D1.2 Requirements from end-users

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Project Consortium

Executive Summary

During a period in which the European Union has taken a firm step towards the twin transition towards the establishment of both a green economy and a digital economy, the issue of digital water has never been so prominent. Therefore, it is necessary to correctly comprehend the needs of all sectors if funded projects are to prove of any use in the future growth of digitalisation within a sector, that of water, which in many cases is slow to adapt to changing circumstances and which is, in the opinion of the digital sector, a relatively small market from which to benefit. The purpose of F4W is to adapt the mechanisms of the FIWARE smart solution platform so that it constitutes a beneficial and progressive series of interoperable and standardised interfaces for water sector stakeholders and solution providers. To successfully address the requirements of all stakeholders, it has been deemed necessary within the scope of WP1 to investigate what systems have been or are currently employed by the water sector, what gaps are the water sector aware of and what is the sector's opinion concerning smart applications (a data-driven decision support system to decide future measures required at near-real time) as well as the experience which the sector has had to date with such technology.

Four separate deliverables have been created which seek to determine the specific needs of the partner water utilities of the four Demo Cases (D1.1), the opportunity for technical innovation (D1.3) reflecting input from private and public companies, universities and sensors providers and this document (D1.2) which reflects the perception, regarding smart solution platforms, of the water utility, the drinking water supplier, and those responsible for wastewater treatment, be they public, private or public-private. The results of all three deliverables feed a gap analysis and description of final requirements (D1.4) which in turn will provide essential input for the tasks of WPs 2, 3 and 4.

Based on desk research and the results of a questionnaire (undertaken in order to avoid the duplication of the findings of previous studies) the present document offers a background to the use of open source enabling technology in water management, defines the target group of the survey and then analyses the results of said survey that include how smart applications are currently employed in distinct facets of water management, the type of software currently in use and the demand from the target group for the smart applications which FIWARE4WATER is seeking to provide. The conclusions which are described in this document and which place an emphasis on the input received from the sixty-five participants from 16 different countries who completed the survey demonstrate among other aspects that there exists the need for collaboration between the elements which form the Water-Energy-Food-Ecosystem (WEFE) Nexus and yet from a digital perspective there exist only a limited number of smart applications designed for such a task. Furthermore, the problem is compounded by the fact that the water sector or at least an important number of utilities show no interest in establishing such links. This document also describes how the drinking water sector is, at an operational level, more advanced with regards to digitalisation along the length of the value chain (water demand, management and treatment) whilst wastewater operators, for obvious reasons, show a special interest in the digitalisation of treatment and energy optimisation. Arguably, the most important conclusion to be drawn from D1.2 is the need for water sector and the digital sector to definitively establish a permanent inter-sectoral dialogue in order to satisfy the demands of society as defined within the parameters of the *Twin Transition*.

Related Deliverables

D1.1: “Requirements from Use Cases”
D1.3: “Requirements for innovation”
D5.1: “A study of the perception of digital water and other related innovations and recommendations”

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Introduction

FIWARE4WATER is a project designed to enhance the development of open source enabling solutions in order to confront one of the most important challenges of the 21st Century: WATER. The fact is that the results of this activity will be vital. The World Bank (2019) has called for an improved system of open-source technology which permits a more transparent, secure analysis of current situations, which, when employing the immutable qualities of, for example, *Blockchain* provides greater credibility to available information, permits more effective managerial practices and if a close relationship is established between supplier and end-user, (See D5.1) can be essential in order to permit the consumer to take far better domestic decisions.

FIWARE4WATER will develop and adapt the smart solution platform *FIWARE* so that it is practicable, useful and beneficial to the water sector. The project seeks to serve all stakeholders and actors within the water supply chain, be they cities, water utilities, water authorities, solution providers and citizens. New interfaces and tools will be developed and tested in four demonstration sites in Athens (GR), Cannes (FR), Amsterdam (NL) and Great Torrington (UK). Third-party stakeholders will be engaged by the creation of specifically oriented networks, one of which will have as its target audience, water authorities and companies.

In order to ensure that the work of the consortium is correctly planned and relevant to the needs of the different target actors, the FIWARE4WATER consortium commenced its activities by investigating what systems have been or are currently employed by the water sector, what gaps are the water sector aware of and what is the sector's opinion concerning smart applications (a data-driven decision support system to decide future measures required at near-real time) and the experience which the sector has had to date with such technology.

With the aim of accessing this information, a questionnaire (See Annex A) was created so as to obtain further insight as to how best focus project activities regarding the future development of the open source enabling technology in water management. In return, the participants would be maintained fully informed of subsequent developments and invited at a later stage of the project to contribute further to the activities of the consortium.

The methodology employed was the aforementioned questionnaire placed on SURVEYMONKEY. Sixty-five participants from 16 different countries completed the survey, the results of which are presented in this document. After briefly describing the use of open source enabling technology in water management, the target groups for this particular study and the reasons why a questionnaire was employed, the results of the analysis are presented and conclusions are drawn. In coordination with the findings of D1.1 and D1.3, together with the recommendations that have been described in D5.1, this document seeks to permit FIWARE4WATER to be able to adapt its approach in a way, that the results of the initiative can be truly effective in the short, medium and long-term.

The target of this investigation was the utility, the supplier, be they public, private, public-private concerned with only drinking water, wastewater or both. Which type of utility supplies its clients varies according to the country, the region or the city in question. One of the principal challenges for this action is to be able to comprehend the determining circumstances of the different types of operators and provide not only truly relevant solutions for such stakeholders but also enable in the long-term a means for such entities to establish cross-border collaboration and experience exchange to the advantage of all concerned.

I. Background

I.1. The use of open source enabling technology in water management

The European Commission over the past ten years has demonstrated an almost bi-polar approach to the subject of water and ICT. Whilst much public funding has been dedicated to investigating the issue, different Directorate Generals (DGs) of the Commission, undoubtedly the most effective of the European institutions, have often pursued contradictory and counter-productive approaches supported by different units within the same administration. The Strategic Implementation Plan (SIP) of the European Innovation Partnership (EIP) for Smart Cities and Communities has consistently refused to acknowledge water and waste as essential components for the creation of future sustainable communities. The aforementioned document does not contemplate water or waste and yet the same DG, (in this case DG CONNECT) is also responsible for the creation of the ICT4WATER Forum which expresses an opposing ambition. The lack of scope that has been observed with regards to the EIP for Water was also interpreted by many observers as an indication that DG Environment itself did not give the digitalization of water or waste the priority status that it deserves, despite the same DG actively and passively supporting the notions of a circular economy.

The inter-departmental rivalries and contradictions have nevertheless failed to dampen an ever-increasing belief in the fact that the water and wastewater sectors must be digitalised. The International Water Association (IWA) defines the digitalisation of water as "*the employment of data, automation and artificial intelligence in order to extend natural water resources, reduce Non-Revenue Water (NRW), increase the life of infrastructures and provide financial security*." (Sarni et al. 2019). Digital water techniques can be applied at any point of the water life cycle. Within a specific geographical area of any particular natural water system, the relationships between the natural resource and the utility, the utility and the customer and the customer and the environment are all open to improvement thanks to the employment of digital water.

In the words of Fekri Hassan, "*The history of water management is nothing less than the history of humankind in its attempts to eke out a living and, whenever possible, satisfy its desires. For human beings water was not merely a substance that sustained life. It was, above all, an elemental ingredient in the way people conceived of the world and a principal component in the expression of their thoughts and emotions.*" (Hassan, 2011). The original Industrial Revolution signified the moment when water, transformed into steam, became the basis of mechanisation. The modern successor to the Industrial Revolution, named by the Germans, *Industry 4.0* contains essential elements for the management of water such as artificial intelligence, virtual reality, cloud computing, cognitive computing, the Internet of Things (IoT) and the Internet of Nano Things (IoNT), or the Internet of Everything (IoE), and big data analytics. And yet, the water sector which was arguably the principal driving force behind human development has still not, as a modern-day factor, fully embraced Industry 4.0, described by the World Economic Forum (WEF) as "*a fundamental change in the way we live, work and relate to one another*" (Prisecaru, 2016).

Digital Water is water-specific data science and compared to the advances noted in other sectors such as energy or transport, its uptake has been slow. The world of water is a heterogeneous eco-system, whose stakeholders have interpreted the importance of Industry 4.0 in different ways. Large multinationals have embraced smart technology whilst smaller, more regional or local utilities have often proved reluctant to advance. This is due to a number of reasons but principally the fact that water supply is a critical infrastructure and that there is only a limited free market has led to a feeling that the need to innovate is less urgent. Furthermore, the size of utilities and hence, the capacity for investment in innovation, varies considerably in Europe. It must be noted that there are European regions which have numerous micro-suppliers. In Germany, for example, there are nearly 6,000 water supply companies.

However, with the issue of water scarcity becoming far more acute, especially in Southern Europe, over the last decade and the fact that a number of utilities have been privatized the situation has altered. Both these occurrences have coincided with technical developments such as sensor-to-sensor communication and data transmission technologies such as LoRa which have been accompanied by a reduction in costs. Data storage, low-cost sensors (water meters, water quality sensors, LabOnChip, Smart Meters) and powerful open-source libraries for Machine Learning and Artificial Intelligence (Tensorflow, Scikit-learn) together with the appearance of start-ups and non-water ICT companies entering the water sector are factors which have combined to represent the catalyst of a sectoral change of heart.

Much technology exists and in many cases is being applied to a certain extent, especially by the larger, multinational institutions. Remote monitoring, the use of sensors to control quality, detect leakage and other damaging occurrences, process monitoring and optimisation employing real-time data sources, the employment of Augmented Reality (AR) and Virtual Reality (VR) which improves decision-making thanks to three-dimensional modelling and the more efficient training of personnel are just some examples, as is the use of websites, mobile phones and smart meter technologies which make administrative duties far more efficient and contribute to the identification of behavioural patterns which permits a more effective approach to strategic planning.

In 2013 Mukhopadhyay and Mason concluded that "*…there is a growing need for the water industry to tighten its control and develop its understanding of what is happening to water resources in both fine detail and in real-time*" whilst in 2019, the IWA stated that "*Water and wastewater utilities must embrace digital solutions. There is really no alternative*." (Sarni et al. 2019). The European Union Water Alliance (EUWA) in a statement to be presented to the newly appointed Commissioners who will serve between 2019 and 2024 has underlined the fact that "*Digitalising the water sector can be a solution to survey the infrastructure and achieve full transparency on water quality and quantity. It can also support stringent compliance monitoring, faster penalisation and optimise infrastructure use to maximise resilience, reducing the necessity for renovation investments."* The message does appear to have finally permeated the water industry. Now FIWARE4WATER must understand to what extent this is currently influencing the management of the aforementioned utilities.

I.2. The target participants

Water is supplied and wastewater is treated by public utilities, private companies, public-private partnerships (PPPs), social cooperatives and by individuals with legal access to wells. The water obtained from primary sources such as groundwater (aquifers), surface water (lakes and rivers), and the sea through desalination is more often than not purified and disinfected before entering reservoirs. Wastewater, often but not always managed by the same utility, is normally conducted to a sewer system and upon arrival in a wastewater treatment plant (WWTP) is sanitized before being discharged back into the eco-system or reused by industry, agriculture and to an increasing extent, urban greening.

Water governance, the creation of policies and the enforcement of regulations is implemented, in general, by national and supranational governmental entities. The utilities, the target participants of this document, are responsible for the supply to the end-user and in most cases, the treatment of used water whilst adhering to the directives currently applied by the political administrations. In Europe, national and regional law is based on supranational regulations, such as the Water Framework Directive (WFD), the Environmental Quality Standards Directive (EQSD), the Groundwater Directive (GWD) and the Floods Directive (FD) created by the European Union. Water utilities are not homogenous organisations. There exist many differences according to the areas they serve and the administrative structure employed.

Some utilities are responsible for providing water to a single municipality. Others supply a region as is often the case in Germany, France, Italy and Romania. In a number of federal nations such as Brazil, states receive their water from a single provider, which in essence is what occurs, for example in England and Wales where water has been privatised and where entities such as the FIWARE4WATER partner, South West Water, take responsibility for the water supply and sewage of an entire region. In small countries such as Jordan, there exist national water services and indeed a Ministry of Water. Such controlled systems of water supply dominate in Europe, but beyond, it must be noted that in rural areas of the World, water is provided by local community groups which seek to supply one or more small villages, sometimes in the most rudimentary of manners, leading to low levels of sanitation and an increased health risk. In most cases in Europe, the supplier of water is also responsible for sewage. Some, for example, Frankfurt in Germany, are also responsible for electricity.

At present, in the World, 90% of urban water supply is the domain of the public sector. The property of the state or local governments, they are non-profit making organisations responding to the philosophy that water is a basic human right. Many private-dominated platforms criticise such arrangements as being inefficient, open to the influence of political-party interest and overstaffed. The remaining 10% is controlled by the private sector and PPPs. Such suppliers are contracted by the relevant public political administration for a certain period of time. The most common form of agreement is a concession or lease whereby the actual infrastructure employed remains public property. Spain is an example of a country where this type of arrangement is prevalent. Large multinationals such as Suez and Veolia are key players in this aspect and whilst they have led the digitalisation of water, it can also be argued that they have, over the last decade, constituted the principal obstacle to public debate about water as a global issue.

This debate which is now being openly supported by supranational agencies such as the EU, the OECD, the UN, the World Bank and the World Economic Forum (See: D5.1) has led to municipalities being consistently called upon to accept a more pivotal role in global environmental issues over the last ten years. As a direct result, there are a number of European cities who have in recent years taken back control of their water management in a move known as *remunicipalisation*. Perhaps the best-known example of such a move took place in 2009 when the City of Paris decided to revoke its agreement with Suez and Veolia and as a result was able to reduce water tariffs by 5% a year later.

In general, the supply of water and treatment of sewage by private interests has not resulted in either lower prices or higher investment. The Public Private Infrastructure Advisory Facility (PPIAF) of the World Bank, which had previously been a strong advocate of water-based privatisation stated in 2009 that "*the private operator may reap all the gains through profits, passing on none of the cost savings to consumers*". (Kishimoto 2009). This has indeed been the principal cause for disagreement whether the issue is private ownership of water services or the Public-Private-Partnership approach described below.

The public-versus-private debate has raged for many years and will continue to do so, as water becomes a more publically-visible issue. The argument that public water management results in revenue being dedicated to the improvement of service, that a consequence of public control is greater transparency and easier access to cheaper funding is countered by those who point out that publically controlled water systems also demonstrate much greater levels of corruption propagated by complex bureaucracies who have proved incapable of addressing such vital aspects as high water loss through leakage.

Sometimes, erroneously perceived as a compromise within the public-versus-private debate, Public-Private Partnerships (PPPs) are a product of the end of the last century. Defined by Weimer and Vining (2017) as "*a private entity financing, constructing, or managing a project in return for a promised stream of payments directly from government or indirectly from users over the projected life of the project or some other specified period of time*", they have proved to be controversial. Although first created at the beginning of the 19th Century, it was the British Prime Minister, Tony Blair who basing his strategy on the Private Finance Initiative (PFI) of his predecessor, John Major, really established the concept in Europe. Within the water sector, the approach grew in the 1990s but was quickly criticised for not producing the expected benefits such as improvements in public water utilities, lower prices, large volumes of investment, and improved access for the poor to quality water and sanitation. Indeed, there now exists a higher level of water poverty than before and as has been noted above, the World Bank, once a vociferous advocate of the PPP formula is, at present, strongly reluctant to promote it further. (Hoedeman *et al*. 2005).

The target participants approached by FIWARE4WATER represented all three types of water supplier and wastewater treatment organization described above. Of those asked, 57% were public entities, 29% were private companies and 14% described themselves as PPPs.

I.3. The survey methodology employed

The credibility and effectiveness of a survey is only as valid as the measures taken with regards to a questionnaire's preparation and dissemination. The reason to undertake such an activity must be clear. The objective is not to duplicate information already obtained from earlier investigation but rather to obtain data which does not exist and which may or may not support conclusions drawn from previously studied secondary sources.

Objectivity and the fact that all respondents will answer the same questions dote the methodology of questionnaires with a capacity to observe unbiased tendencies. Questions can be asked in a variety of manners. Face-to-face interviews provide immediate responses but do not allow the responder much time to carefully consider their opinion. Interviews by telephone have the same disadvantage and furthermore, do not allow a conversation to develop between the researcher and their interlocutor. The distribution of a questionnaire by mail is perhaps more impersonal but at the same time permits a wider distribution of the survey in question and is obviously much cheaper and logistically far easier to undertake. For this deliverable, interviewees were encouraged by e-mail (and in a few cases by phone) to participate by entering SURVEYMONKEY. This is an effective web-based method in that it permits one to obtain input from many geographical areas in a relatively short period of time and with very few overheads. The results, if the questionnaire is designed well, are easy to collate and the data is readily accessible for study and the drawing of conclusions. Eliminating the recording of answers by interviewers in situ avoids the problem of human error when noting the replies. The fact that, in the case of this deliverable, the target group were utilities meant that there did not exist a problem regarding connectivity, although two completed questionnaires received from non-European countries were handwritten.

The questions included in the survey (See: Annex A) were designed so that the information obtained would be precisely that which the technical partners of FIWARE4WATER required. Many of the recommendations which have been put forward by writers such as Owens (2002) were applied. Rühlemann (2014) pointed out when defining what he named as 'recipient design' that the language used must be fully comprehensible to the target audience. Therefore, the questions were asked employing a clear, unambiguous vocabulary and almost all of the answers were of the YES/NO variety thus permitting the responders to complete the survey in a short period of time. At certain points of the questionnaire, participants could add a limited amount of extra information if they felt the need to do so. Strict ethical practices were applied, observing the established EU data protection legislation so that there existed no infringements on privacy. Responders were required to sign an *Agreement to Participate* after having read an explanation of the project itself, why their participation was important, what their participation consisted of and a description of their legal rights.

In 2012, Seale noted that no single method of obtaining public opinion and the subsequent drawing of conclusions can be deemed perfect. However, and despite the eternal academic conflicts between natural scientists and their social counterparts, social research has demonstrated itself to be more than capable of being extraordinarily rigorous and objective. This has been the key element that the providers of the information and conclusions below have borne in mind as they have prepared this document.

II. Results of the analysis

The survey created by the FIWARE4WATER consortium sought to be both comprehensible and relevant to the different types of entity approached in the European countries of Spain, The United Kingdom, Belgium, Greece, Italy, the Netherlands, Germany, Cyprus, Romania and Moldavia together with non-European states such as Kenya, Brazil, India, Israel, Cameroon and Morocco. As has been stated in Section II.2, three types of water-based operators were contacted together with a number of representatives from other related sectors and the answers received from 65 responders were provided by public entities (57%) private companies (29%) and public-private partnerships or PPPs (14%).

25 interviewees both supplied water and took responsibility for wastewater treatment.

24 participants were exclusively water suppliers.

3 participants were exclusively wastewater treatment operators.

3 respondents were from the research sector.

3 were representatives of digital service developers.

3 were agriculturalists.

2 worked in the energy sector.

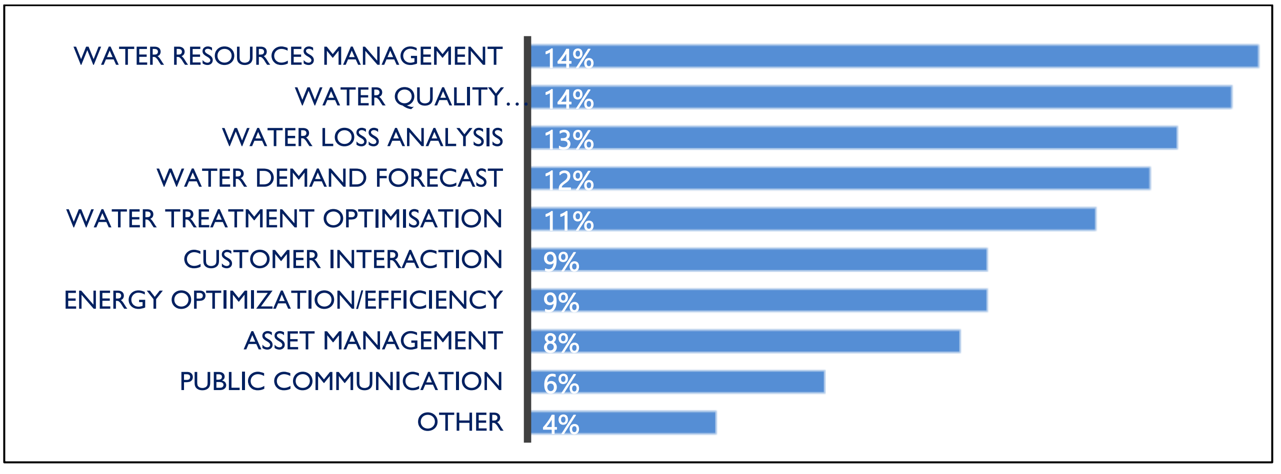
1 came from the world of education

1 was involved in weather forecasting.

II.1. The employment of Smart Applications related to Drinking Water

Q01: In which aspects are you employing smart applications? (Yes / No) - (Multiple answers possible)

65 RESPONDERS INDICATED 189 ASPECTS OF EMPLOYING SMART APPLICATIONS IN THE FOLLOWING PERCENTAGES:



TOTAL NUMBER OF RESPONDERS TO THIS QUESTION: 65

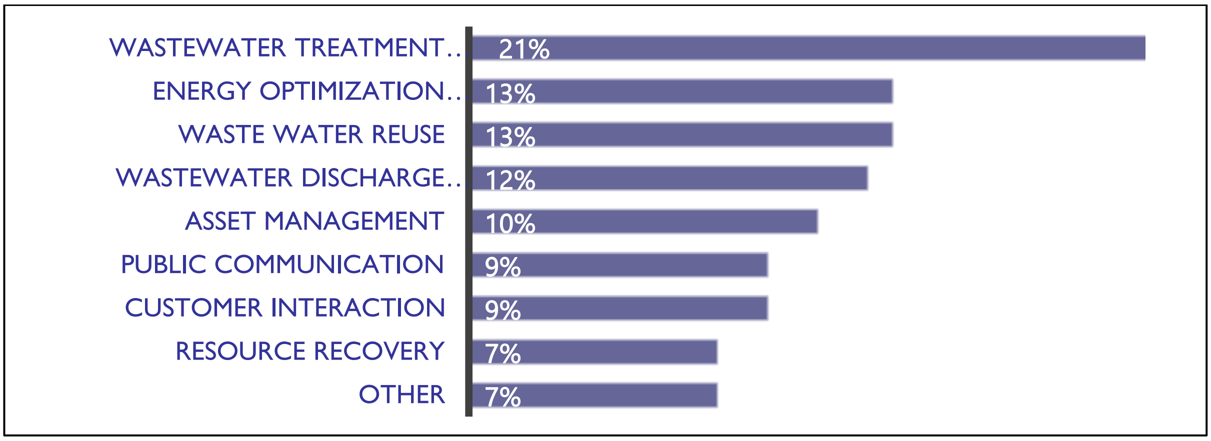
USE	NUMBER OF RESPONDERS INDICATING THIS USE	PERCENTAGE OF RESPONDERS INDICATING THIS USE
Other	7	10.7%
Public Communication	11	16.9%
Asset Management	16	24.8%
Energy Optimization/Efficiency	17	26.1%
Customer interaction	17	26.1%
Water treatment optimisation	21	32.3%
Water demand forecast	23	35.3%
Water loss analysis	24	36.9%
Water quality monitoring/event detection	26	40%
Water Resources Management	27	41.5%

In this first question, the 65 participants could indicate all those aspects in which they employed smart applications with regards to the supply of drinking water. The percentages represented in the first graph are those percentages of the uses indicated. For example, 27 interviewees indicated that they employ smart applications when dealing with water resource management. This constitutes 14% of all the uses indicated but demonstrates that 41.5% of those questioned use smart technology with regards to this specific issue. (See the second table). The results demonstrate that almost the same number employ a smart approach to the subject of water quality, (26 interviewees, 40%) and water loss analysis (24 interviewees, 36.9%). A much smaller number, (17 interviewees, 26.1%) employ ICT for energy optimisation which is an issue that represents an important gap, (as is confirmed in other results presented below) and interaction with the customer. This last result is the reflection of the influence of interviewees from Eastern Europe, an area of the continent which will be especially important during the course of FIWARE4WATER and as this and other results will demonstrate have shown to date little or no interest in maintaining householders informed with regards to their water supply. The results cannot be described as surprising but do provide the first signs of some of the general points of concern which the water sector has been slow to recognise such as the aforementioned lack of inter-sectoral awareness between water and energy and the extremely small number of respondents (16.9%) who consider public communication to be important (a meagre 6% of the total number of uses indicated). With regards to other uses one interesting aspect was provided by a participant from India who noted that they were employing ICT for the planning of irrigation systems.

II.2. The employment of Smart Applications related to Waste Water

Q01: In which aspects are you employing smart applications? (Yes / No) - (Multiple answers possible)

28 RESPONDERS INDICATED 136 USES OF SMART APPLICATIONS RELATED TO WASTE WATER IN THE FOLLOWING PERCENTAGES



TOTAL NUMBER OF RESPONDERS TO THIS QUESTION: 28

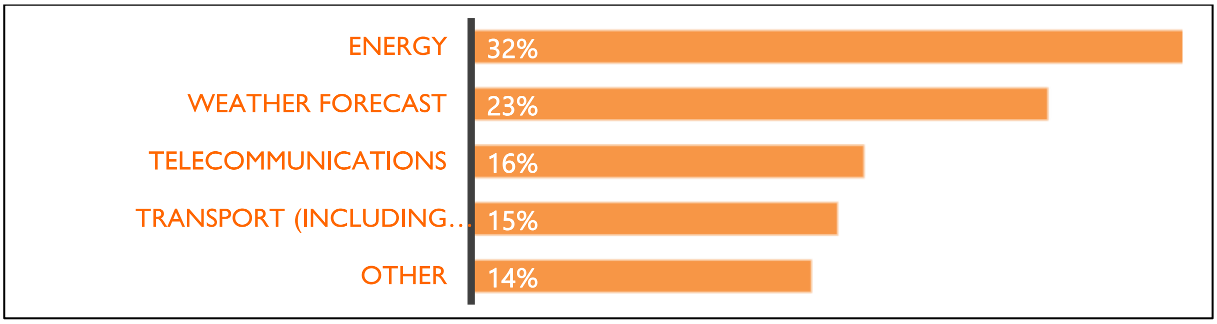
USE	NUMBER OF RESPONDERS INDICATING THIS USE	PERCENTAGE OF RESPONDERS INDICATING THIS USE
Other	10	35.7%
Resource Recovery	10	35.7%
Customer Interaction	12	42.8%
Public Communication	12	42.8%
Asset Management	14	50%
Wastewater Discharge Forecast	16	57.1%
Wastewater Reuse	17	60.7%
Energy Optimisation/Efficiency	17	60.7%
Wastewater Treatment Plant optimisation	28	100%

Of the 65 interviewees approached, 25 supplied water and took responsibility for wastewater treatment and a further three were exclusively wastewater treatment operators. These 28 entities were those who contested the question above and who indicated 136 different uses in relation to this question. The most notable figure therefore is that all those companies involved in wastewater employ smart applications to optimise their Wastewater Treatment Plants (WWTP). Indeed, the figures obtained would suggest that operators involved in the treatment of wastewater are much more inclined to employ ICT in other aspects too. Whilst in relation to the use of smart applications in the supply of drinking water, only 26.1% employed ICT with regards to the optimisation of energy, in the wastewater sector the figure was 60.7%, the second most common use together with wastewater reuse. These figures certainly reflect the demands of supranational and national legislation in relation to what is still an extremely difficult issue to transmit to the general public and it is interesting that 42.8% of those who answered employed smart applications in relation to both customer interaction and public communication which is a much higher proportion than that observed with regards to the supply of drinking water (Customer interaction 26.1%, public communication 16.9%). Resource recovery, a vital aspect for both alternative energy and sustainability strategies and approaches to the establishment of a circular economy was an aspect that only 10 of the 28 responders (35.7%) indicated thus highlighting an important gap to be examined, especially in Eastern Europe. For example, in Romania, all the companies are public, with the exception of the utility that supplies Bucharest and undertake the dual role of drinking water supplier and the entity responsible for wastewater treatment. Only three responded affirmatively to resource recovery.

II.3. The employment of Smart Applications related to Other Sustainability-related Sectors

Q01: In which aspects are you employing smart applications? (Yes / No) - (Multiple answers possible)

38 RESPONDERS INDICATED 94 USES OF SMART APPLICATIONS IN RELATION TO OTHER SUSTAINABILITY-RELATED SECTORS IN THE FOLLOWING PERCENTAGES



TOTAL NUMBER OF RESPONDERS TO THIS QUESTION: 38

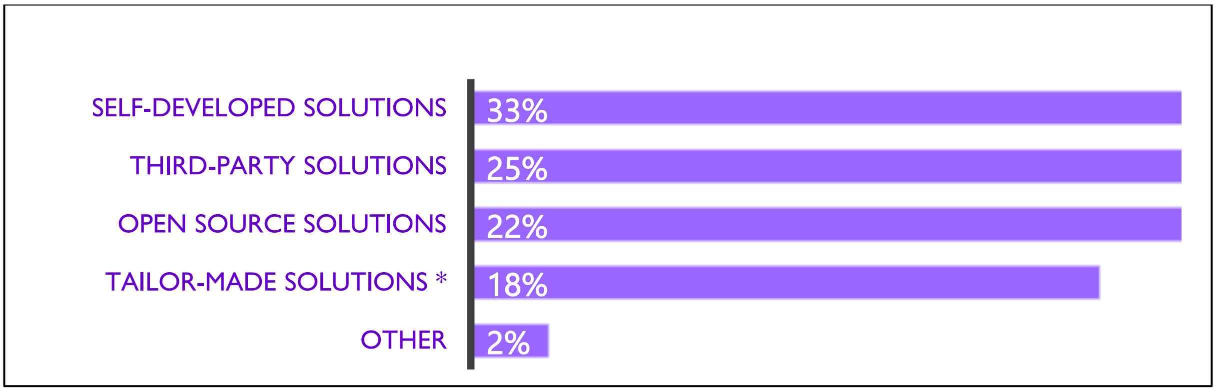
USE	NUMBER OF RESPONDERS INDICATING THIS USE	PERCENTAGE OF RESPONDERS INDICATING THIS USE
Other	13	34.2%
Transport (Including mobility)	14	36.8%
Telecommunications	15	39.4%
Weather forecast	22	57.8%
Energy	30	78.9%

The results with regards to the employment of smart applications in relation to other sustainability-related sectors produced answers which supported that which could be discerned in the previous question. The majority of those who supplied answers in this section (38) were those who were involved in the treatment of wastewater and the dominance of actions related to energy optimisation reflected in the previous question is further supported here by the fact that 78.9% of the 38 entities which responded indicate energy. The use of ICT with regards to the obtaining of weather forecasts does not necessarily reflect that the entity which has answered employs its own system but perhaps merely restricts its activity to consulting the internet. 13 entities indicated *Other* uses. A closer inspection of the answers reflect that the term *Other* uses had been misunderstood by some of the interviewees (7) but four indicated how they were applying ICT with regards to agriculture, specifically irrigation systems and two employed smart applications to control air quality, in Belgium and the Netherlands. Irrigation is agriculture and this reflects the fact that especially in Northern Europe, the Water-Energy-Food-Ecosystem (WEFE) Nexus is beginning to establish itself as a vital factor. This will be further discussed below, but at this point, suffice to say that inter-sectoral collaboration and an increasing awareness that all the components of a sustainable society have both positive and negative aspects on each other in a series of complex interactions is vital, as is the fact that existing smart technologies can clearly facilitate the construction of these necessary relationships.

II.4. Types of software currently employed

Q02: Which types of software are you currently using? - (Multiple answers possible)

64 RESPONDERS INDICATED 130 SOFTWARE SOLUTIONS IN THE FOLLOWING PERCENTAGES



TOTAL NUMBER OF RESPONDERS TO THIS QUESTION: 64

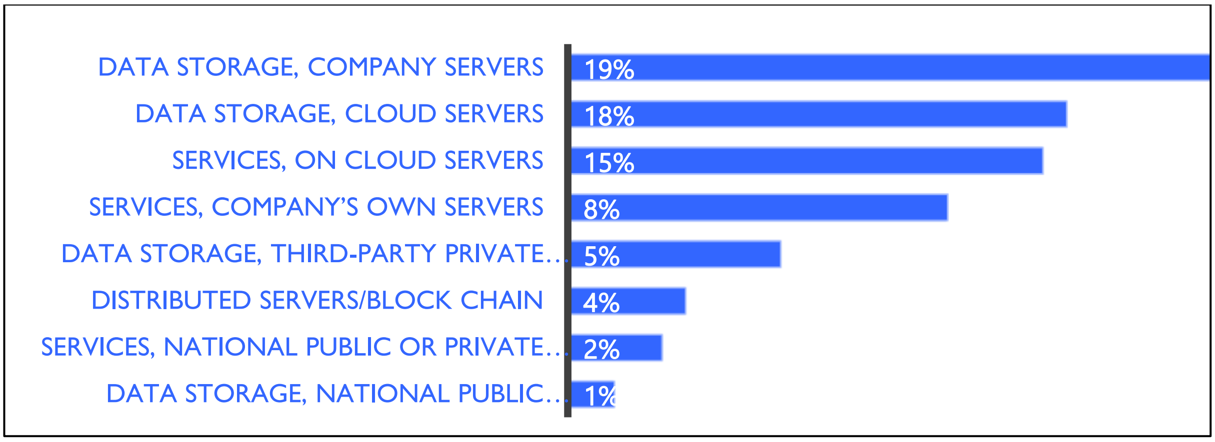
TYPE OF SOFTWARE SOLUTION	NUMBER OF RESPONDERS INDICATING THIS SOLUTION	PERCENTAGE OF RESPONDERS INDICATING THIS SOLUTION
Other	3	4.6%
Tailor-made solutions	24	37.5%
Open source solutions	28	43.8%
Third-party solutions	32	50%
Self-developed solutions	43	67.2%

On average, the entities asked currently employ software from two sources. Only one utility from Cameroon stated that it did not use any form of software in its operations. The two most common approaches are software developed by the IT department of the utility itself whilst for certain applications, the same utilities turn to an external company to supply specific solutions. This is especially so when speaking of smaller companies. Larger multinational corporations tend to employ third-party solutions which are previously validated by external agencies, but smaller entities due, to an important extent, to a mistrust of external parties or internal corporate regulations, combined with an often-misinformed concern for security are reticent to explore external options. The result is a lack of standardisation in the water sector which in turn leads to an incapacity to adopt successful methodologies used by other stakeholders. This situation is especially noticeable in Eastern Europe. All of the utilities in this region are public, and the employment of external agencies involves a long, complex procedure in order to contract external services via the publication of a tender. Thus, they rely on self-developed solutions and are used neither to cooperating with external parties nor to the concept of open-source applications, a factor which explains why only 43.8% of those asked affirmed the use of open source enabling technologies.

II.5. Current Data Management practices

Q03: Which options for data management exist in your company? (Multiple answers possible)

64 RESPONDERS INDICATED 109 DATA MANAGEMENT PRACTICES IN THE FOLLOWING PERCENTAGES



TOTAL NUMBER OF RESPONDERS TO THIS QUESTION: 64

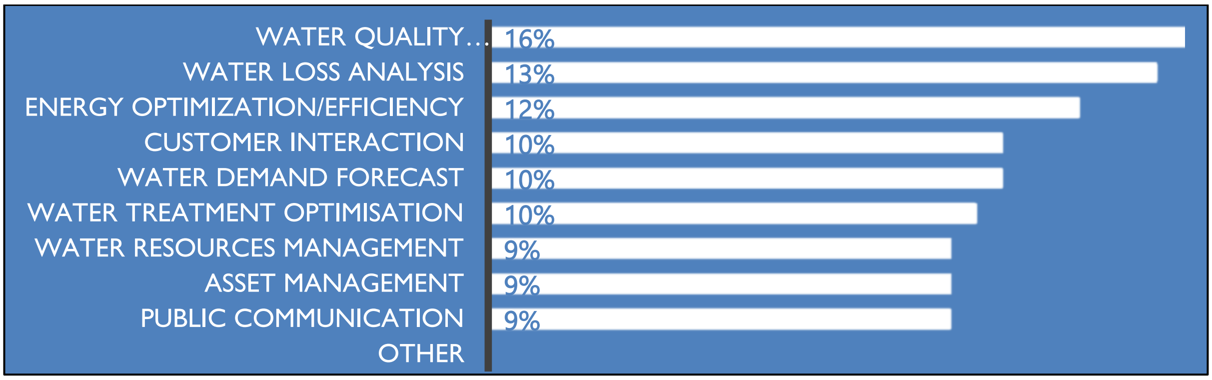
DATA MANAGEMENT PRACTICE	NUMBER OF RESPONDERS INDICATING THIS OPTION	PERCENTAGE OF RESPONDERS INDICATING THIS OPTION
Distributed servers/Block chain	5	7.8%
Services are only permitted on national public or private servers	4	6.2%
Services are permitted on cloud servers	20	31.2%
Services are only permitted on the company's own servers	16	25%
Data storage is undertaken on third-party private servers in the same country	9	14%
Data storage is undertaken on national public servers in the same country	2	3.1%
Data storage is permitted on cloud servers, for example, Amazon, Microsoft, Google, etc.	21	32.8%
Data storage is only permitted on the company's own servers	32	50%

The answers provided here produce a clear broad reflection of current data management systems within the water sector. It is a reflection of a company's internal administrative policy and national or supranational regulations which deal with the collection and storage of data. To a certain extent, cost may be a factor. In Eastern Europe, all utilities use their own servers which is why the tables above demonstrate a noticeable gap between two general philosophies; 50% of the responders stated that data storage is only permitted on the utility's own servers with 25% stating that the same is true for services. On the other hand, 32.8% stated that the use of cloud servers is permitted to store data whilst 31.2% employed cloud to provide services.

II.6. Current demand for Smart applications in Drinking Water

Q04: In which smart applications you currently don't use, are you interested in implementing? (Multiple answers possible)

65 RESPONDERS INDICATED 194 APPLICATIONS FOR THE MANAGEMENT OF DRINKING WATER WHICH THEY WOULD BE INTERESTED IN IMPLEMENTING IN THE FOLLOWING PERCENTAGES



TOTAL NUMBER OF RESPONDERS TO THIS QUESTION: 65

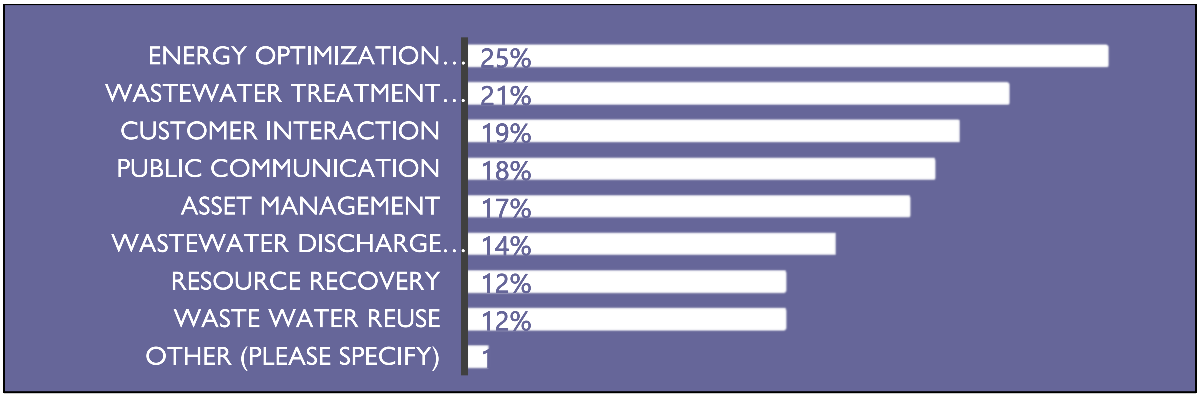
ASPECT OF DRINKING WATER MANAGEMENT	NUMBER OF RESPONDERS INDICATING THIS ASPECT	PERCENTAGE OF RESPONDERS INDICATING THIS ASPECT
Other	0	0%
Public communication	18	27.7%
Asset management	18	27.7%
Water resources management	18	27.7%
Water treatment optimisation	19	29.2%
Water demand forecast	20	30.7%
Customer interaction	20	30.7%
Energy optimisation and efficiency	23	35.3%
Water loss analysis	26	40%
Water quality monitoring and event detection	32	49.2%

Whilst the first question of the survey sought to establish in what aspects of drinking water supply, smart applications are currently used, this question was intended to reveal in which aspects there is a demand for smart technology. It is not surprising that the most important concern for utilities is water quality no matter the geographical area in question. In Eastern Europe, many of the companies are currently renewing the infrastructure and the sole priority is water quality. They have, to date shown little or no interest in any of the other aspects indicated. The question of communication is a problem. In Question 1 it was clear that public communication was extremely low in the list of priorities with only 11 interviewees stating that smart technology was applied to this facet. Here only 18 responders constituting 27.7% stated an interest in the future use of such technology. With regards to customer interaction the potential demand is higher (30.7%). This is logical considering that only a quarter of the entities approached stated they at present they employ ICT for their interaction with householders but the figures regarding communication with the customer and society at large still demonstrate that the water sector, compared to other sustainability-related fields such as transport, energy or ICT itself, is traditionally reluctant to embrace more transparent approaches. In the same way that many feel that being what to a certain extent constitutes a local monopoly, reduces the perceived need to *sell oneself*. This is a dangerous trait as long-term measures require political and therefore public understanding, support and policy continuity. The water sector must seek that support by informing and involving the communities they supply.

II.7. Current demand for Smart applications in Wastewater

Q04: In which smart applications you currently don't use, are you interested in implementing? (Multiple answers possible)

28 RESPONDERS INDICATED 105 APPLICATIONS FOR THE MANAGEMENT OF WASTE WATER WHICH THEY WOULD BE INTERESTED IN IMPLEMENTING IN THE FOLLOWING PERCENTAGES



TOTAL NUMBER OF RESPONDERS TO THIS QUESTION: 28

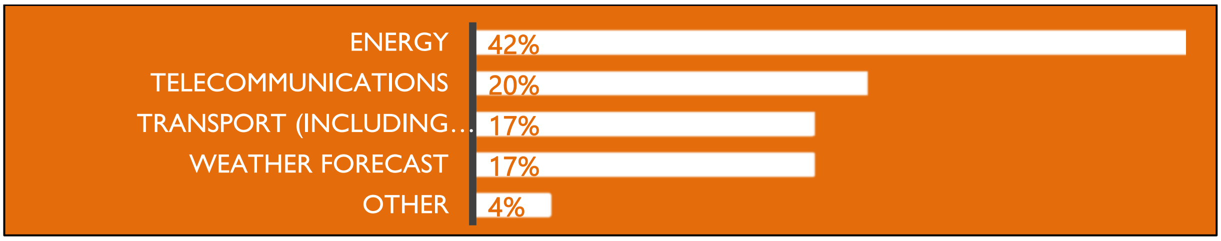
ASPECT OF WASTE WATER MANAGEMENT	NUMBER OF RESPONDERS INDICATING THIS ASPECT	PERCENTAGE OF RESPONDERS INDICATING THIS ASPECT
Other	1	3,5%
Waste water reuse	13	46.4%
Resource recovery	13	46.4%
Waste water discharge	15	53.5%
Asset management	18	64.2%
Public communication	19	67.8%
Customer interaction	20	71.4%
Waste water treatment	22	78.5%
Energy optimisation and efficiency	26	92.8%

Due to the issue at hand, the wastewater branch of the water sector appears far more disposed to take advantage of the possibilities offered by effective public communication and customer interaction. Furthermore, the fact over 92% of those who responded identified a need for energy optimisation and efficiency demonstrates two important factors; firstly, the economic reality that energy represents 30% of the operational costs for a wastewater utility and secondly, the apparent fact that wastewater experts are more conscious of the importance of the previously mentioned WEFE Nexus than other colleagues from the water sector. Nevertheless, one must careful when reaching and describing broad conclusions. In Romania and Moldavia, for example, there exists the need and intention to reduce energy costs, but the solution is not regarded as one to found by the employment of smart technologies but rather the installation of physical renewable energy practices such as wind-power and photovoltaic (PV) panels. Finally, it must be noted here that smart applications to facilitate the relationship between water and energy are scarce. This is an important gap which must be addressed and is clearly seen in the answers to the last question below.

II.8. Current demand for Smart applications in Non-Water Sectors

Q04: In which smart applications you currently don't use, are you interested in implementing? (Multiple answers possible)

46 RESPONDERS INDICATED 76 APPLICATIONS IN NON-WATER SECTORS WHICH THEY WOULD BE INTERESTED IN EMPLOYING IN THE FOLLOWING PERCENTAGES



TOTAL NUMBER OF RESPONDERS TO THIS QUESTION: 46

NON-WATER SECTOR	NUMBER OF RESPONDERS INDICATING THIS SECTOR	PERCENTAGE OF RESPONDERS INDICATING THIS SECTOR
Other	3	6.5%
Weather Forecasting	13	28.2%
Transport (Including mobility)	13	28.2%
Telecommunications	15	36.2%
Energy	32	69.5%

Lending further weight to what has already been stated, the fact that 42% of the applications indicated where for energy and that 69.5% of the participants demonstrated this demand the conclusion that can be drawn here is for an immediate need for closer collaboration between the water and energy sector. Transport, another pillar of the sustainable concept is not identified by the water sector as a high-profile priority, although over a quarter of the responders did indicate this sector.

III. Conclusions and recommendations for the future development of Fiware4Water

At a socio-political level, in the face of an increasing public awareness regarding the challenges presented by climate change a number of technical factors are being recognised by supranational entities as being key to society's capacity to adapt to and develop a more sustainable way of living. The water sector is and must be central to these future strategies and the work of FIWARE4WATER will have an important technological role to play as will many other funded projects which have come under the umbrella of the ICT4WATER created under the supervision of DG CONNECT.

Open source enabling technology in water management will be important as it will contribute to three important strategical elements. As has been seen above, there exists a growing realisation, especially on the part of those involved in wastewater treatment that there is a need for true inter-sectoral collaboration between all the elements of the WEFE Nexus. A gap has been identified in that the number of smart applications addressing this aspect is limited, whilst many water utilities no matter whether they are public, private or PPPs show little concern for establishing such ties. FIWARE4WATER must contribute to the creation of inter-sectoral bridges in the same way that utilities, supported by smart technology can contribute to the second necessary condition which is the strengthening of supranational policy by way of implementation at a local and regional level. The third factor which must be enhanced through the use of smart open-source technology is what is called the Quadruple Helix, whereby at a local and regional level, all stakeholders including and indeed supported by the utilities, work in unison to envisage, develop, implement and analyse actions which result in improved water management. Here the public sector, private sector, research sector and ordinary, hitherto, uninformed citizens work together in order to establish a broad socio-political and technical consensus which can produce long term visions.

From a more practical, technical perspective a number of points may be raised after having observed the results of this questionnaire. None of the results produced were especially surprising to those experts consulted. Indeed, the answers appeared to confirm what the more technical partners of the FIWARE4WATER consortium already believed with regards to utilities and their priorities. The drinking water sector is, at an operational level, more advanced with regards to digitalisation along the length of the value chain (water demand, management and treatment) whilst wastewater operators, for obvious reasons, show a special interest in the digitalisation of treatment and energy optimisation.

Leading companies in the drinking water sector are applying many smart services and have the capacity to serve as an example to more traditional utilities. Nevertheless, as has been noted above, the water sector is not famed for its capacity to share and learn from one another and the process will be slow. This should not constitute a deterrent but rather a challenge to be overcome. The more that is discovered about the replicability of such methods employed the more beneficial such hitherto heterogeneous applications would be to the sector as a whole. In the same way, the advances that the wastewater branch of the water sector has made and is anxious, according to this survey, to continue making with regards to energy optimisation, supported by digitalisation and analytics should be shared with their drinking water counterparts.

It is clear that water utilities must place more emphasis on digitalisation, not only in Eastern Europe but also in many areas where the level of employment of such technology is still relatively low compared to the transport or energy sector. The efficient collection and storage of data is vital. Data is the principal ingredient required to apply analytical strategies and to make decision-making more effective.

There exist, in the opinion of FIWARE4WATER, too many self-developed solutions which leads one to ask whether or not the same challenges are being repeatedly addressed and whether or not there exists an open-source solution. The consortium advocates the establishment of standardised, interoperable and open-source software for water management whether it be concerned with water quality, leakage or energy consumption together with less perceived priorities such as demand forecasting and customer relations. Many of the utilities approached demonstrate that they are reluctant to incorporate cloud services which provide improved ICT infrastructure management, security and scalability. During the course of FIWARE4WATER, the storage of data, its security and the geographical and legislative restrictions for such servers to be adopted must be further investigated.

Such conclusions will serve for nothing if they are not taken into account by the further work of the FIWARE4WATER consortium as it proceeds to execute WP2, 3 and 4. This deliverable, together with D1.1, 1.3 and 1.4 reflect the parameters within which it is necessary to further develop an open-source platform that will transform data into tangible aids that lead to the improvement of water management. The minimum technical requirements in order to ensure that the platform is both interoperable and usable throughout Europe, whilst permitting SMEs to develop new services and products has been collected. Furthermore, the results of Work Package 1 as a whole, must also feed the ambitions of Work Package 5 which will look to broaden the social and political acceptance and application both of the FIWARE mechanisms and of digital water management as a whole. This will serve to lend an EU-added value to the initiative. By contacting and engaging stakeholders from Europe, Work Package 1 has already commenced a process of communication and dissemination. Just as importantly, the involvement of non-consortium stakeholders lead to the results of the project being deployable within any existing European system. This in turn will encourage a more interactive attitude at a trans-European level.

List of Acronyms/Glossary

F4W	Fiware4Water project
NGI	Next Generation Internet *The Next Generation Internet (NGI) initiative, launched by the European Commission in the autumn of 2016, aims to shape the future internet as an interoperable platform ecosystem that embodies the values that Europe holds dear: openness, inclusivity, transparency, privacy, cooperation, and protection of data.*
WPL	Work Packages Leaders
DG	Directorate General of the European Commission
SIP	Strategic Implementation Plan
EIP	European Innovation Partnership
IWA	International Water Association
EUWA	European Union Water Alliance
WWTP	Wastewater Treatment Plant
PPP	Public-Private Partnership
PPIAF	Public Private Infrastructure Advisory Facility of the World Bank
OECD	Organisation for Economic Cooperation and Development
PFI	Private Financing Initiative
WFD	Water Framework Directive
EQSD	Environmental Quality Standards Directive
GWD	Groundwater Directive
FD	Floods Directive
WEFE	Water-Energy-Food-Ecosystem Nexus

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Annex A: The Questionnaire

QUESTIONNAIRE

AND

AGREEMENT TO PARTICIPATE

Dear Sir/Madam,

FIWARE4WATER is a project funded by the European Commission aimed at enhancing the development of solutions to one of the most important issues of the 21st Century: WATER. **FIWARE4WATER** will link the water sector to the smart solution platform "FIWARE", the objective of which is to support SMEs and developers in creating the next generation of internet services. All users in the water supply chain will benefit from this action, be they cities, water utilities, water authorities, solution providers and citizens. Several interfaces and tools will be developed for the benefit of all water-based end-users and will be demonstrated in four demo cases in Athens (GR), Cannes (FR), Amsterdam (NL) and Great Torrington (UK).

In a second phase, potential European actors and stakeholders will be informed and engaged by the creation of three stakeholder networks: one for municipalities, one for water authorities and companies and one for technology providers.

FIWARE4WATER would like to collect information regarding the interaction and functionalities with different systems related to the water sector. The main aim is to ensure the future compatibility of and support to the developing FIWARE platform systems.

Thus, concentrating on current systems and applications currently being used or which have been used in the past, whilst also considering other necessities which are not catered for at present, we would ask you to answer the following questions.

If you are happy to be involved, please give your consent by signing the form below (**Agreement to Participate**). Please keep one electronic copy for your records, and send the signed form to **FIWARE4WATER** (contact details below) with the completed questionnaire.

What is the purpose of your involvement? The purpose of this questionnaire is to learn about your opinion and understanding of **smart applications (a data driven decision support system e.g. using water consumption data and weather forecasts to decide future measures required at near-real time)** and the experience which you and/or the entity you represent has with regards to such technology.

What will your participation involve? We require you to participate by completing a questionnaire with six questions. Completing the survey should take no longer than ten minutes. Your name and personal details will not appear on any material arising from this research.

You may decide to withdraw from this study at any time. If you would like that your answers are removed from this study please contact **FIWARE4WATER** (contact details below).

Why should you participate? By participating, you provide information that will permit the FIWARE4WATER consortium to focus correctly on future developments of the project. You will be fully informed of these developments and will be invited at a later stage of the project to contribute further should you wish to do so.

How will the results be used? The data from this study will be analysed and used for project reports and presentations and in academic publications. Neither your name nor any other personal identifying information will appear in any reports, papers or presentations resulting from this study. Data may be made available to the project partners to assist them in assessing and improving the project – this data will not contain any identifying information.

What will happen to information you provide? All data collected and processed will be handled in compliance with UK and EU data protection legislation. All information will be anonymised and stored in a secure location.

Participation in this research activity is voluntary. You may decide not to answer any of the questions if you wish. You may also decide to withdraw at any time. You will not be contacted after the activity is complete unless you seek to be involved further.

The Project Coordinator has reviewed and approved the methodology for the data collection for the FIWARE4WATER project. If you have any questions regarding this study or would like any additional information, please do not hesitate to contact us.

If you have any queries specifically about Data Protection Issues, you may contact s.siauve@oieau.fr

Agreement to Participate

I understand that:

• My participation is entirely voluntary.

• I am completely free to refuse to answer questions.

• I may be asked for clarification of some points, but I am not obliged to clarify or participate further.

• I can decide not to participate at this point and that I can withdraw my participation at any time. If I decide to do so, any material regarding my participation will be deleted or destroyed.

•If I have any questions regarding this study or would like any additional information, I can contact the researcher:

Dr. Richard Elelman.

Tel: (+34) 93 877 73 73 email: richard.elelman@eurecat.org

• All individual results will be treated confidentially. Results will only be reported for the group as a whole and in an anonymised manner.

• The anonymised research data will be kept safely in a secure location only accessible by the researchers.

• The objectives and procedures of this study have been reviewed and approved by the Project Coordinator

• My name, email address and availability provided via the sign-up form will only be accessible to the researchers.

I declare that I have read and understood this form, that I have been able to ask questions, and that I consent to participate in this study.

Participant name (please print):

Date:

Signature:

THE QUESTIONNAIRE

Q01: In which aspects are you employing smart applications? (Yes / No)

(Multiple answers possible)

Drinking Water:

- Water loss analysis	**Y / N**
- Water demand forecast	**Y / N**
- Water treatment optimisation	**Y / N**
- Water quality monitoring and event detection	**Y / N**
- Customer interaction	**Y / N**
- Public Communication	**Y / N**
- Asset Management	**Y / N**
- Water Resources Management	**Y / N**
- Energy Optimization/Efficiency	**Y / N**

- Any other? (Please describe – Max: 10 words)

  ____

Waste Water:

- Wastewater discharge forecast	**Y / N**
- Wastewater treatment plant optimisation	**Y / N**
- Waste Water Reuse	**Y / N**
- Resource Recovery	**Y / N**
- Customer interaction	**Y / N**
- Public Communication	**Y / N**
- Asset Management	**Y / N**
- Energy Optimization /Efficiency	**Y / N**

- Any other? (Please describe – Max: 10 words)

  ____

Other sectors:

- Energy	**Y / N**
- Transport (Including mobility)	**Y / N**
- Telecommunications	**Y / N**
- Weather forecast	**Y / N**

- Any other? (Please describe – Max: 10 words)

  ____

Q02: Which types of software are you currently using?

- Self-developed solutions **Y/ N**
- Third-party solutions **Y/ N**
- Specialised in-house solutions developed by a contracted third-party (tailor-made solutions). **Y/ N**
- Open Source solutions **Y/ N**
- Any other? (Please describe – Max: 10 words)

  ____

Q03: Which options for data management exist in your company?
(multiple answers possible)

- Data storage is only permitted on the company's own servers **Y/ N**
- Data storage is permitted on cloud servers, for example, Amazon, Microsoft, Google, etc. **Y/ N**
- Data storage is undertaken on national public servers in the same country **Y/ N**
- Data storage is undertaken on third-party private servers in the same country **Y/ N**
- Services are only permitted on the company's own servers **Y/ N**
- Services are permitted on cloud servers **Y/ N**
- Services are only permitted on national public or private servers **Y/ N**
- Distributed servers/Block chain **Y/ N**
- Any other? (Please describe – Max: 10 words)

  ____

Q04: In which smart applications you currently don't use, are you interested in implementing?
(multiple answers possible)
Drinking Water:

- Water loss analysis **Y / N**
- Water demand forecast **Y / N**
- Water treatment optimisation **Y / N**
- Water quality monitoring and event detection **Y / N**
- Customer interaction **Y / N**
- Public Communication **Y / N**
- Asset Management **Y / N**
- Water Resources Management **Y / N**
- Energy Optimization/Efficiency **Y / N**
- Any other? (Please describe – Max: 10 words)

  ____

Waste Water:

- Wastewater discharge forecast **Y / N**
- Wastewater treatment plant optimisation **Y / N**
- Waste Water Reuse **Y / N**
- Resource Recovery **Y / N**

- Customer interaction **Y / N**
- Public Communication **Y / N**
- Asset Management **Y / N**
- Energy Optimization /Efficiency **Y / N**
- Any other? (Please describe – Max: 10 words)

  ____

Other sectors:

- Energy **Y / N**
- Transport (Including mobility) **Y / N**
- Telecommunications **Y / N**
- Weather forecast **Y / N**
- Any other? (Please describe – Max: 10 words)

  ____

Q05: With reference to Question 4, could you please describe any applications you would like to implement and explain why.

____
____
____

Q06: Some information about your company

- Country: _____________
- Legal status
  - public utility
  - private utility
  - public-private utility
- Sector:
  - drinking water
  - waste water
  - both
  - other: ____________
- size of utility (Choose one of two options to reply):

In terms of supply density____________________________

Or In terms of inhabitants per km^2): _____________________

THANK YOU FOR PARTICIPATING.

PLEASE RETURN THE COMPLETED AGREEMENT TO PARTICIPATE AND QUESTIONNAIRE BEFORE 30.09.2019 TO:

richard.elelman@eurecat.org