IMPLEMENTING SMART WATER METERING AT THE GERMAN WATER COMPANY JURAGRUPPE

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ABSTRACT

The Juragruppe supplies around 24,000 inhabitants with drinking water within an area stretching over 80 km and with over 7,000 connections. The company undertakes installation, maintenance, meter readings and the rectification of most damage scenarios.

The Juragruppe water association, based in Southern Germany, has chosen ultrasonic water meters which can be read wirelessly.

Purpose: To increase efficiency, reach a higher level of customer satisfaction, simplification of administrative work and to detect any water loss more quickly.

This paper outlines the significant differences between the costly and labour-intensive method of reading the meters in the past and the new installation of remotely readable meters as a "Mobile Drive By" solution in combination with stationary data concentrators as an Automatic Meter Reading ("AMR") installation.

It also describes the operational process, by reading the meters from a car using Google maps with visual and acoustical confirmation for the driver on a standard Android smart phone, the data transmission to a fixed installed data concentrator, the cloud based connection to the central server and the administration of the collected data.

The paper describes the ultrasonic principle and the communication method of the water meters. It considers specific requirements for New Zealand and Australia regarding compliances as far as they are different from Europe. Finally, the paper identifies the Return On Investment aspects and other benefits for the Juragruppe water company and their customers.

KEYWORDS

Wireless Water Meters, Ultrasonic Water Meters, Wireless M-Bus Standard, Advanced Metering Infrastructure, Drive-By-Meter Reading. Automatic Meter Reading.

1 INTRODUCTION

The Juragruppe, with a staff of eleven employees, is a public corporation founded in 1978. The association has five communities in its membership. This is a typical structure for rural areas in Germany.

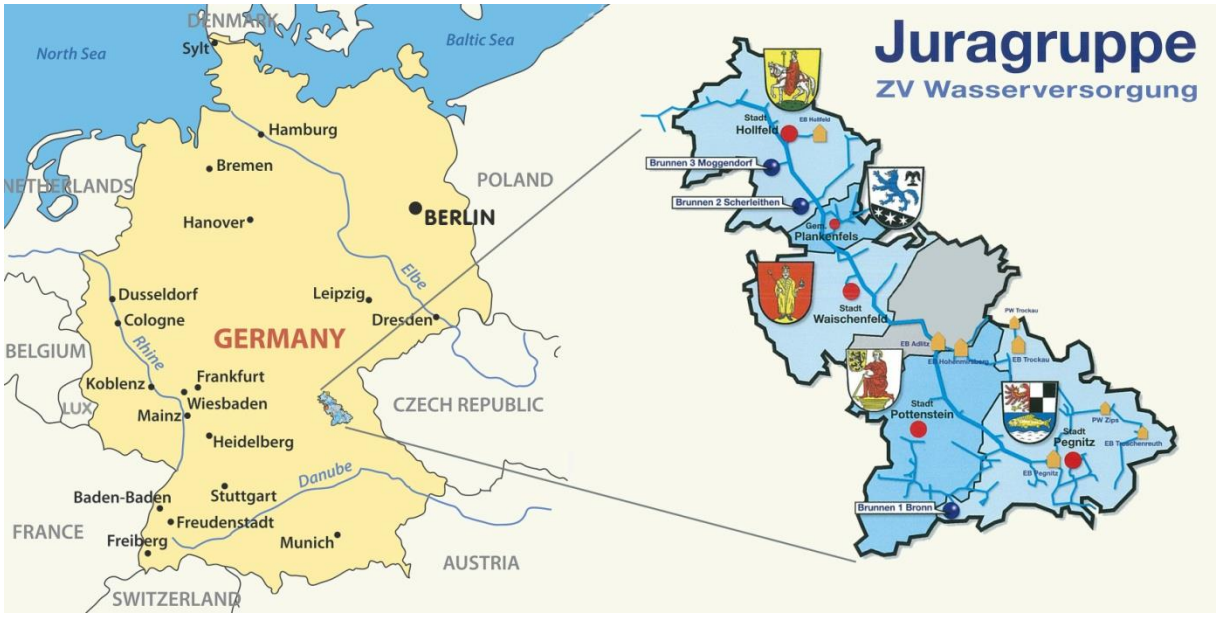

Figure 1 Location Juragruppe in Germany

The aim of the Juragruppe is to provide a quantitative and high-quality drinking water supply for all members of the association. The total investment since 1982 amounts to more than 60 million Euros.

The overall length of the supply network today is approximately 186 km (without residential service lines). This includes 10 construction and soil containers, 39 water delivery bays and approximately 850 hydrants.

The estimated 23,500 residents, with more than 7000 house connections, are supplied with drinking water. The annual consumption is about 1.2 million cubic meters.

Figure 2 Juragruppe staff and supply area

The Juragruppe extracts 100% natural protected groundwater from underground aquifers. There is no water treatment in place. The drinking water contains no chemical additives and comes clean and fresh directly out of the deep wells in the protected local areas.

In 1995, Juragruppe introduced a SCADA system to monitor and control the main water supply grid (which is still in place).

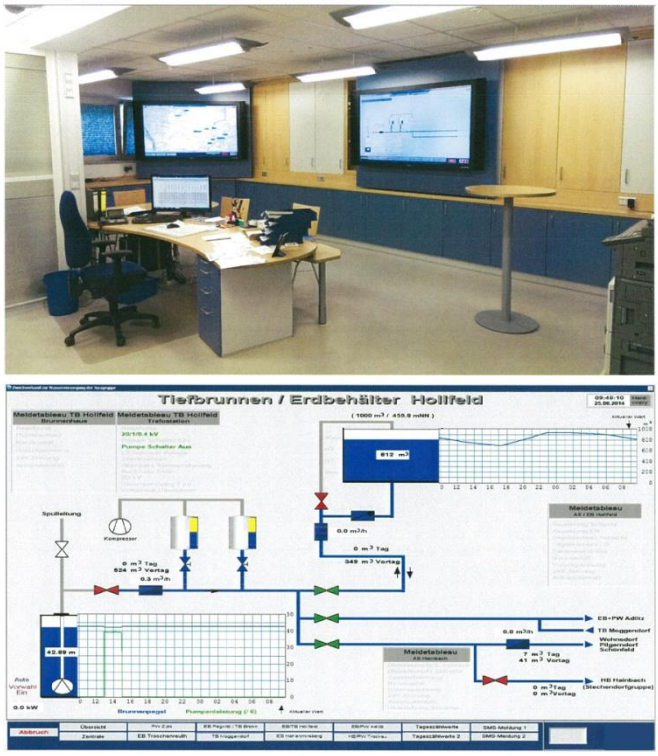

Figure 3 Central control room, deep well screen-shoot

In 2012, Juragruppe decided to change the old metering structure for their residential and commercial customers. The existing mechanical meters were replaced by wireless readable ultrasonic meters.

The new generation of meters makes it possible to minimise water loss by identifying leaks far quicker than with the old system. The remote system enables the Juragruppe to detect burst pipes via the meters in their delivery manholes. Previously, the detection of excess consumption of this nature would have meant a search in the area surrounding the manhole. The ability to read the daily consumption from the new meters enables Juragruppe to determine whether a leak has occurred somewhere on the mains network or within a residential or commercial property. This means enormous labour and water savings.

Figure 4 Wireless Water Meter

1.1 GENERAL ASPECTS

Extreme weather conditions, pollution or overpopulation – the causes of water stress are numerous and diverse; and the need for conservation of water globally attracts still more political attention. The situation becomes all the more critical as the water supply problem is interwoven with environmental, development and security issues.

And the problem cannot be said to be limited to economically undeveloped regions. High living standards seem to entail high water consumption, as is clearly illustrated by the fact that it takes 1,000-3,000 liters of water to produce just one kilogram of rice and 13,000 to 15,000 liters to produce one kilogram of grain-fed beef.[i]

Given the very different drivers such as water intensive agriculture, urbanization and tourism, practically no country will be left untouched by the water crisis. Even in less challenged areas in Mid- and Northern Europe or here in New Zealand, water costs for domestic use are now almost as much as household energy costs. Hence consumer awareness is growing, and people are demanding fair billing and a high degree of professionalism and efficiency from their water supplier.

1.1.1 PRICING WATER

The aggravating water crisis brings about an increasing political focus on water metering. *China has adopted a "one household one water meter" policy; and the European Commission has identified water tariffs and compulsory metering as one of the key challenges to move towards a water saving economy*.[ii]

Recognizing pricing as an efficient incentive for saving water, measuring water consumption on a household level is required. The number of water-meters worldwide is well over 900 million in 2010 and the number of households worldwide is close to 1.9 billion.[iii]

Approximately 80 million water meters are delivered annually, equaling a 6.6% growth rate predominantly driven by China.[iv]

Obviously, water metering is perceived to be an effective means of obtaining water efficiency information which is only natural when considering the water meter's important role as a cash register - a cash register that serves not only to secure the revenue of water suppliers and thereby the possibility of investing in water saving technologies, but also to visualise the water consumption in terms of capital. Pricing the water consumption correctly is a great opportunity for the water supplier to educate its consumers into being more “usage aware” customers.

1.1.2 AUTOMATIC METER READING (AMR)

There is a growing need for automatic reading of water meters as a rationalisation of an otherwise expensive and bothersome part of managing a water utility. In addition, AMR allows the water utility to control the frequency of the meter reads and conveys a fuller overview of the consumption pattern.

Electronic water meters have a variety of capabilities in terms of automatic meter reading, be it integration into a radio mesh network or wireless reading by means of hand held devices or concentrators. Smart meters, concentrators and gateways form an Advanced Metering Infrastructure.

The different systems and the components of the entire system are described in more detail below.

2 ADVANCED WATER METERING INFRASTRUCTURE

In addition to the existing infrastructure (see Appendix A), which is controlled and monitored by a SCADA system, a wireless water metering system was implemented.

2.1 SYSTEM COMPONENTS

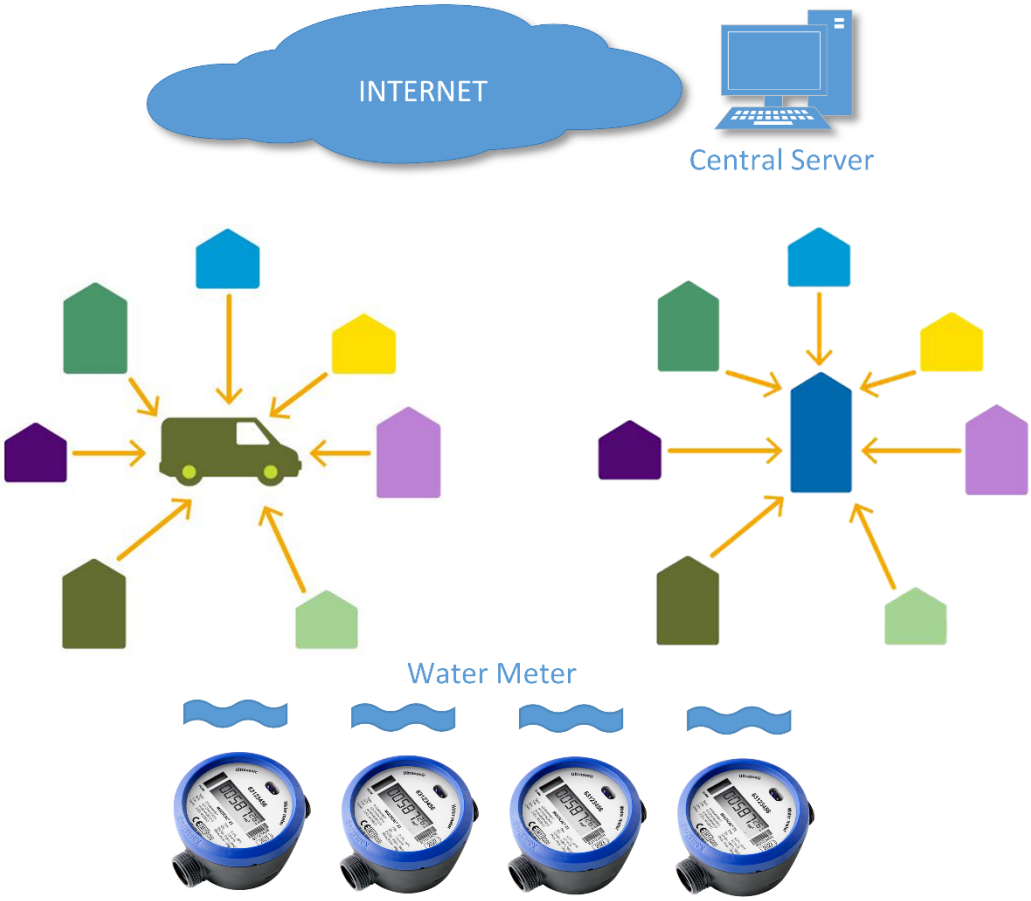

Figure 5 System Overview "Drive-By" and AMR

The wireless metering system consists of different layers with the following components:

1. Central server, application and database with a secured internet communication.
2. "Drive By" reading system with a mobile phone application and/or AMR with concentrators and high gain antennas (aerials).
3. Wireless ultrasonic water meters for residential or commercial consumers.

The main difference between the "Drive By" and the AMR system are the reading cycles. The AMR can provide constantly relevant data and events. It is a fixed installation and reads the water meters at a distance of up to 10km.

The "Drive By" data is only available if somebody physically collects the data and events by driving through the community where the meters are installed.

Both methods can work independently or together as a combined solution. The best solution will depend on the location of the metering devices and the frequency of readings which are required.

2.1.1 CENTRAL SERVER

The software and hardware are installed in Juragruppe's main office building. The metering application and the database are installed on a dedicated server. The staff PCs communicate over the local area network (LAN). The central server receives the metering data over the internet and provides the data to the billing system and service department.

Juragruppe decided to maintain the central server for metering in-house. However, another possibility would be to use the application as a "Hosted" or "Cloud-Based Solution".

The decision to go in-house or outsourced depends on the existing infrastructure (i.e. backup, existing server structure) and the available IT skills and manpower.

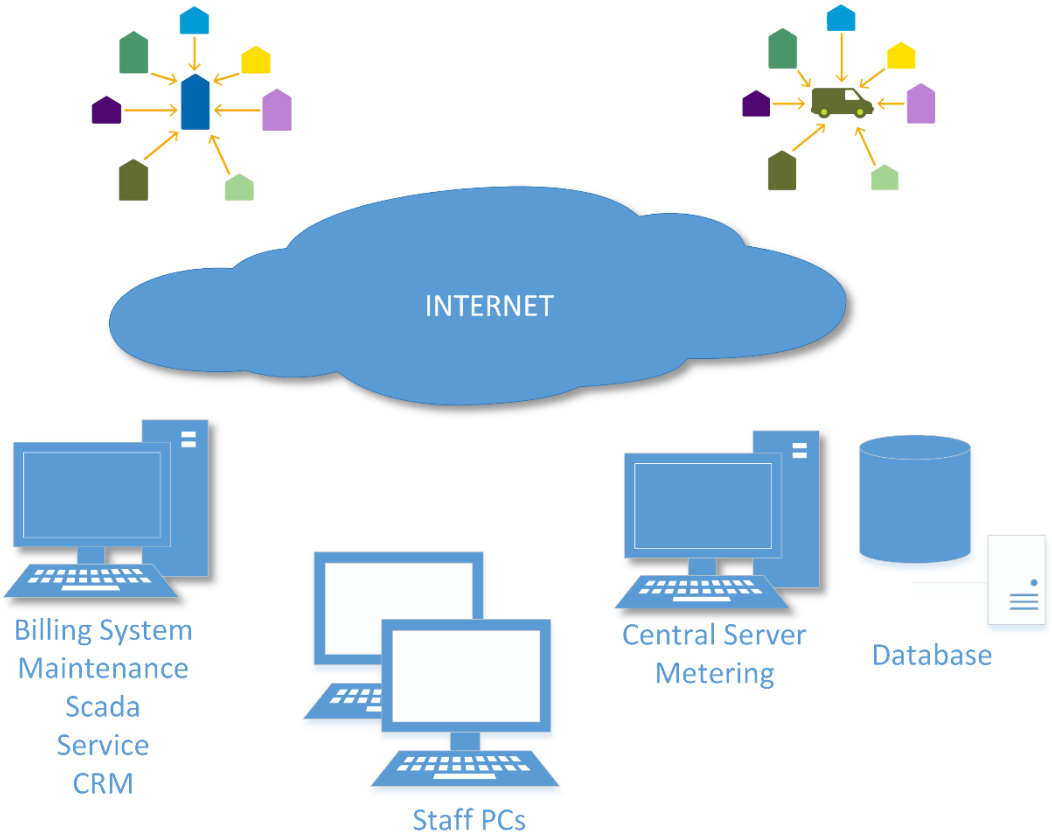

Figure 6 Central IT configuration

Larger installations are likely to benefit from an automated interface to a billing or ERP system (e.g. SAP) as well as the use of an existing database infrastructure like MS-SQL or Oracle.

All communication over the internet has to be encrypted and secured.

Juragruppe receives not only consumption data from the water meters, but also event data like leakage or burst. Even tamper attempts are detected. Juragruppe's service department receives this information and can quickly react to it.

The SCADA system receives the consumption data and uses this for the calculation of water losses.

2.1.2 METERING APPLICATION ON THE CENTRAL SERVER

Juragruppe has installed the metering application (Kamstrup READy Manager) on the central server. This provides all the necessary information to the operator and administrator. It also provides an automated export function to the billing system and a notification system for the service department.

1. Water-meters and the readings
2. Encryption keys for the meter reading
3. Customers with geo-position and meter-ID
4. Logger data
5. Events (Info-Codes)
6. Export
7. Basic configuration

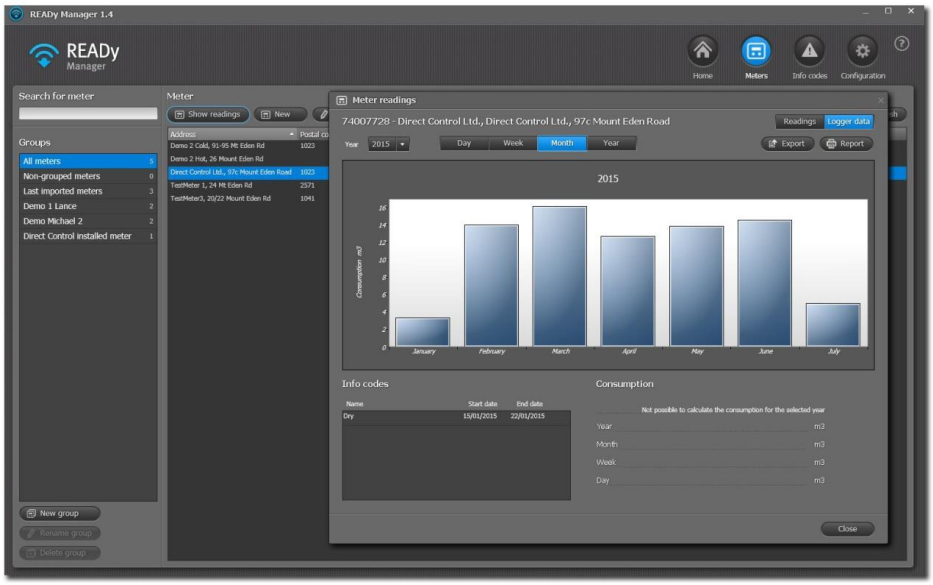

Figure 7 READy Manager "Log View"

The software READy Manager can be downloaded from Kamstrup's website. Kamstrup also provides a free trial package.

Each meter is created automatically in READy Manager via the enclosed meter file or online with the Kamstrup Encryption Server.

With the import function, master data and customer addresses can be imported and connected with meter numbers, thus making manual entry of addresses unnecessary.

The READy Manager has an export generator which ensures that individual formats are configured, and via the flexible user interface, data can be exported for many various purposes.

The metering application receives the signals from the mobile phone and the concentrators in the field. It provides the meter-data, encryption keys and the geo-positions for the mobile application.

2.1.3 DRIVE BY READING

Juragruppe has one vehicle equipped with a converter for wirelessly reading the M-Bus meters. The wireless M-Bus signal is transmitted by the water meters every 16 seconds (if they are configured for “Drive By”). The converter communicates over Bluetooth with an application on a mobile phone.

The driver “collects” the water meter readings, guided by Google Maps (see Figure 8). The red dots show individual water meters. The blue dot shows the position of the driver.

The red dots disappear as the driver’s phone receives the meter data.

The mobile phone transmits the collected data to the central server over a mobile connection and the internet.

Figure 8 “Drive By” configuration

The driver receives both optical and acoustical signals for each reading received. The corresponding red spot (representing each meter) will disappear from the display once read. The driver is alerted immediately of a leakage or tamper event.

The driver transmits the readings to the central server after he has finished a tour.

2.1.4 MOBILE APP

The mobile app reads the meters and provides information about the status of the installation. The driver can find a specific meter and can transmit the collected data to the central server.

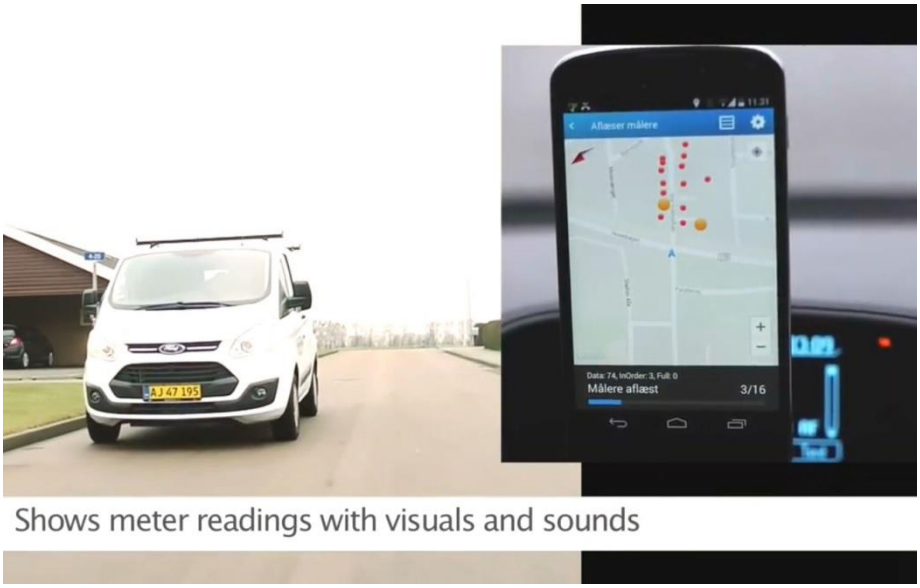

Figure 9"Drive-By" and mobile App

The system used by Juragruppe only requires standard Android phones which can also be used by the staff for normal communication.

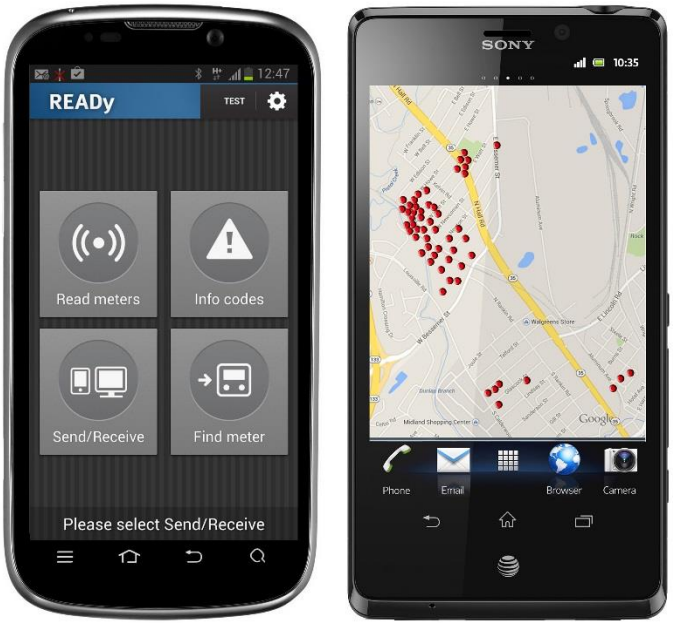

Figure 10 Mobile phones with App

Figure 10 shows an example of the "Drive By" system. Some of the water meters are widespread over the area and could not be easily read with an AMR system.

OPTICAL EYE

If an event is detected on the mobile app, the driver is able to physically check the meter and access more information via an “Optical Eye” directly out of the water-meter. This data is normally not transmitted over the wireless interface as it would cause too much traffic and would slow down the reading process.

The Optical Eye communicates to the water-meter over a standard infrared interface (IRDA). It connects to the mobile app via Bluetooth. This only has to be done only in a service case or if more information is required by the customer in case of a leak or dispute.

Figure 11 Mounting of the “Optical Eye”

The logged data is transferred first to the mobile app and then transmitted to the central server.

Figure 12 Log readings of the mobile App

2.1.5 AUTOMATIC METER READING (AMR)

Some locations of the Juragruppe network are covered by automatic meter reading, including some commercial consumers with larger water meters.

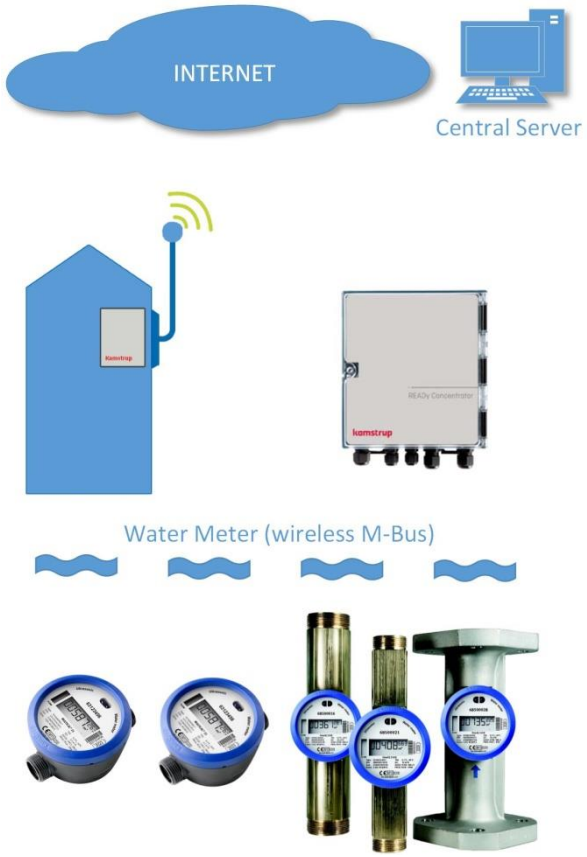

Figure 13 AMR "Automatic Meter Reading" configuration

One of the latest steps at Juragruppe has been the installation of an AMR system for a specific area with both residential and commercial water meters.

The AMR solution provides data and information every hour. A concentrator with a high gain antenna is receiving the data of the water-meter over a maximum distance of 10 kilometers.

Figure 14 AMR concentrator and antenna

This solution requires good reception, so an antenna has to be mounted in a high position. The concentrator needs an internet communication. This could be a DSL or mobile connection.

SETUP AND SYSTEM CHECK

The setup of the concentrator is monitored by installation tools. In the example below, all 287 water-meters show a reasonable signal quality.

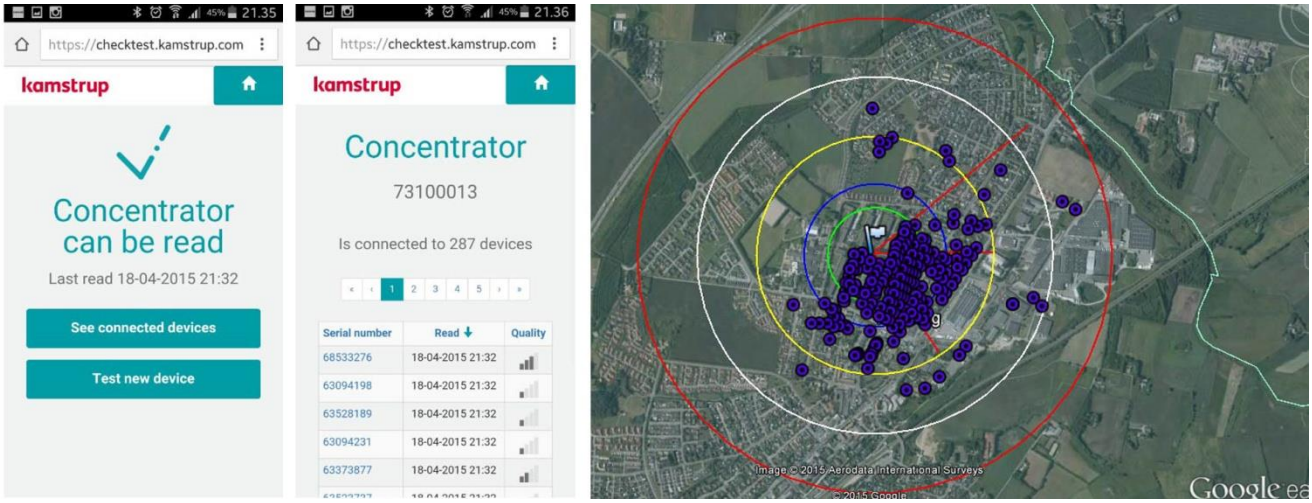

Figure 15 AMR coverage and system check

The utility staff can use a mobile application on their phone or tablet as an online tool to test the installation ("Check Test").

The concentrator collects the data from the water-meters and transmits it to the central server. The connections are monitored. The service department is notified in case of an event (i.e. loss of communication, leakage).

The AMR system provides more information than the "Drive By" solution. There are limitations for AMR applications especially wide spread water-meter installations, which cannot be covered by the concentrator.

Events (info codes) are registered much earlier by an AMR than by a drive-by solution, so that consequential loss from leakage, burst and reverse flow can be reduced by early detection.

Information about low temperatures is available to such a degree that it can be used to avoid frost damage.

Consumption information from individual water-meters is available online and can be used for end-user visualisation tools.

Consumption data from district-meters is collected online. Night-consumption patterns and trends can be analysed by the utility and used for effective localisation and limitation of leaks in the distribution network.

2.1.6 ULTRASONIC WATER-METERS

Juragruppe has an installation base of about 7000 ultrasonic water-meters, communicating over wireless M-Bus, for their residential and commercial customers.

Juragruppe selected the Danish company Kamstrup as their Smart Metering supplier.

Kamstrup offers intelligent water meters for residential and commercial applications. The water meters are approved by international standards (MID and OIML R49) and various national metrological standards in e.g. Australia, Brazil, South Africa and India.

The entire product portfolio offered by Kamstrup consists of electronic water meters that have no moving parts (static water meters). The main advantages and benefits are:

- Long term stability and accurate measuring – reliability in consumption and billing
- Built-in remote reading functionality – meter reading at any time desired and less labour costs
- Leak surveillance to quickly discover water waste – reduction of water waste and minimizing non-revenue water
- Information about tamper and operational failures – prevention of fraud and operational reliability
- Low start flow – ensuring precise billing of water consumption
- Long battery lifetime – no maintenance and low operational costs
- Eco-friendly material – high reusability and low environmental impact

With the objective of providing reliable information on water consumption and to proactively engage consumers in water conservation, smart water metering offers an array of possibilities.

The residential water meter has its place at the end of the distribution system from where regular trustworthy data is crucial for water pricing as well as for estimating renovation projects.

When applying smart technology in water meters they will not only serve as instruments for billing, but also as tools for trouble shooting, early warning, and analysis and for consumer oriented visualisation of consumption.

Three aspects of the smart water meter must be considered as equally important: the metering principle, the intelligent features and the communication method.

Figure 16 Kamstrup water meter family

METERING PRINCIPLE

The ultrasonic metering principle is a proven method of providing reliable and accurate water metering data.

The ultrasonic meter has no moving parts. Two ultrasonic transducers are used to send sound signals both against and with the flow. The ultrasonic signal traveling with the flow reaches the opposite transducer first. The time difference (ΔT) between the two signals can be converted into flow velocity and subsequently into volume.

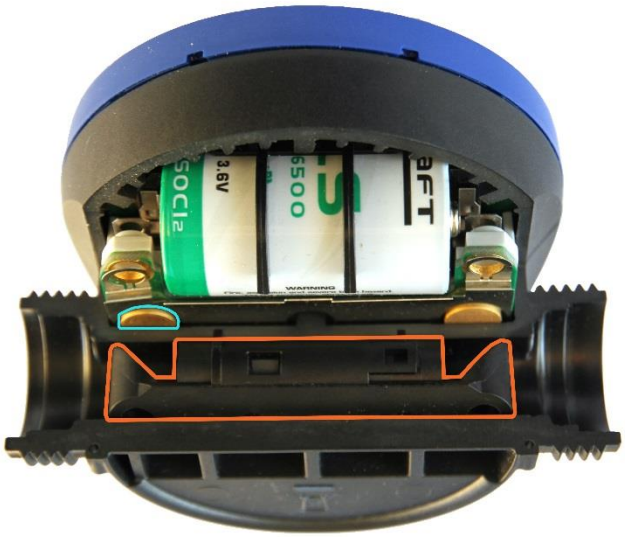

Figure 17 View of a meter for training purposes

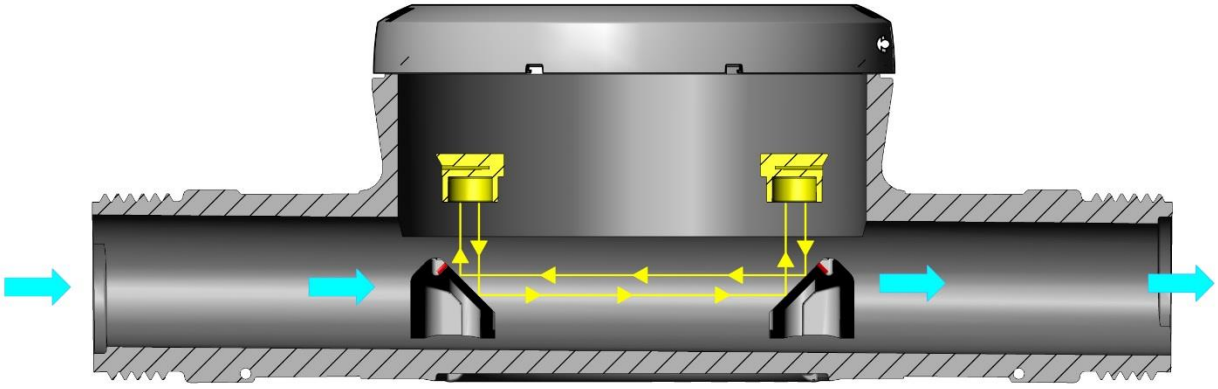

Figure 18 Ultrasonic metering principle

Traditional mechanical water meters differ in that they contain an impeller which is vulnerable to particles and chalk sediments. A possible consequence is that the meter will over time stop registering the very low flow rates that can be signs of leaks in the system.

PRECISION AND DURABILITY

The use of ultrasonic technology for measuring water consumption is particularly useful for measuring low flow rates. Capturing low flow rates is extremely important in order to accurately record household consumption. Meters that start counting at 15 or even 20 litres per hour will often not register a leaking toilet/tap. However, some ultrasonic water meters start measuring at a flow rate as low as 2 litres per hour so this usage can be captured.

Furthermore, the absence of mechanical parts in the ultrasonic water meter means there is no internal wear and tear: the meter can be mounted regardless of the pipe construction, and it is immune to impurities and sediments in the water to which traditional mechanical water meters are sensitive. As a consequence, ultrasonic meters have a significantly longer lifespan than mechanical meters.

FLOODABLE ENVIRONMENT

Water meters are often placed in moist environments. This has previously been an impediment to utilities, however electronic meters with IP68 protection are now being marketed. They endure immersion in water where the battery driven water meter will keep functioning for at least 16 years under rough conditions.

LEAK DETECTION

Small leakages are hard to detect and can easily develop into major leaks/ pipe bursts. Early detection of leaks can minimise/ prevent costly repairs and waste of water. Electronic water meters are programmable and can be set to provide an alert if during a 24 hour period they do not register at least one hour with zero flow thus indicating a possible leak in the system. Likewise they can be programmed to notify in case of a sudden excessive flow.

DIAGNOSING AND TROUBLE SHOOTING

An electronic water meter virtually serves as a surveillance instrument for optimising the distribution grid. There are water meters with comprehensive logging capacities enabling a detailed mapping of the consumption history.

PSEUDOMONAS AERUGINOSA BACTERIA

In August 2014, water meters installed in drinking water networks in Hamburg Germany, were found to contain Pseudomonas aeruginosa germs. German authorities had to recall tens of thousands of water meters.

The contamination of the water meter with Pseudomonas aeruginosa was not a one-off; it was subsequently found in water meters from various manufacturers in Germany.

It is likely that the contamination happened via the test water used in the production and/or testing or calibration of the water meters. There might also be a contamination during the storage and shipping process.

Juragruppe made sure that Kamstrup had the necessary preventions in place to avoid contamination, including:.

- Airtight sealed blister packing
- Regular purification (heating up to 70 degrees) of the testing water
- Permanent UV sterilisation of the testing water
- Robotic assembly line
- External laboratory tests of the test water on microorganisms and legionella

Figure 19Airtight sealed blister packing

WIRELESS M-BUS COMMUNICATION

The Kamstrup water-meters used by Juragruppe communicate over wireless M-Bus, which is based on the wired M-Bus according to a European standard (EN 13757-2 physical and link layer, EN 13757-3 application layer) for the remote reading of meters and sensors.[v]

Based on this M-Bus standard, the OMS group was formed. With the "OMS metering system specification" the OMS-Group has developed and open, vendor independent standard for communications interfaces and basic requirements.[vi]

The OMS primary communication interface is based on the Wireless M-Bus standard (EN 13757-4:2005) and specifies the communication between a multi-utility communication (MUC) controller or gateway, and electricity, gas, water and heat meters. The specification is becoming widely accepted in Europe as a basis for new advanced metering infrastructure (AMI) installations.

Wireless M-Bus Communication Modes

Mode	Communication	Description
S1	Unidirectional	In the Stationary mode, the metering devices send their data several times a day. In this mode, the data collector may save power as the metering devices send a wakeup signal before transmitting their data.
S2	Bidirectional	Bidirectional version of S1.
T1	Unidirectional	In the Frequent Transmit mode, the metering devices periodically send their data to collectors in range. The interval is configurable in terms of several seconds or minutes.
T2	Bidirectional	Bidirectional version of T1. The data collector may request dedicated data from the metering devices.
C1	Unidirectional	"Compact Mode" mode. This mode is similar to mode T but it allows for transmission of more data within the same energy budget and with the same duty cycle. It is suitable for walk-by and/or drive-by readout. The common reception of mode T and mode C frames with a single receiver is possible
C2	Bidirectional	Bidirectional version of C1. The data collector may request dedicated data from the metering devices.

Table 1 Communication modes wireless M-Bus

The Kamstrup water-meters used by Juragruppe are using C1 mode. In the “Drive-By” version a complete data telegram is transmitted every 16 seconds. This allows a car to drive at 20 km/h. The normal transmission power is 10 mW.

The meters are set up differently for an AMR installation. The transmission cycle is between 30 minutes and one hour. The transmission power is up to 20 mW.

Most of the wireless meters are using the C-1 mode to provide long lifetime of the battery. It is a de facto standard. Not all suppliers are compliant with the OMS standard, which can lead to integration problems with third party devices.

FREQUENCY SPECTRUM IN EUROPE, NEW ZEALAND AND AUSTRALIA

The standards in Germany are defined by the responsible federal office, the “Bundesnetzagentur”.

The Bundesnetzagentur discusses and coordinates radio technical parameters relevant to compatibility in cooperation with users, operators, manufacturers and other regulatory authorities in the context of international bodies (i.e. ITU-R, CEPT, ETSI).

They are reflected in

- *The Radio Regulations and Recommendations of the ITU-R,*
- *Reports, Recommendations and Decisions of CEPT ECC,*
- *Standards (i.e. ETSI),*
- *The Table of Frequency Allocations and the Frequency Usage Plan, and*
- *Frequency assignments.* [vii]

The installed water-meters have been approved by the German authorities.

A water-meter, like the ones Juragruppe are using, are per definition Short Range Devices (SRD) that offer a low risk of interference with other radio services, usually because their transmitted power, and hence their range, is low.

The definition 'Short Range Device' may be applied to many different types of wireless equipment, including various forms of metering equipment using wireless M-Bus infrastructures.

Figure 20 Assigned frequencies for SRD (Short Range Devices)

SRDs like smart meters in Europe are using the 868 MHz frequency. The maximal transmission power is not restricted like in NZ and is sufficient to provide a usable reading distance. Most of the water-meters in Germany are installed in the concrete basements of the houses.

RESTRICTIONS OF THE 868 MHZ FREQUENCY IN NZ/AUS

This 868 frequency band is not allowed in Australia and restricted to 2 mW transmission power in New Zealand.

This restriction does not allow the normal reading distance for wireless M-Bus.

It is illegal to operate SRDs like water-meter on 868 MHz with a transmission power above 2 mW!

The assigned frequency for New Zealand and Australia is 923 MHz.

A number of suppliers and distributors in NZ are offering solutions in the 868 frequency spectrum regardless of the existing restrictions. This might be because it is a new evolving market or it is due to an imprecise research of the situation.

There is also a very small gap in the 400 MHz band. It is not recommended to use this for SRDs because of the high usage of other organizations with overlapping frequencies and higher transmission allowance.

In New Zealand, electrical and electronic products on sale or in use must comply with Electromagnetic Compatibility (EMC) Standards. Radio products are required to meet radio standards and license conditions. In both cases, compliance documentation and labelling are required.

Figure 21 Assigned frequency and marks for SRDs

The Kamstrup water-meter family is compliant and approved by the Radio Spectrum Management (RSM), a unit of the Ministry of Business, Innovation and Employment (MBIE) and labeled with the necessary compliance marks. The meters are operating on 923 MHz, the assigned frequency for SRDs in NZ/AUS.

RADIOFREQUENCY EXPOSURE STANDARD

Juragruppe faced some questions regarding the introduction of smart radio based water meters. Issues around health and privacy factors were raised, particularly regarding smart power meters. However, Juragruppe informed their customers early about the changes and faced no major problems.

In Germany the Federal Office for Radiation Protection (BfS)[viii] has no concerns regarding wireless smart meters. As long they are compliant with the requirements of the responsible federal office “Bundesnetzagentur”

The statement of the New Zealand authorities is very similar to the German BfS:

You’re only exposed to low levels of radiofrequency radiation from a smart meter. Smart meters:

- Use a relatively low-power transmitter
- Are normally installed outside the building
- Only transmit periodically, using very brief signals.

Exposures to radiofrequency radiation from a smart meter are very low in comparison to the limits set out in the New Zealand radiofrequency exposure standard (even if the meter is installed inside the house).[ix]

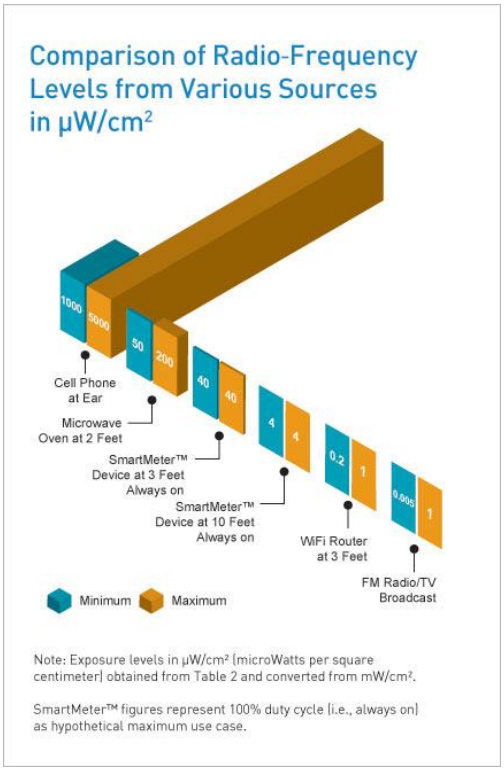

Figure 22 Comparison RF Levels

In January, 2011, the California Council on Science and Technology released a preliminary study entitled "Health Impacts of Radio Frequency from Smart Meters".

Wireless smart meters, when installed and properly maintained, result in much smaller levels of radio frequency (RF) exposure than many existing common household electronic devices, particularly cell phones and microwave ovens.[x]

PRIVACY AND SECURED COMMUNICATION

The water-meters installed by Juragruppe have to be compliant with the German and European regulations regarding the Renewable Energy Law (*Erneuerbare-Energien-Gesetz* (*EEG*), Smart Metering in Germany[xi]) and the *Common Criteria Protection Profile BSI-CC-PP-0077-V2-2015 of the Federal Office for Information Security (BSI)*[xii]

The *Open Metering System Specification BSI TR-03109*[xiii] specifies the communication and the encryption of OMS (Open Metering System) devices operating with wireless M-Bus.

According to these regulations, the wireless water meters installed at Juragruppe, had to fulfill the following criteria:

- Encrypted communication using a AES Key with 128 bit length
- Each meter has to use an own key (no general or site/customer keys allowed)
- The key management and distribution has to be secured ("Key Derivation Function")

The New Zealand standards are not as specific as the European regulations and we are basically regulated by the Privacy Commissioner's Office which develops and promotes a culture in which personal information is protected and respected. They state the following regarding smart-meters: *"They also need to have strong security standards to ensure information is transmitted safely online."*[xiv].

CHECKLIST WATER METERS

The following fact and check-list was used by Juragruppe during the selection process for the water meters.

Requirement	Advantage	Benefit
Ultrasonic technology	• Long term stability and accurate measuring • Highest measuring quality • No mechanical parts	• Reliability in consumption and billing • Maintenance-free • Low lifetime costs • Revenues
Vacuum sealing with IP68 approval	• The electronics are 100 % protected against penetration of water • The meter can be installed in basements, bathrooms and meter pits	• Flexible mounting • Longevity with no need for after-sales service
Built-in wireless M-Bus Europe = 868 MHz **NZ/AUS = 923 MHz**	• Remote reading • Drive By or AMR • EN5011 and EN4286 compliant • **AS/NZS CISPR11 and AS/NZ 4268 for NZ/AUS**	• Safe reading with encryption for export to billing packages • Reading at any time desired • Less labour costs
Open standardized radio with C-mode	• Long battery lifetime • Frequent transmission for walk-by/drive-by and AMR solutions • Short data packages	• Energy saving • Flexible reading facilities • Safe communication • Positive user experience
Leak surveillance	• Warning system to quickly • discover water waste	• Reduction of both water • consumption and expenses
Info codes	• Inform about 5 operational failures: Tamper, dry, reverse, leak and burst	• Prevention of fraud • Avoiding water waste • Data safety and operational reliability
Optical IRDA interface	• Possible to read consumption data, detailed logged data. Read and change the configuration of the meter	• Large number of data available • Possible to analyze the consumption during a specific period
Installation	• The meter can be installed • both horizontally and vertically • independent of piping and • installation conditions	• Flexible installation • Same meter for different installations, and thereby cost saving
Extensions	• Can meet existing standards • Free choice between Q_3 2.5 and 4.0 m_3/h independent of meter length	• The extensions make the meter fit into existing installations • Only one meter length needed in stock • Competitive installations
Eco-friendly meter	• High reusability and low environmental impact according to Carbon Footprint* • PPS material is free from lead and other heavy metals	• Safe recycling • Social and environmental responsibility

Table 2 Check list water meters

* Carbon Footprint is an environmental report which ensures that 80 % of the material can be recycled.

3 CONCLUSIONS

Residential smart water metering is acknowledged as an important means to manage water stress. The meters will play an essential role providing water utilities with a wealth of information, helping to reduce water losses, increase efficiency, ensuring correct bills are issued, providing a professional customer service and maintaining a robust distribution network.

Smart water meters are becoming increasingly competitive with traditional mechanical meters, particularly when considering the life cycle costs and the benefits gained from automatic meter reading and leak detection.

3.1 REDUCING WATER LOSSES

The heart of the installed water-meters is the ultrasonic measuring principle, which secures high accuracy throughout a long product life because the ultrasonic meter is without movable parts in the pipe.

Even a slight imprecision in the measuring method will add up to large amounts of water when multiplied over a large number of meters. Therefore, high accuracy of each water meter is essential for capturing the total water demand. The meter starts measuring at a water flow as low as 2 litres per hour, and the flow sensor is subjected to a thorough OIML R49 type-approval testing with the purpose of ensuring a long term, stable and reliable water meter.

It requires a measurement method with a high accuracy to determine the losses in a network. Juragruppe has an actual loss of 3%. The losses before the introduction of the new water meters were 12%.

3.2 COST-BENEFIT ANALYSIS

In assessing their options in metering technology, Juragruppe completed an in-depth cost-benefit analysis of mechanical versus static water meters. The costs for installation for either meter type are the same; the main difference in costs for the two metering types lies in the initial purchase cost versus recurring operating costs. Static smart meters have a higher initial cost, but the benefits of this advanced technology more than compensate for the initial cost because operational costs are significantly reduced.

Despite a higher initial price per water meter, Juragruppe saves money in the long run. The savings are primarily obtained through lower administration/labour costs, more accurate collection of data and earlier detection of leaks (minimising water losses), and longer lifetime of the static water meters compared to mechanical meters.

3.3 DRIVE-BY AND AUTOMATIC METER READING

The new static water meters are read via drive-by or online via a stationary concentrator; the utility does not have to rely on the consumer to properly read the meter or disturb them to obtain the consumption data. This means that when Juragruppe wants to obtain consumption information, they simply drive by the home and the meter information is automatically collected and transferred to the billing software. The meters read by the stationary concentrator are available permanently in a daily or hourly cycle if necessary.

The previous method of reading the meters was characterised as an enormously costly and labour-intensive process. Unfortunately, residents were often not at home, making it necessary for Juragruppe employees to make numerous attempts to read the meter. A trial which allowed the customers to submit their water consumption online or by post failed.

Following installation of the remotely readable meters, Juragruppe employees are able to quickly and efficiently read all the meters by driving past the premises or receive the data from the concentrators, because the consumption data is transmitted wirelessly. Not only does this save Juragruppe time but also significant costs.

This process also improves customer convenience, as they are no longer disturbed by meter readers.

By submitting consumption and operating data in high resolution and at frequent intervals, the new water meters will support Juragruppe in its digitalisation process.

In addition to obtaining consumption data in a timely manner, the data obtained is much more detailed than that previously available. Because information such as leaks, bursts, highest and lowest flow rates are also collected, Juragruppe can understand consumers' water usage habits and better prepare for future water demands.

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APPENDIX A

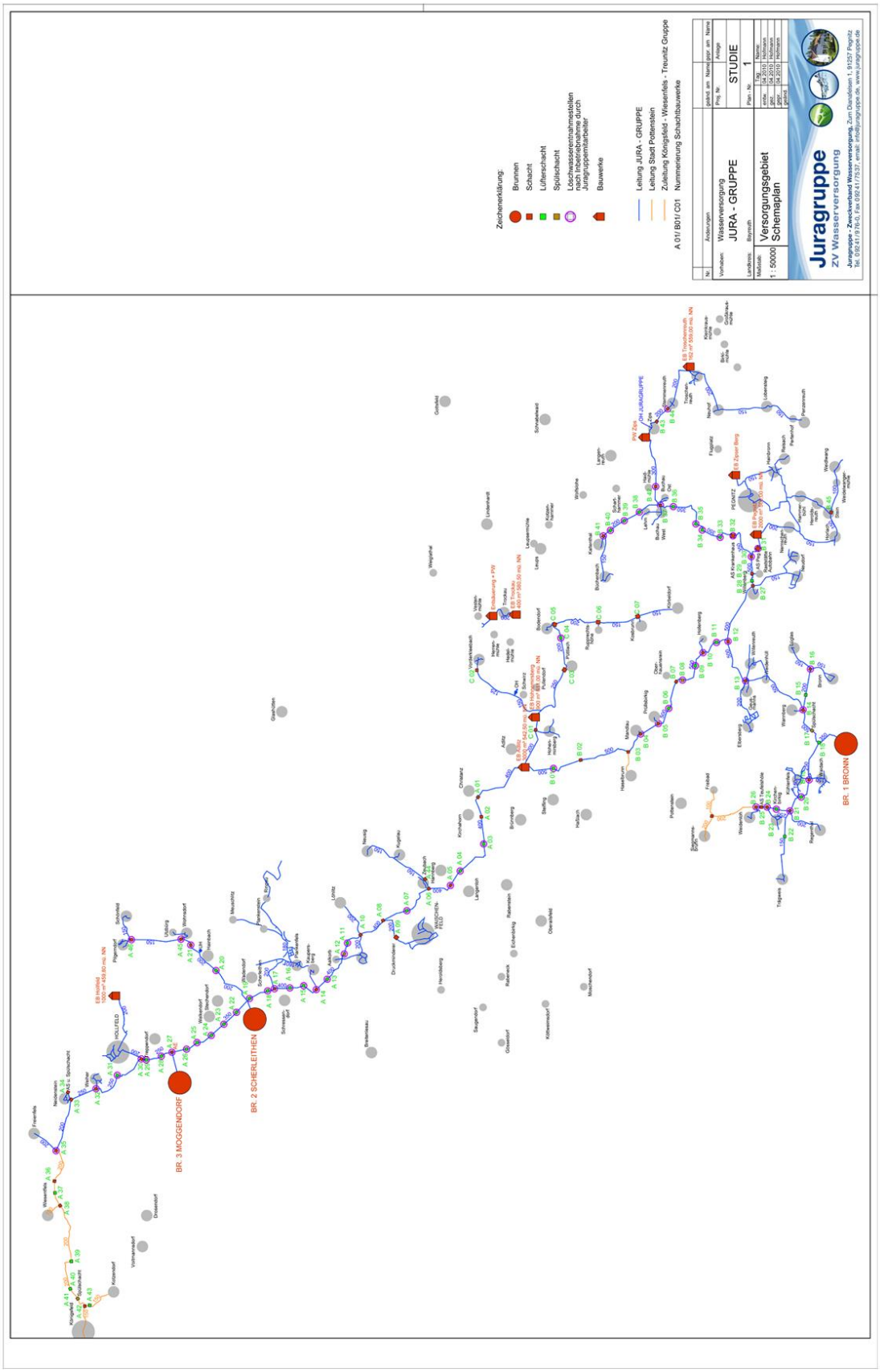

Figure 23 Juragruppe network

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