water damages in households equalled 3.100 € in 2022. For Bronderslev Water-district the statistics can be translated into 175 insurance-damages per year out of 6.5000 installations totalling approx. 550.000 € per year (4 mio. DKK).

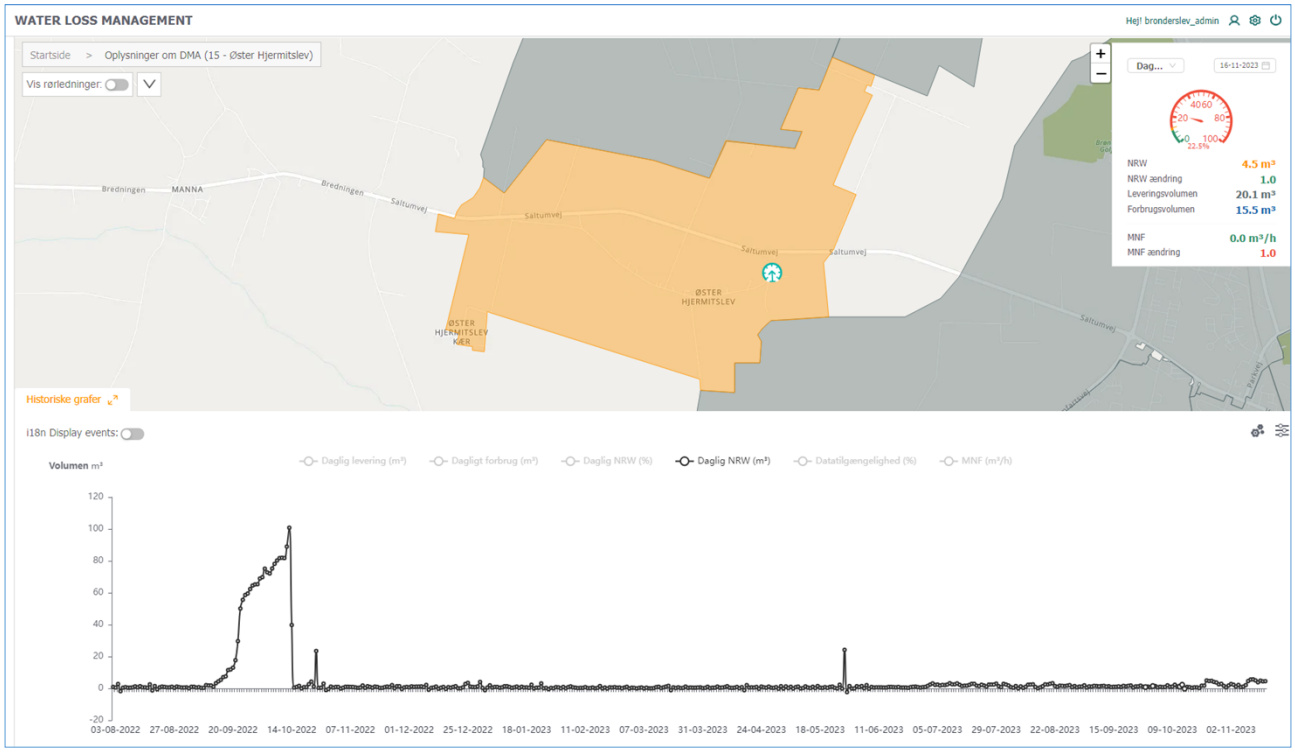

Figure 3: The figure shows how a sudden rise in the NRW in a specific DMA is highly visible in the WLM system - and that it was quickly found and repaired.

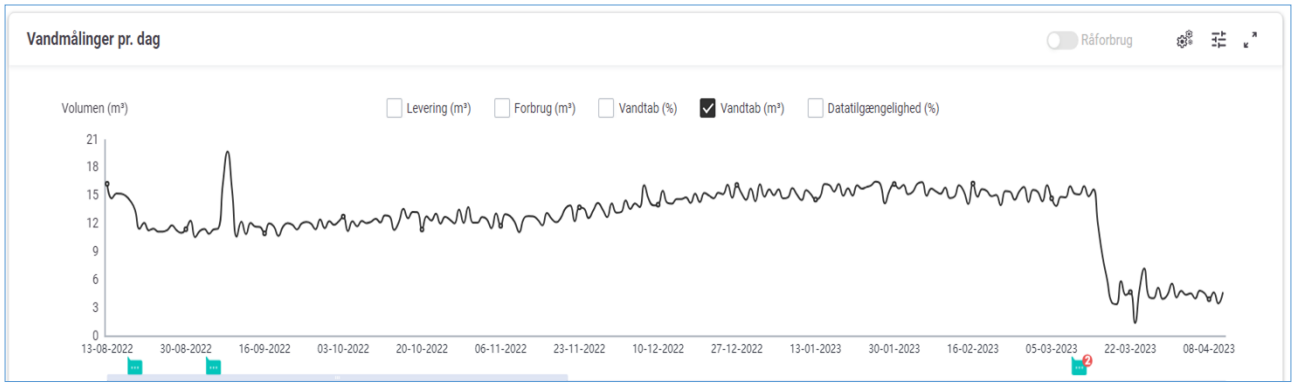

Figure 4: In mid-2022 BWC took over a small local water distribution system. At the same time BWC "inherited" an old background leakage with a loss of 10 m³ / day running for at least 7 months = min. 2.200 m³ lost. Finally, in March 2023 the leakage was found and stopped. Because the leakage was placed at the privately owned part of the service connection it was possible for BWC to reclaim almost 5.000 € from the private consumer (a small company).

Figure 5: A local Supermarket gets mid-January a leak in the internal system. They receive a warning from BWC, and they fix the problem effectively two weeks later.

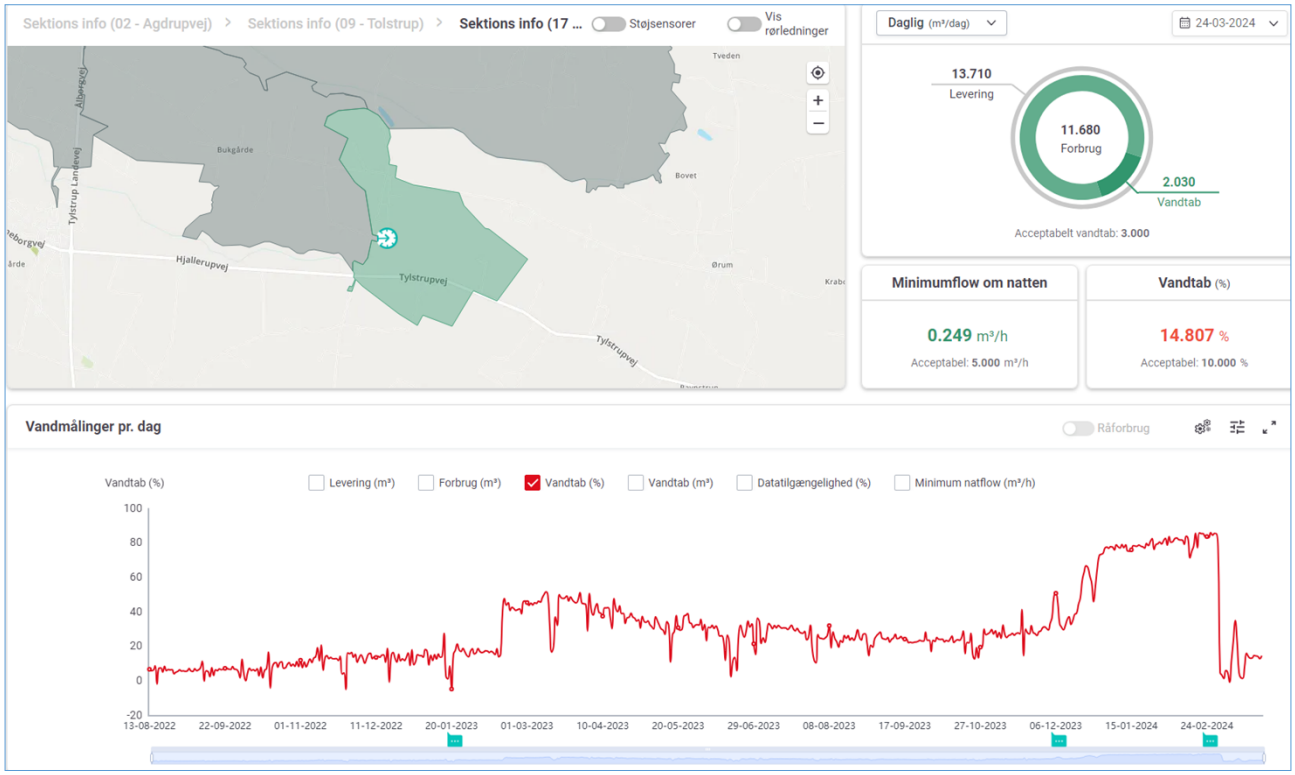

Figure 6: From mid-2022 to the start of 2023 the water loss-pct. in this particular but rather small section rose from 6-7 pct. to 10-15 pct. Suddenly, mid-January 2023 the leakage rose to 30-40 pct. At the start of 2024 it further rose to 60-80 pct. corresponding to 50-60 m³/day. At the end of February, the problem was finally fixed. The leakage was located in an agricultural area with bad digital historical pipe-recording and was not easy to find.

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Annex 1

Smart Meters - A simplified Business Case based on a Tender at a Danish utility
2023 and experiences from Bronderslev Water Company (BWC) having Static Meters installed since 2014.

Basic info from 2023-tender:
7.500 smart meters (premium quality)
Radio Technology: MIOTY for meterering
Estimated lifetime for static meters: 15 years
1.500.000 m³ water produced per year
OBS: It is assumed that the Water Distribution Network is divided into many DMA's (or divison is in progress)

	EUR	Remarks
Total Investment costs		
Total investment in smart meter-solution versus tradional meters	715.000	Figures from tender. The more meters you but, the cheaper.
40 € - Reduction in investments due to ordinary replacement-plan	-300.000	The utility has to replace old meters anyway (one new smart meter in good quality = approx 90 EUR; a new,
Installation and costs for interim call center, antennas/radiotechnology, project costs etc. during installation period	750.000	Figures from tender, rounded up
+ 10 % for unexp. Installations costs, internal hours etc.	75.000	Unforeseen costs (buffer)
Total investment	**1.240.000**	

SIMPLIFIED BUSINESS CASE:	**Low**	**Median calculation**	**High**	
Annual costs				
Depreciation of new assets (15 years)		-85.000		
Average Interests per year (4%)		-45.000		
Software, hosting, support from supplier		-15.000		
	-145.000	-145.000	-145.000	
Savings and benefits - 1: The basics				
More easy meterreadings, billing-process and costumer-dialoque etc. (administrative reliefs)		25.000		Estimate based on experiences from BWC
More easy/Diminished tehcnical support to costumers		55.000		Reduced staff in meter dept. Based on experiences from BWC
Better control of network, improved use of man-hours		25.000		Estimate based on experiences from BWC
	75.000	105.000	125.000	
BOTTOM-LINE 1:	**-70.000**	**-40.000**	**-20.000**	
Savings and benefits - 2: Includes obtained data-driven benefits				
Active Water Loss Management within DMAs = reduced water losses. 1 m³ lost water in pipe network: **0.4** EUR in production price (median = 1.500.000*0,4*0,05)	25.000	30.000	75.000	*Assumed (median calc.):* - That water losses can be brought down with 5 percent points in 5 years through the active use of data. Some utilities can reduce much more. - That the network is divided into (many) uniques DMAs
BOTTOM-LINE 2:	**-45.000**	**-10.000**	**55.000**	
Savings and benefits - 3: Optional business opportunity:				
Charge consumers for an extra annual fixed meter-fee, e.g. **6** EUR/meter (median calc. = 7.500*6)	30.000	45.000	75.000	Ranges from 4, over **6**, to 10 € additional fee (low-median-high)
BOTTOM-LINE 3:	**-15.000**	**35.000**	**130.000**	
Savings and benefits - 4: Includes benefits for the households				
Household savings (instant sms- or APP warning to households when internal leaks appears, less broken inventory, insurance savings etc.)	40.000	50.000	100.000	Experience-based min. savings from Bronderslev. If the water meter-reading is used also to bill for the discharge of sewage water - as in DK - the figure is 5-fold higher *).
BOTTOM-LINE 4 (an additional scope):	**25.000**	**85.000**	**230.000**	

*): Bonus Info: The average compensation for water damages in households from the Danish Insurance Companies from hidden pipes and connection pipes equalled approx. 3.100 € in 2022. (Source: Forsikring og Pension, www.fogp.dk)

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