D6.6 FIWARE4Water Challenges

Author: Ángeles Tejado (FF)

Co-Authors: Fernando López (FF), Alberto Abella (FF), Marc Ribalta (EUT), Benoit Orihuela (EGM), Joshua Pocock (SWW), Sonia Siauve (OiEau), Panagiotis Kossieris (NTUA), Albert Chen (UNEXE), Lydia Lyroudia (KWR)

September 2020

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant agreement No. 821036.

Disclaimer

Intellectual Property Rights

Project Consortium

Executive Summary

This Deliverable takes a deep dive into the organization and analysis of the Fiware4Water Challenges, whose activity started at the beginning of the project. It presents a detailed account of all planification, organisation, dissemination, communication, and stakeholder engagement activities carried out to design, implement, and launch the Challenges, as well as the complete Guide for Applicants and results after evaluation of the submitted proposals.

The FIWARE4Water Challenges belong to the Ecosystem Building activities carried out to foster promotion, knowledge transfer, collaboration, and broad uptake of Fiware4Water technologies by SMEs interested in data sharing and standards for context information management and exploitation of data across different verticals. In this context, an initial scope of work was defined outlining the needs and desired outcomes to get results that could demonstrate FIWARE capabilities and the potential of its interoperable and standardized interfaces for both the water sector and end-users such as cities, water utilities, water authorities, solution providers and citizens, allowing cross-domain cooperation and data exchange.

To address our goals, the roadmap of activities (Section II) was prepared for that purpose, including initial outreach activities to engage potential adopters in the FIWARE Ecosystem aimed at understanding better their status and needs in terms of data sharing, the kind and quality of the data available and also their interest and commitment in proposing concrete challenges. After the first inputs received, that highlighted the risks and issues of data access and sharing, we redefined our targets and focused our efforts in engaging the organisations actively contributing in Fiware4Water Demo Cases and the sister projects of the Digital Water 2020 (DW2020) working group, in order to detect specific challenges that they were facing and could be solved by small companies working in the water sector. During this process, we learned that resiliency, early detection, and predictive models were the most important and challenging topics for these organisations. Therefore, and based on the inputs received, the competition focused on data analysis (processing with ML/AI) using F4W-RA for a better management of water data, improving the quality and efficiency of the services, and avoiding extra costs and decision-making times in water treatment.

Based on the use cases provided by the organizations that finally engaged in the process, three challenges (Section IV) of a total proposed four, were launched with a good geographic coverage across Europe (United Kingdom, Italy and Bulgaria) to analyse sewer network's behaviour, explore in real-time the quality of sensor data for water quality assessment, and identify short term water network events and longer-term trends in flow data using anomaly detection methods and time-series analysis.

Due to certain restrictions that prevented the distribution of monetary prizes, different mechanisms to promote the results in an attractive way were defined taking advantage of planned dissemination events and new opportunities like the joint participation in the IBM Call for Code.

The FIWARE4Water Challenges have been an excellent opportunity to collaborate with sister projects in the DW2020 as well as the promotion and wider uptake of the Fiware4Water technologies. Nevertheless, different areas of improvement were identified and are summarized in the conclusions in Section IX.

Finally, the development of the challenges has helped us to understand the problems faced by the main actors in the water sector and set up a good collaborative environment to position FIWARE in the water sector and spur its adoption.

Related Deliverables

This document is related to the Fiware4Water Reference Architecture defined in D2.1 - Specification of system architecture for water consumption and quality monitoring as well as with the BigData and AI frameworks defined in the corresponding D2.2 - Extension of FIWARE ecosystem with Big- Data and AI frameworks.

Additionally, the corresponding data models used in the integration of the ML processes as well as the data models needed to process the context information provider on each of the challenges has been developed under the activities of the Task 2.3 - Common Information Models for Water Management and will be reflected in the D2.3 - Extension of FIWARE for supporting water management and quality monitoring use cases.

Document Information

Programme	H2020 – SC0511-2018
Project Acronym	Fiware4Water
Project full name	FIWARE for the Next Generation Internet Services for the WATER sector
Deliverable	D6.6: FIWARE4Water Challenges
Work Package	WP6: Ecosystem building for communication and dissemination strategy and activities
Task	Task 6.2: SME Ecosystem building
Lead Beneficiary	10 - FIWARE
Author(s)	Ángeles Tejado (FF)
Contributor(s)	Fernando López (FF), Alberto Abella (FF), Marc Ribalta (EUT), Benoit Orihuela (EGM), Joshua Pocock (SWW), Sonia Siauve (OiEau), Panagiotis Kossieris (NTUA), Albert Chen (UNEXE), Lydia Lyroudia (KWR)
Quality check	Sonia Siauve (OiEau)
Planned Delivery Date	M26 (31 July 2021)
Actual Delivery Date	M28 (17 September 2021)
Dissemination Level	Public (Information available in the Grant Agreement)

Revision history

Version	Date	Author(s)/Contributor(s)	Notes
Draft1	10/06/2021	Ángeles Tejado	
Draft2	09/08/2021	Ángeles Tejado	
Draft3	19/08/2021	Fernando López	Review content, adding new images and introduce sections 6.2.2, 8.2, 8.4
Draft4	14/09/2021	Fernando López, Alberto Abella, Ángeles Tejado	Editing, executive summary, conclusions, and partners contribution integration
Draft5	16/09/2021	Sonia Siauve (OiEau)	Quality check
Final version	17/09/2021	Fernando López	Final version

Table of content

List of figures

List of tables

List of Acronyms/Glossary

AD	*Aktsionerno Druzhestvo* (акционерно дружество) - the Bulgarian type of joint-stock company.
AI	Artificial Intelligence
API	Application Programming Interface
BSD	Berkeley Software Distribution
CEF	Connecting Europe Facility
CEST	Central European Summer Time
CSO	Combined Sewer Overflows
CSV	Comma Separated Values
DIH	Digital Innovation Hub
DMA	District Metered Areas
DT	Date Time, , Day of flow measurement (e.g.: 01/04/2020 00:00)
DTT	Extended Date Time (DT) with 15 minutes period flow (e.g.: 01/04/2020 00:15)
DW2020	Digital Water 2020
ETSI	European Telecommunications Standards Institute
EUPL	European Union Public Licence
F4W	Fiware4Water
F4W-RA	Fiware4Water Reference Architecture
GPLv2	GNU General Public License v2
GPLv3	GNU General Public License v3
GPRS	General Packet Radio Service
MIT	Massachusetts Institute of Technology
ML	Machine Learning
MVP	Minimum Viable Product
NGSI	Next Generation Services Interface
NGSI-LD	Next Generation Services Interface – Linked Data
OCT	Overseas Countries Territories
SWW	South West Water
WWTP	Wastewater Treatment Plant

Introduction

The FIWARE4Water Challenges deliverable (D6.6) belongs to WP6 Task 6.2 Ecosystem Building (M6-M36). Activities on this task are the essence of the Demo Network #3, therefore the challenges' development should be understood in the context of the general ecosystem building activities. The general objectives of this task, connected to the Demo Network #3 are:

- Open up the FIWARE ecosystem experience to Fiware4water Communication and Community in order to build on fostering promotion, knowledge transfer, collaboration, and broad uptake of technologies by SMEs. The aim is to bring support to the development of an ecosystem which will bring opportunities to all around Europe, particularly start-ups and SMEs.

- Develop specific communication and dissemination activities to raise awareness on the Fiware4Water positioning and value proposition within the FIWARE Community and FIWARE Ecosystem around with the proper selection of channels and target audiences to maximize project's impact and nurture in particular SMEs working in Smart City projects and interested in data sharing and standards for context information management and exploitation of data across verticals.

- Support the development of an ecosystem based on Open Source, Open APIs, and Standard technologies that will bring opportunities and will demonstrate FIWARE capabilities and the potential of its interoperable and standardized interfaces for both the water sector and end-users such as cities, water utilities, water authorities, solution providers and citizens, allowing cross-domain cooperation and data exchange.

This deliverable is catalogued as Other and Public and therefore accessible to anyone willing to organize a challenge on water. The document is divided into nine Chapters:

1. FIWARE4Water Ecosystem Building: introduction to the context of the FIWARE4Water Challenges' development as part of the ecosystem building activities carried out to promote FIWARE4Water outcomes within the FIWARE Community and Ecosystem.

2. FIWARE4Water Challenges Roadmap: definition of the activities carried out from M1 to M26 with regards to organisation and development of the challenges.

3. Fiware4Water Challenges - Guide for Applicants: offering and value proposition of the challenges, as well as the complete description of each competition, rules, and prices.

4. FIWARE4Water Challenges description: definition, support, and help kits to work on each of the challenges.

5. Registration Process and the Devpost platform: summary of the tool used to launch the challenges as well as the process to register the participants on the challenge.

6. Communication and Dissemination: activities carried out to promote the challenges.

7. Assessment of the submitted Challenges: analytic report of the participation in the FIWARE4Water Challenges.

8. Promotion of the FIWARE4Water Challenges Results: activities carried out to promote the FIWARE4Water Challenges winner.

9. Conclusions: lessons learnt and conclusions in the execution of the FIWARE4Water Challenges.

I. FIWARE4Water Ecosystem Building

The FIWARE Ecosystem accelerates the emergence of innovative marketplaces of smart portable and interoperable solutions, guiding industries, governments, universities, and civil society to develop their smart vision. This ecosystem shares a common vision and promotes open source technologies and standards as main drivers for the development of smart solutions in a faster, easier, interoperable, and affordable way, avoiding vendor lock-in scenarios, whilst also nourishing FIWARE as a sustainable business model.

The FIWARE Foundation supports this ecosystem together with a growing global community that shares the vision and efforts of making FIWARE open source technology the best instrument for industries, governments, universities, and associations to reach their full potential and scale up their activities to enter new markets and grow their businesses. On that front, FIWARE open source technology has been successfully used in the development of smart platforms, ranging from Japan to Uruguay, to name but a few ways in which FIWARE technologies have been getting cities and regions ready for the smarter future.

Figure 1: The FIWARE Ecosystem

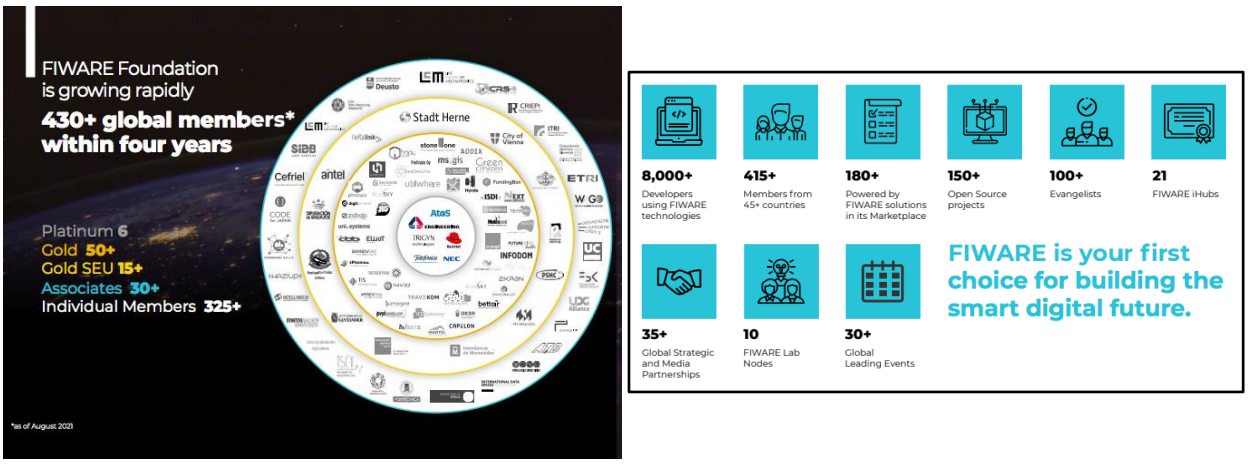


Figure 2: FIWARE Ecosystem in numbers

With the aim of helping to solve some of the challenges that the water sector is facing and bringing support to the development of smart water applications by companies all around Europe, particularly start-ups and SMEs, the FIWARE Foundation has opened up its ecosystem experience to FIWARE4Water in order to foster knowledge transfer, collaboration, and broad uptake of FIWARE4Water technologies by SMEs. To reach this main objective, the FIWARE Foundation has used, among others, three main channels: the FIWARE iHub network, the FIWARE marketplace and F4W Challenges targeting the whole FIWARE Ecosystem.

Building upon the FIWARE community, FIWARE4Water aims to create an inclusive and continuously growing network of water management companies and organisations of any kind. With the support of the FIWARE iHubs, we have enriched our technology transfer programmes to support water management-oriented SMEs in addressing the challenges in their own value chains, while supporting system integrators (innovators) in developing smart water management solutions for addressing these challenges.

The expected impact of the FIWARE4Water in growing the FIWARE Ecosystem includes:

- Increase the number of FIWARE iHubs that contribute to a rapid commercialization of those smart water management solutions through the FIWARE4Water platform for smart water management.

- Bring SMEs better opportunities to reach target customers and partners, as well as gaining market share by becoming part of a sustainable innovation-driven ecosystem, visible through the FIWARE Marketplace, leveraging on continuous marketing effort and supported by a vibrant Community.

I.1. The FIWARE Marketplace

The FIWARE Marketplace is a global one-stop shop that gives access to a wide range of “Powered by FIWARE” solutions and platforms, FIWARE-ready technologies, and solutions, as well as related training, coaching, consultancy, integration, and support services. The “Powered by FIWARE” and “FIWARE-ready” labels help entrepreneurs to gain visibility and credibility, essential to building partnerships and gaining market traction.

FIWARE MARKETPLACE
80 Powered by FIWARE Solutions
17 Powered by FIWARE Platforms
50 FIWARE-ready IoT Devices
12 FIWARE-ready Software Enablers
18 FIWARE Consultancy and Integration Services
8 FIWARE Training and Coaching Services
3 CEF Building Blocks
TOTAL: 188 ENTRIES

Table 1: FIWARE Marketplace

I.2. The FIWARE iHubs Network

Our aim is to build an ecosystem that can be used globally as middleware, and local action is needed to achieve this. This is why FIWARE is establishing FIWARE iHubs worldwide, to support companies, cities, and developers with an easy access to open source technologies, business development and community building.

The FIWARE iHubs are innovation centres that promote the adoption of open source FIWARE platform technologies to support digitalisation, business development and leadership through community building, training, and educational activities. The main objective of the FIWARE iHubs network is to address the traditional barriers for business expansion of SMEs and large companies, by providing innovative technologies and an ecosystem that connects them to their target markets. Each FIWARE iHub boost collaboration at local level and between regions acting as a meeting point for start-ups, SMEs, private companies, public administrations, universities, and research institutions, supporting all these actors to make a real impact in the market.

FIWARE iHubs focuses on matchmaking market solutions with internal challenges, accelerating the development, use and commercialization of FIWARE solutions, and nurturing a culture of digital innovation and collaboration at a local level. We understand that the driving force of the data economy is the collaboration between the many players in society, not just a single individual or company.

- Each FIWARE iHub brings added value to local communities thanks to a technology that is addressing innovation needs and challenges in different sectors.
- Each FIWARE iHubs is part of a worldwide community then, goes beyond regional boundaries and helps its clients to gain global positioning, get worldwide promotion and international scalability
- Being part of a community, they will also benefit from multi-partner cooperation to reach their markets and also a continuous technical enablement.

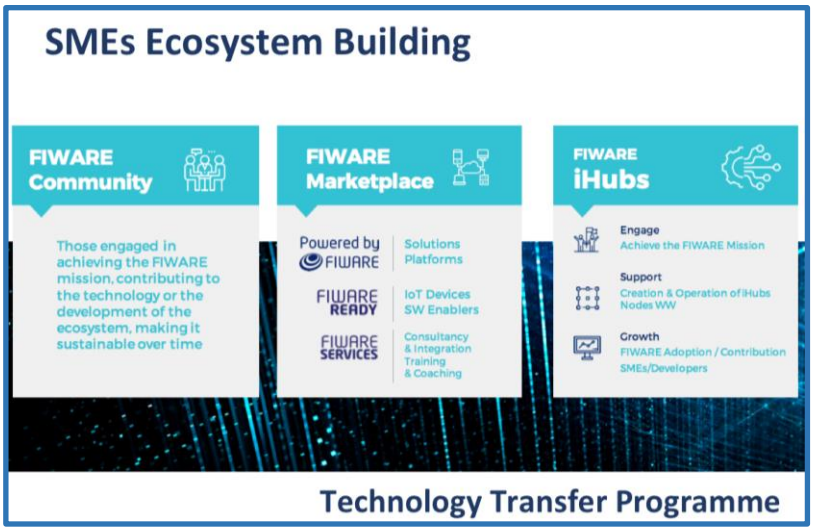


Figure 3: Machine learning development flow

II. FIWARE4Water Challenges Roadmap

The challenge's roadmap was designed to support the development of innovative water-related applications within the FIWARE ecosystem and beyond to increase internal and external interoperability of water services within smart cities.

II.1. Changes in the schedule

On M11-M12 we discussed and finally proposed a change in the schedule of the challenges and an amendment on the description of Milestone 10 and D6.6:

- Change in Milestone description MS10 “FIWARE4Water challenges performed” to M25 (end of June 2021). It means of verification “FIWARE4Water challenges performed, Awards presented to winners”. This meaning that: the challenges have been defined, described, launched (open call), promoted, applications gathered, selection of winners done, and awards officially presented to winners.

- Deliverable D.6.6 “FIWARE4Water Challenges” - M26 (end of July 2021). As the milestone will be performed in M25 we consider one month to present the deliverable with all the information required.

Note: The challenges were performed at the end of July 2021, therefore the submission of this deliverable has been postponed to the end of August 2021 (M27).

There are two major reasons why this change of the schedule was proposed:

- Firstly, at the time the FIWARE4Water proposal was written, and even the FIWARE4Water Grant Agreement signed, the Orion product (only market-ready implementation of the FIWARE Context Broker) was only supporting the NGSIv2 API, which was the predecessor of the NGSI-LD API finally standardized by ETSI. Therefore, Orion and the NGSIv2 API would be used in the project and challenges would be launched based on them as initially planned. However, parallel to development of the project, the estimations about dates for a first implementation of NGSI-LD have become clearer and a reasonable complete beta version of the Orion-LD implementation is planned for the FIWARE release planned in M16 (end of September 2020), which will be officially

announced at the FIWARE Summit (Málaga 28-29 September 2020). Hence, it was worth considering that NGSI-LD could be used in the project instead of NGSIv2, not only for the development of the first prototypes of pilots considered in the project but also for developments associated with the planned F4W challenges. This required an adjustment of the planning associated with F4W Challenges.

- Secondly, Demo Cases should be engaged as facilitators / supporters of the challenges and should contribute to their definition. As soon as the platform was ready (M16), they would test the platform and give their feedback for its evolution. Demo Cases were therefore asked to prepare/propose at least one challenge targeted to extend their functionality by means of adding applications which exploit a) historical data or real time data they can provide or b) new data coming from additional sources.

The detailed work plan and roadmap associated to the new schedule was the following:

- The design and implementation of the F4W platform Reference Architecture (Task 2.1) has been started based on the requirements defined in WP1. Components of the Reference Architecture will be ready for use by the Demo Cases on M16.

- Task 2.3: Common Information Models for Water Management although planned to start in M18 already started at M8. FIWARE smart data models should play an important role in the usage/testing of the platform based on NGSI-LD.

Considering the aforementioned points, the dates on the F4W challenges work plan and roadmap were redefined as follows:

- Phase 1: Preparations (M1-M13) - definition of objectives, budget available, tentative prize structure, innovation, and growth opportunity, launch of the FIWARE4Water questionnaire (M5), activity review and follow up. Analysis of the contributions from WP1 survey and requirements (M8-M10).

- Phase 2: Definition of Scope (M13-M16) - analysis of the engagement Platforms, environments for supporting the F4W challenges, supportive partners, facilitators. During the 2020 FIWARE Summit (cancelled because Covid), a workshop was planned that could help to discuss the general scope of the challenges and define next steps engaging the Demo Cases owners.

- Phase 3: Design (M16-M20) - define the number of Challenges, terms and conditions, legal basis & contest rules, eligibility criteria & evaluation process (relying on demo cases contributions, liaisons with facilitators and sponsors, demonstrations of interest, relation with data models) review of the tentative prize structure. Calendar for the launching, application, and implementation.

- Phase 4: Open Call (M20 - M23) - official launch of the Open Call and period until deadline during which support is provided to applicants: technical webinars for applicants (supported by all project partners with a clear role on defining architecture and data models), info days, feedback sessions, interactions, assess applications, evaluation.

- Phase 5: Selection of winners (M24-M25) - send files corresponding to finalist to members of defined jury, run final decision, publish list of winners, and give away prizes in an Award Ceremony

during the 2021 FIWARE Summit (initially planned end of September 2021 and postponed due to Covid restrictions).

- Phase 6: Refinement of implementation (MVP)* and promotion (M26-M36). Depending on the engagement of the partners, facilitators, networks, sponsors, the idea is to support the development of MVPs (Minimum Viable Products) as part of the award. We looked for cities, utilities, iHubs that could support the further development of the winner's ideas and first prototypes. During this period, we were planning to also build impact stories and try to bring the new proposed solutions in the FIWARE Marketplace.

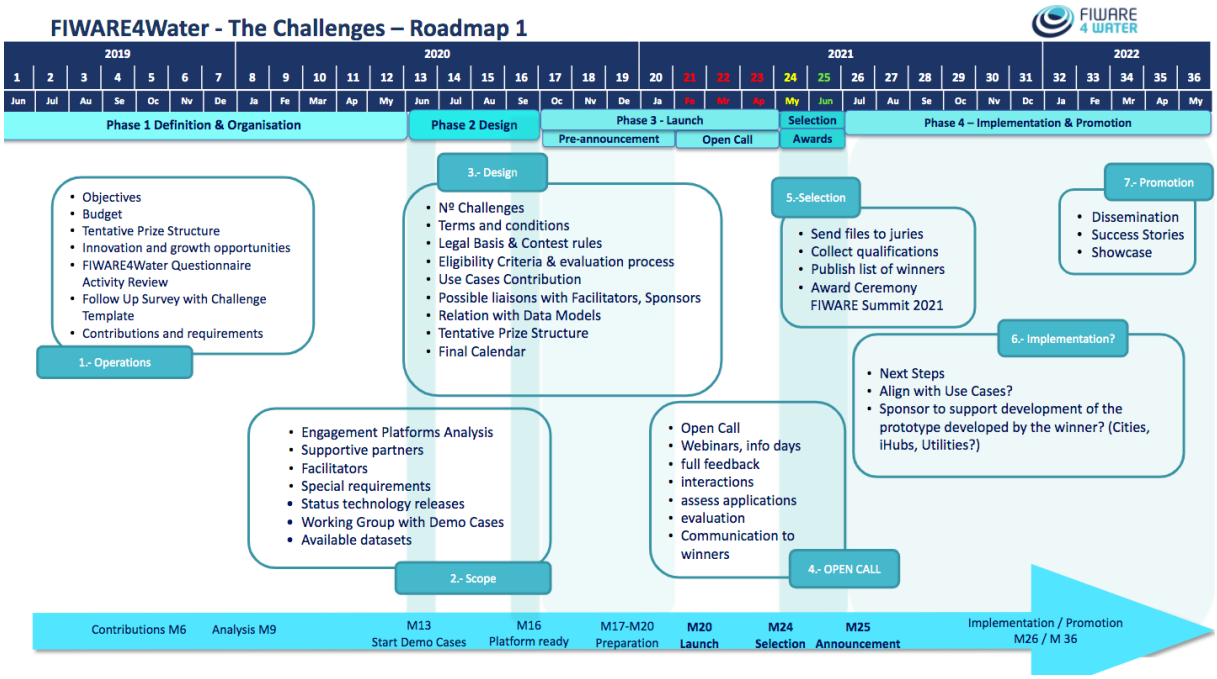


Figure 4: FIWARE4Water Challenges Roadmap

II.2. Phase 1 - Preparations (M1-M13)

As planned, Phase 1 included the definition of the objectives, analysis of the budget available, the tentative prize structure, innovation, and growth opportunities. Due to the fact that monetary prizes were not allowed, in order to boost participation, we tried to involve facilitators, sponsors and other stakeholders from the very early beginning of the project with the following target profiles:

1. Facilitators: water utilities, technological centres, public administrations with the ambition of improving competitiveness through better access to technological and business development activities and fostering innovation through the adoption of new technologies and community building. Looking for: new markets development, competitiveness, digital transformation, vision and future, solvency, expertise, reputation, and support.

2. Technology Providers: Cutting-edge technology experts selling tech in global markets, FIWARE Based (or interested in).

   Looking for: new FIWARE technical expert candidates, knowhow in water, energy, industry & smart cities, access to international markets.

3. Digital Innovation Hubs: one-stop-shops that help companies to become more competitive with regard to their business/production processes, products or services using digital technologies

   Looking for: access new technologies, innovation, activities, and resources oriented to supporting start-ups, pilot programmes, etc.

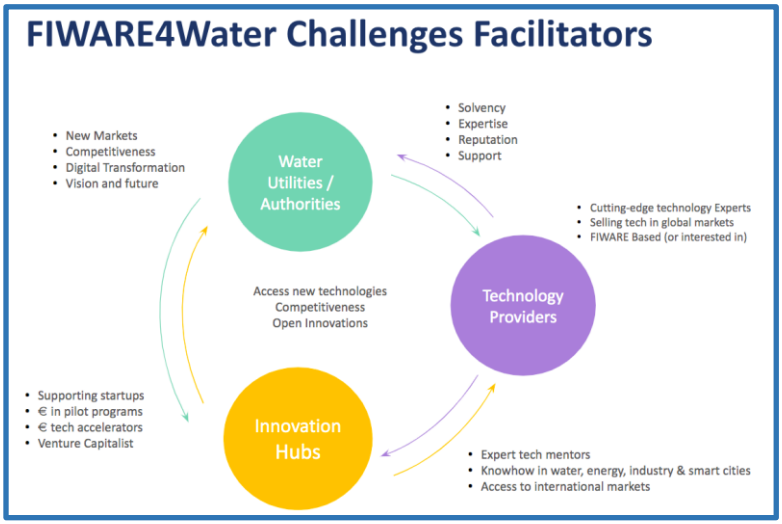


Figure 5: FIWARE4Water Challenges Facilitators

Presentations were done to:

- Global Omnium: 5 world top water utilities - 4 continents - 400 cities in Spain - 7 million customers - Drinking water supply, sanitation, purification, irrigation.
- Kommunal 4.0 - HST Systemtechnik GmbH & Co. KG (consortium leader) - Centralization of information in municipal water management. - Digitization of municipal infrastructures
- Plataforma Tecnológica del Agua: Coordination Spanish DIH network in collaboration with DIHNET – Integration into the DIH already supported by the Galician government.

The objective was to get involvement of these companies in a win-win situation offering them promotion through the sponsorship and getting from their side some support for pilot development & monetary prizes.

Note that the objective of the challenges as defined in the Grand Agreement was to grow the ecosystem of SMEs developing Powered by FIWARE Solutions using FIWARE4Water technologies. This promise, given the design of the proposal, was unaffordable without sponsors & facilitators.

The support from the sponsors would bring this contribution to the challenges:

- Sensors (mobile sensor units, IoT Devices…) – Datasets

- Wireless sensor networks, water quality control systems, park, and garden irrigation…
- Combining interoperable industrial IoT technologies under a Smart City focus
- Digital Transformation Context
- Possibility of implementing pilots

With the following fundamental requirements:

- Collecting representative data
- Harmonized data models

During this phase, a Fiware4Water questionnaire was sent to the FIWARE Ecosystem in M5. The questionnaire was part of Task 1.3 and the objective was to collect feedback in terms of creating the corresponding requirements for a FIWARE Reference Architecture related to Water Management with two specific questionnaires:

- SURVEY #1 - Requirements from the end-users to get details about which smart applications they were using, which software used on a smart application, the data management practices and the current demand for smart applications.
- SURVEY #2 - Requirements for innovation, in which we asked them about the usage of the open source platform, sharing water-related data, and technical information about the data.

The questionnaires were translated to different languages (Deutsch, English, Español, Français, Dutch) to facilitate the understanding of the questionnaires and help users to complete them.

In the email we also explained what the project was about and why we were contacting them as an important game-changer in the Water sector to join forces in developing specific water-related innovations. Understanding that so far little progress had been made on developing specific water-related applications using FIWARE Technology, due to fragmentation of the water sector, restrained by licensed platforms and lagging behind other sectors (e.g., telecommunications) regarding interoperability, standardization, cross-domain cooperation, and data exchange, we thought that together with them, we could solve pressing issues in the Water Sector with the use of FIWARE technology.

The results of this survey can be reviewed in D1.3. For the challenges development we used the answers to some of the questions included in the survey, for example:

- Are you interested in solving a problem by sharing one or more datasets related to the Water Sector?
- Are you willing to provide one or more Challenges to Fiware4Water?

- Are you using any standard data model for your data?
- Are you interested in using the standardized models developed in Fiware4Water?

It is important to clarify that this note was included in the survey:

> *"A Challenge does not only mean a data set, but also a concrete question or problem to be solved. The idea is that this Challenge is published on the FIWARE platform just like a simple data set. Anyone, be it an interested citizen, a start-up, or a company can work on this challenge and try to develop a solution. An example:*
>
> *Given is a data set containing time series of different water quality sensors. The sensors monitor the quality of drinking water at the exit of a waterworks. The employees visually check the time series on a daily basis in order to detect deviations or deteriorations in water quality. The question is whether an algorithm can be developed that automates this check and issues an alarm in the event of changes. In order to test the performance of the algorithm, additional information is provided for each point in time as to whether or not there was a real change in water quality at that time.*
>
> *In addition to a good challenge, a so-called metric should also be provided, i.e., a calculation rule with which the performance of the algorithm is determined on the basis of its calculations/outputs. In this example, this could be the accuracy, which describes how often the algorithm has correctly detected a change in water quality.*
>
> *If you are willing to provide a challenge, it will of course be published in a standardized and anonymous way. Fiware4Water plans to publish challenges from time to time and create incentives for others to participate. So, if you are willing to provide a challenge, the advantage for you is that your problem will be solved and helped by someone else. Such competitions are widely used in other industries. A prominent example is the data science platform Kaggle (https://www.kaggle.com/), where numerous companies published challenges to solve their problems (automotive, trading sector, financial sector; companies like Santander, Google, Mercedes etc.)."*

We followed up on a total of 20 responses from different users. Activities performed following up the results of the survey are summarized in this table:

Question	Yes	Emailing
Are you interested in solving a problem by sharing one or more datasets related to the Water Sector?	8	2
Are you willing to provide one or more Challenges to Fiware4Water?	1	2
Both	11	2

Table 2: Information obtained from the Task 1.3 Questionnaire

Email templates sent to possible challenge's sponsors and data sets providers can be reviewed in this link[1]:

- Those interested in providing Data and Challenges, with no relevant interest in FIWARE
- Those with Interest in providing Data and Challenges and interested in FIWARE
- Those interested in providing with a Challenge but no datasets
- Those just willing to share data

One to one conversation without positive results in terms of "challenge proposals" (meaning real issues to propose to the SMEs community) were held in some cases after two rounds of emails.

In short, after their positive answer, the participants were asked to propose a challenge using this template:

- Title of the Challenge - Problem to be solved
- Summary of the Challenge proposed
- Water Domain
- Proposed by - Companies / Organisations involved
- Description of the challenge and the benefits that the solution will bring providing quantifiable indicators if possible
- Expected Outcomes and measures
- Data Sources
- Prize - Such as money, involvement in pilots, projects, friendship, implementation
- Target Audience

II.3. Phase 2: Definition of Scope (M13-M16)

After the results with the Phase 1 survey follow up, a specific working group was set up in September 2020 when the F4W-RA components, especially the new FIWARE Release with NGSI-LD support, were ready for use by the Demo Cases.

The objective this time was to work in the definition of Challenges, terms and conditions, legal basis & contest rules, eligibility criteria & evaluation process, relying on FIWARE4Water demo cases contributions. Five meetings were held from October 2020 to December 2021 with the objective of launching the challenges in the planned months scheduled. A detailed presentation with the background was shared with all the participants: EGM, Suez, Eurecat, OIEau, Exeter, Waternet, NTUA, South West Water and colleagues from the DW2020.

[1] https://docs.google.com/document/d/1lRTtN3Rq5IVwZnvdfqNgVcYPN-taC_LGJUbP_oxy45o/edit?usp=sharing

Working group activities

The working group discussed together on the following topics:

- Challenges definition and positioning.
- Applicant targets.
- Issues/problems to solve (business/technical).
- Concrete outcomes, consider the evaluation process.
- Which kind of data are we able to provide?
- Timing and resources.

Most important conclusion was that the integration of FIWARE within the legacy systems and supporting reference architecture was at a very premature stage to conceptualise a challenge in most of the use cases. Therefore, we decided to adapt to the contributions gathered from Digital Water City (proposing two challenges for Milano and Sofia) and FIWARE4Water (South West Water use case).

II.4. Phase 3 to Phase 6: Design and Implementation

The Challenges definition, terms and conditions, legal basis, contest rules, eligibility criteria, evaluation process, prize structure, calendar for the launching, application and implementation is defined in section 0 in the complete guide for applicants.

Due to the nature of the challenges proposed that finally were targeting data scientist to propose Machine Learning and Artificial Intelligence algorithms and the time restrictions, technical webinars were not scheduled, and we set up a slack channel to support applicants with the contribution from EGM, Eurecat and the FIWARE Foundation.

Details on the implementation and promotion are described in Sections 0 and VI.

III. Fiware4Water Challenges - Guide for Applicants

III.1. What is FIWARE4Water

FIWARE4Water is a European research and innovation project aimed at creating more efficient water management processes and bringing together communities of innovation suppliers and end-users. The project links the water sector to the smart solution platform 'FIWARE' via demonstration projects in the water cycle. FIWARE makes it possible to combine and process various data streams, such as water quality and meteorological information, into a standardised output. The water sector can then use this output, for instance, to improve operational management, create maps and build AI systems.

Fiware4Water is moving ahead diving into the digital transformation of the water sector and demonstrating FIWARE capabilities and the potential of its interoperable and standardized interfaces for both the water sector and end users such as cities, water utilities, water authorities, solution providers and citizens, allowing cross-domain cooperation and data exchange.

The development of modular smart applications using FIWARE and open API architecture for the real-time management of water systems will connect the end-users and innovation supplier communities for water compliant interfaces and data models on a comprehensive cross-domain platform associated with 4 demo cases for smart water applications and 3 demo networks.

Fiware4Water, is led by the International Office for Water (France) and counts with a consortium formed by 14 European partners. The project results will be validated in real scenarios in the city of Athens (Greece), Cannes (France), Amsterdam (The Netherlands) and Cranbrook (United Kingdom)

Fiware4Water consortium:

Office International de l'Eau, Easy Global Market SAS, National Technical University of Athens, University of Exeter, Deutsche Verein des Gas- und Wasserfaches, Centre national de la recherche scientifique, Etaireia Ydreyseos Kai Apochetefseos Proteyoysis Anonimi Etaireia, FIWARE, Waternet, SUEZ Smart Solutions, Business Development Group, South West Water

For more information, visit Fiware4Water website[2]. You can also contact us by email challenges.support@fiware4water.eu. More details on how to contact us can be found in section 15[3] of the guide for applicants.

III.2. What does Fiware4Water offer

Fiware4Water is bringing water into cross domain applications, using standardised interfaces, models, and methods, also to increase interoperability. We are boosting innovation in the water domain helping to take the most of data and generate significant benefits for European SMEs. The economic consequences of the implementation of the FIWARE methodology will provide outstanding opportunities for local businesses and especially SMEs to become not only passive receivers of innovation but proactive catalysts for future developments.

The main benefits offered by Fiware4Water are:

- support SMEs and developers in creating innovative services.
- make these services as generic, interoperable, and replicable as possible
- exploit those services under the FIWARE marketplace/platform
- adapt new devices (water quality sensors and smart meters) to be FIWARE-compliant and thus highly interoperable

[2] https://www.fiware4water.eu
[3] https://docs.google.com/document/d/1RiFFizD60CKrqwfG5-eJ9Wnx2PMtAokYAJi6RpJBT8o/edit#heading=h.3fwokq0

We are supporting solutions to increase internal and external interoperability of water services within the smart city, kick-starting the creation of a new innovation ecosystem for water sector services.

We are offering an open architecture that can be used by water utilities as well as third parties to develop solutions and applications. By providing representative data of specific fields (smart meter readings, time series of flow/pressure of water distribution networks, etc.) in a standardized form, third parties can develop new ideas of how to use this data to solve specific problems (e. g., leak detection).

Fiware4Water is about creating a reference architecture for how FIWARE can be used in Water Management and test it in real pilots. We are launching a number of challenges where we provide the FIWARE platform and ask developers/SMEs/start-ups to come with proposals of solutions. The challenges are targeted to the definition of Machine Learning (ML) models to be integrated in a FIWARE stack that includes a framework for AI/ML services we are building within the project.

III.3. Deadlines

- Opening of the submission is Wednesday, 26 May 2021 at 4:00 PM CEST
- Submission deadline between Tuesday, 29 June 2021 at 8:45 AM and Thursday, 1 July 2021 at 6:00 PM (CEST)
- Preselection process from Thursday 1 to Thursday 8 July 2021
- Communication preselected solutions: Thursday 8 July
- Elevator Pitches: Thursday, 15 July 2021 from 9:00 AM to 5:00 PM CEST
- Consensus meeting: Friday, 16 July 2021
- Communication to winners: Monday, 19 July 2021
- 31 August 2021: Official announcement of winners during the Aqua360 Virtual Conference (https://www.aqua360.net).

The Fiware4Water Challenges may also include virtual training sessions on Fiware4Water technology.

III.4. Eligibility Criteria

All applicants will have to abide by all general requirements described in this section to be considered eligible for Fiware4Water Challenges. Therefore, please read this section carefully.

III.4.1 Who are we looking for?

Participants of this Fiware4Water Challenges must be 18 years old or have reached the age of emancipation in the jurisdiction in which they are submitting the challenges. We are looking for individuals, teams or SMEs registered in any of the following countries:

- the Member States of the European Union and its Overseas Countries and Territories (OCT)[4], or
- Associated Countries to H2020[5], or
- The United Kingdom, or
- Participants in the DW2020[6] projects and other related EU projects.

All members of your team must meet the eligibility criteria described in this document. If any member of your team is ineligible or otherwise fails to comply with this Participation Agreement, the team as a whole may be disqualified in Offline or Online validation process. Each team is solely responsible for its own cooperation and teamwork. Fiware4Water will not officiate any dispute between members regarding cooperation, participation, conduct, prize sharing or intellectual property ownership.

Select one member of your team to enter the information into the registration form. The team leader who submits the solution will receive an email confirming the submission details. While one team member submits the form, all team members are required to accept the Participation Agreement as part of the registration process.

At registration time, the team information shall be provided through the registration system[7].

Figure 6: FIWARE4Water Challenge registration form

[4] https://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2018-2020/annexes/h2020-wp1820-annex-a-countries-rules_en.pdf
[5] https://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/3cpart/h2020-hi-list-ac_en.pdf
[6] https://ec.europa.eu/easme/en/section/horizon-2020-environment-and-resources/synergy-group-digitalwater2020
[7] http://enquetes2.oieau.fr/index.php/379652

The registration to the Fiware4Water Challenges entails the acceptance of these guidelines and the legal notice[8]. Participants are solely responsible for the information provided and undertake to respond to any requests for information from promoters.

III.4.2 How to apply

Fiware4Water Challenges registration will be open from Wednesday, 26 May 2021 at 4:00 PM (CEST) to Thursday 1 July 2021 at 6:00 PM (CEST). All proposal developed as a part of the Fiware4Water Challenges must be "fresh", meaning that the portion that is included in the main GitHub open repository has been developed during the time period for this Contest (Wednesday, 26 May 2021 at 4:00 PM (CEST) to Thursday 1 July 2021 at 6:00 PM (CEST)) and that all existing dependent libraries are equally available to all participants.

We will evaluate only proposals submitted through the online application[9] within the submission period from Tuesday, 29 June 2021 at 08:45 AM and Thursday, 1 July 2021 at 6:00 PM (CEST). Upon receipt of each proposal, we will send you a confirmation of your submission.

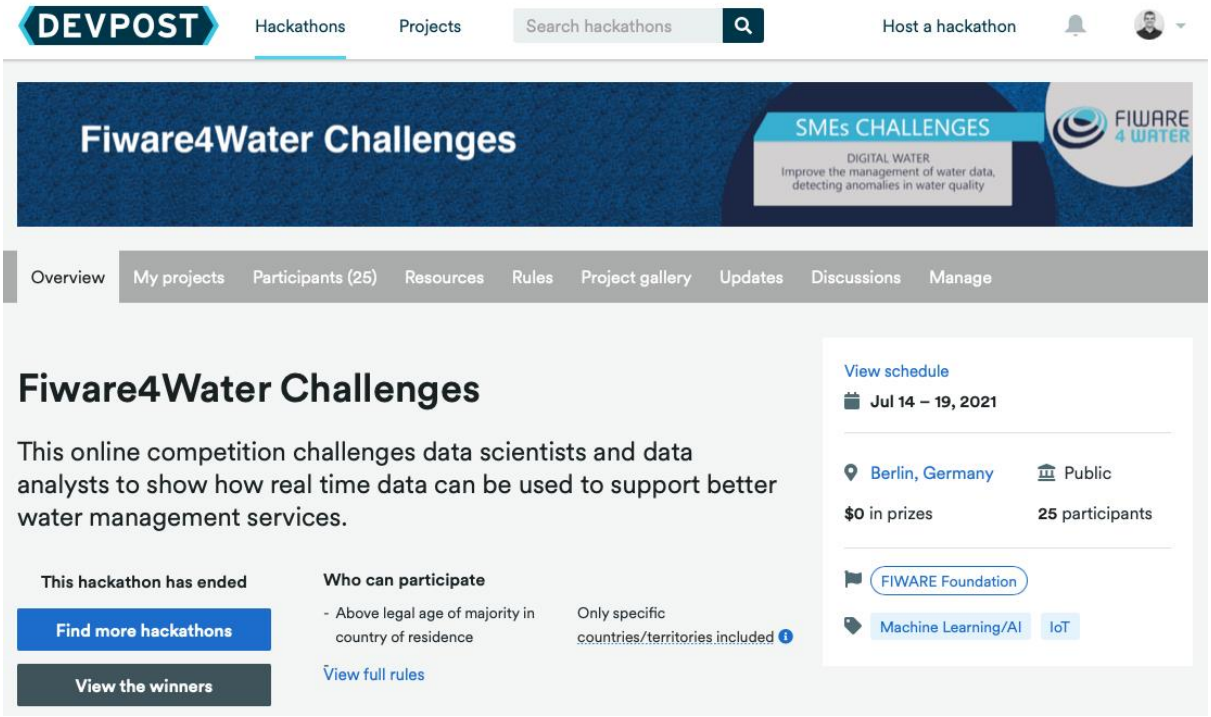


Figure 7: FIWARE4Water Challenge Devpost overview

[8] https://www.fiware4water.eu/legal-notice
[9] https://fiware4water-challenges.devpost.com

III.4.3 Other Eligibility Criteria

When applying to Fiware4Water challenges, please also note that:

- You have to verify the completeness of the registration form, as it will not be possible to add any further information after the deadline. After the proposal is submitted, you will be able to modify the registration form data until the deadline by contacting dpo@oieau.fr.

- You can submit only one proposal to solve a specific challenge. If more than one proposal is identified, only the last proposal which has been submitted in order of time will be evaluated.

- Your proposal must be written in English in all mandatory parts in order to be eligible. Only parts written in English will be evaluated.

- All mandatory sections of your proposal must be completed. The data provided should be actual, true, complete and should allow assessment of the proposal. Additional material, not specifically requested in the online application form, will not be considered for the evaluation. We will check all the information provided in your solution during the evaluation phase.

- Your project should be based on your original work or your right to use the IPR from third parties must be clear. Going forward, any foreseen developments must be free from third party IPRs, or those third-party IPRs must be clearly stated. When using open source components please identify clearly what license they have.

III.5. Experimental data access rights

No GDPR protected data will be used across the challenges. The data supplied for the challenges are subject to copyright. Participants accept the responsibility of their use only for the purpose of the challenge. They commit to remove it once the challenge has been completed. Being accepted as a participant entitles you to access the data according to the specific conditions. By accepting your participation, you are accepting these conditions to access the data.

You agree to use suitable and appropriate measures to prevent persons who have not formally agreed to the rules of the Fiware4Water Challenge from gaining access to the Data Challenges. You agree not to transmit, duplicate, publish, redistribute, or make available this data to any party that is not participating in the Fiware4Water Challenge. You will be responsible for the same should they occur. if there is an unauthorized transmission or access to the data, you agree to notify us immediately upon learning and work to resolve this action.

III.6. Evaluation of proposals

The evaluation process is transparent, fair, and equal to all participants. The evaluation process consists of an analysis of the submitted solutions in two phases. The first stage is focussed on the achievements of the global requirements of the challenge in terms of a real solution and integration with Fiware4Water. This procedure is developed offline. The second stage consists of a set of virtual meetings with the preselected winners candidate in order to see the solution working and answer questions from the jury in order to take the final decision about the winner of the Challenge on each category. Goals for the challenges are explained in Section IV.

III.6.1 Experts Evaluation

In this phase, all eligible proposals will be evaluated by experts in Fiware4Water technologies, Data Models, and Challenges owners. Selected solutions will be appointed to run a demo video conference meeting Thursday, 15 July 2021. Your proposal will be evaluated within the following awarding criteria.

Off-line evaluation (70%)

Each challenge has a set of rules and metrics that are going to be used to score the machine learning models. The best machine learning model delivered will receive the 100% score, while others will have a scoring relative to the performance in comparison with the best model.

On-line evaluation (30%)

This will be assessed on the selection Day (see next section). Only those higher scoring projects will pass to the selection day.

III.6.2 Selection Day (Demo Day)

If your project is among the finalists, you will be invited to an online Selection Day 15th of July, where you will have the opportunity to pitch your project (demo to show the execution) in front of the Fiware4Water Challenge's Jury. After Selection Day, we will communicate the winners of the Fiware4Water Challenges.

III.6.3 Public Presentation of Proposals

Each team presents its proposal with a pitch of 20 minutes in English in a ***Virtual Pitch*** session plus 10 minutes for jury questions. The virtual presentation (with the subsequent evaluation) takes place on Thursday, 15 July 2021 from 9:00 to 17:00 CEST. The virtual session details are communicated to participants in the Slack channel defined in the Section III.14. The Jury, referred to in Section III.6.4, evaluates the proposals according to the info provided for in Section III.6.1.

III.6.4 Composition of the Jury

The final composition of the Jury will be made public by Friday, 2 July 2021 as may be modified, due to the unavailability of one or more members at any time by the promoters.

The expected members of the Jury are:

- At least a representative of FIWARE Foundation, EGM, Eurecat
- At least a representative of the entities providing with the Challenges
- Another independent member expert on water domain

The Jury will meet at the end of the presentations on Thursday, 15 July 2021 and will draw up a ranking of the projects presented for each challenge. This date can be changed depending on the number of proposals submitted to adequate the proper On-line validation during demo day. There will be 3 winning

individuals/teams, one for each challenge. Nevertheless, the jury may reject any Submission that does not satisfy the objectives. The jury is sovereign and its judgment is final. It follows that no complaint can be accepted following the nomination of the winners.

III.6.5 What's Next? Call Agreement preparation and signature

Before the selection starts, we will ask all members participating in a team to approve their participation in the challenge.

Please do it within the deadlines that will be communicated to you. If you fail to deliver the requested documents on time, without clear and reasonable justification, we will exclude you from the further formal assessment and you will be replaced.

III.7. Prizes arrangement

Three winning solutions will be selected. One per each challenge. The prizes include:

1. FIWARE Foundation and EGM intend to create a consortium to submit a proposal for the IBM 2021 Call for Code - Clean Water and Sanitation[10]. One representative (1) for each of the winning solutions will be invited to join the consortium. However, if the consortium agrees to not submit the proposal or the proposal does not get selected, FIWARE Foundation and EGM are not liable for any consequence.

2. Starting from 01.08.2021, one (1) year of free social media promotion and global visibility thanks to being featured throughout international cross-media channels of FIWARE Foundation.

3. Starting from 01.08.2021, automatic subscription to the free technical webinars provided by FIWARE Foundation. Winners can unsubscribe to the event list at any time.

4. Joining the FIWARE Marketplace to provide visibility and commercial opportunities based on the awarded solution.

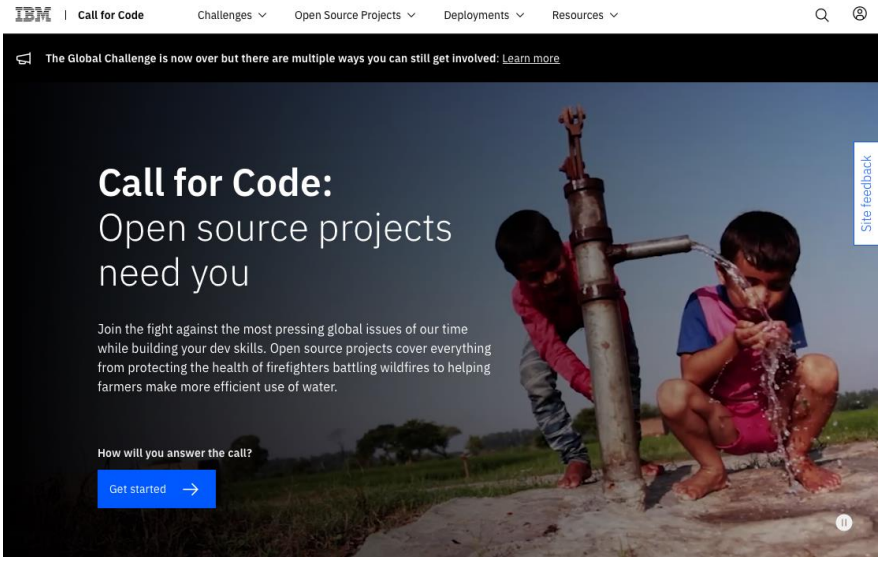


Figure 8: IBM Call for Code

[10] https://developer.ibm.com/blogs/2021-call-for-code-launch

III.8. Intellectual property

The solutions delivered by the teams will be open source[11]. A solution can be freely used, modified, and distributed without worrying about the use of software: personal, internal, or commercial. Nevertheless, the provided data during the competition is private, and belongs to each challenge promoter. Accepted licenses[12] include GPLv2, GPLv3, EUPL, AfferoGPL, MIT, BSD, etc as examples but other licenses compliant with previous requirements will be accepted as well.

III.9. Personal data and Image Rights

Promoters and their members are authorised to disseminate the names of the winners, the name of the project, its purpose and description, together with extracts or images of the final product.

Each team member agrees that the promoters and their members will photograph or film him/her and disseminate to the public images that may include his/her person.

III.10. Right of Disqualification and Exclusion

The promoters reserve the right to disqualify anyone who does not comply with the rules, materials made available to him/her, and the premises of the Challenges.

III.11. Cancellation or Change of Dates

In the event of extraordinary events or other circumstances that make it necessary, the promoters may cancel the Challenge or move it to another date.

III.12. Other Provisions

The participant acknowledges that he/she has been informed that he/she will be held solely responsible for any inaccuracies contained in the registration format he/she has completed or for any failure to comply with the obligations contained in the regulations.

III.13. Applicable Law

The applicable law is the German law. In the event of any dispute concerning the interpretation or enforcement of the Regulation, the case shall be brought before the competent court in Berlin. Promoters and partners are not responsible for damage, loss or theft of materials and equipment used by participants for the performance of their work within the Challenges.

[11] https://opensource.org/osd
[12] https://opensource.org/licenses/category

III.14. Additional Information

- **Where to find additional information:**
  - Fiware4Water website: https://www.fiware4water.eu/smes-challenges
  - Hackathon platform: https://fiware4water-challenges.devpost.com
- **Questions regarding the Challenges process**
  - We have created a specific email account to resolve any management question about the FIWARE4Water Challenge under the Helpdesk at challenges.support@fiware4water.eu.
- **Technical questions**
  - A Slack workspace has been created to allow discussing technical details or problems with the Fiware4Water technical team in a reactive and interactive way.
  - To join the Slack workspace, you can use the following link: https://join.slack.com/t/f4w-challenges/shared_invite/zt-opnbyzg7-TrdHwkHizB1384euyZWJOg

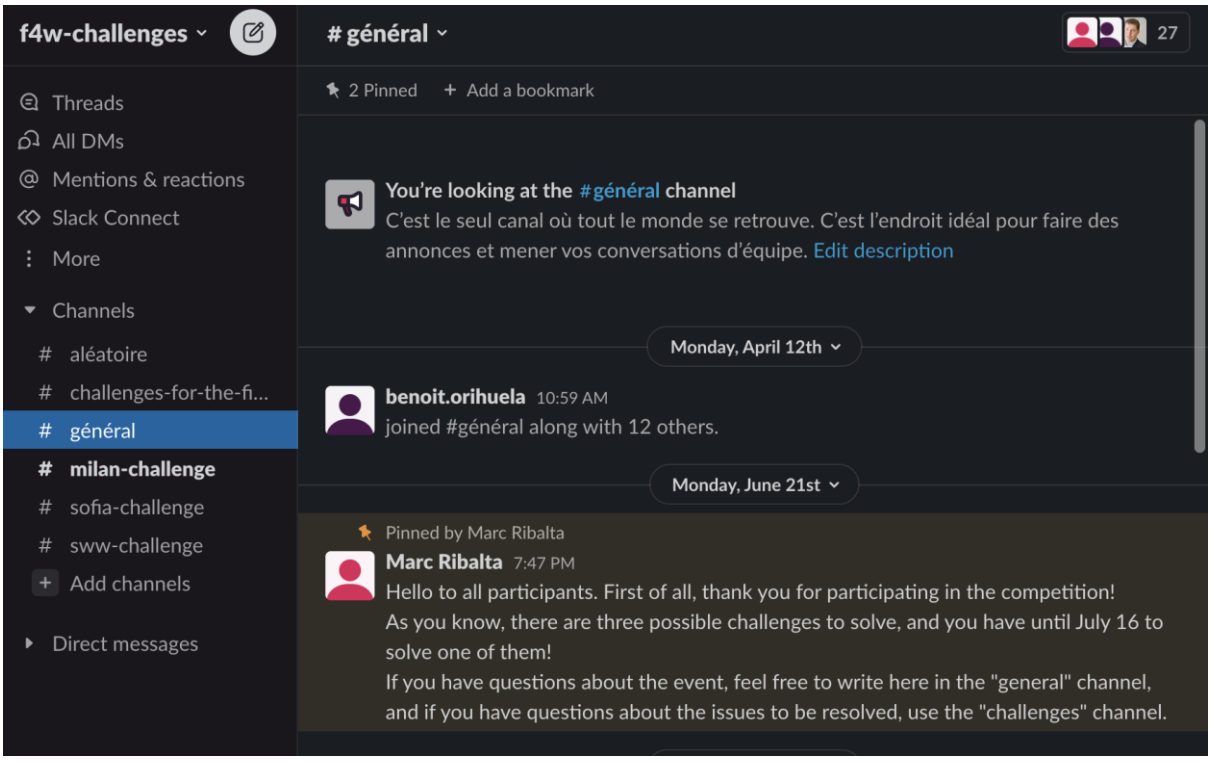


Figure 9: FIWARE4Water Challenge slack channels

  - Once you have joined, you can ask your questions in one of the following ways:
    - In the #general channel if it is a general question about the technical environment, the FIWARE ecosystem, and so on.

- In one of the channels specifically aimed at discussing about a challenge (#sofia-challenge, #milan-challenge, #sww-challenge)
- Also, it is possible the creation of private channel and invite the Fiware4Water technical team in it if the discussion does not want to be disclosed

  - As a side note, when a new technical issue wants to be raised, it was recommended to include the following information in the message:
    - details of the specific problem (error messages encountered, bugs descriptions, i.e., if a dropdown list isn't working, etc.)
    - screenshots of the problem if it can help.
    - Any other relevant information that can be considered appropriate to explain the issue.

- **Slack usage statistics**

  - In the course of the Fiware4Water challenge, 28 members have joined the Slack workspace and 523 messages have been exchanged between the participants and the FIWARE4Water team.

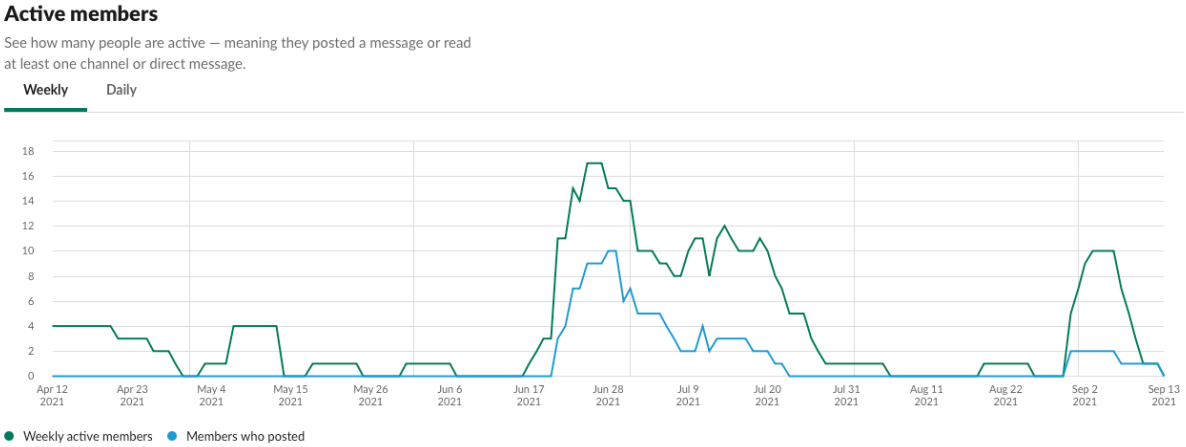


Figure 10: f4w-challenges slack channel, active members

IV. FIWARE4Water Challenges description

This competition challenges data scientists and data analysts to show how real time data can be used to support better water management services through the data generated by digital meters and providing feedback to consumers and water utilities. Evidence through data is critical to address the many challenges that the water sector is facing. Recent advances in machine learning (ML) and data analytics (DA) technologies have provided the opportunity for more efficient use of the vast amount of data generated by sensors, meters, and other devices.

The aim is to improve the management of water data, detecting anomalies in water quality, sensors out of range to evaluate their impact and possible actions by implementing ML/AI algorithms. It is necessary to know how to detect false positives, and other anomalies in the interpretation of the data (processing with ML/AI) to be able to differentiate a non-significant anomaly from those that require action. In short, the solutions to the FIWARE4Water challenges should help to:

- To be able to monitor the quality of the water to be treated in real time and anticipate water treatments based on this data
- To improve the quality of service, improve efficiency to avoid extra costs in water treatment
- To Reduce decision-making times

The details for the reference architecture and the implementation required to address the challenges can be found in detailed document - ML as a service specification[13].

IV.1. Challenge 1 - Sofiyska voda AD

Proposed by: Sofia, Sofiyska voda AD

Title: Analysis of the Sewer Network's behaviour (with perspective of "Real time control of sewer network")

Domain: Real time control of sewer network

Summary: Sofiyska voda AD searches for a solution that can combine both data from sensors' measurements in the sewerage network (level meters, low-cost temperature sensors data for Combined sewer overflow monitoring etc.) and rain gauge data, to be able to perform a cross-analysis of the measured parameters knowing if they happen in dry weather or during rain events. The prospect of the solution will be a real-time control of the behaviour of the sewer system.

Description: For several years since now, Sofiyska voda AD has been measuring the water levels of the sewerage network of the city of Sofia. The measurement is performed with Level Meters and controlled through the SCADA system (see Figure 11).

Figure 11: Installation of the water sensor - 1

[13] https://docs.google.com/document/d/1XFA3lnApJavc_sumLlQYiRrFxfsVhXMOx-A_EOGm2rA/edit?usp=sharing

From 2019, the utility takes part in the Digital Water City Project, as a demonstration city for Low-cost Temperature sensors, monitoring the frequency of overflow of the Combined Sewer overflows (CSOs) (see Figure 12). 20 Offline Temperature sensors are already installed in 10 selected CSOs, 40 other CSOs are going to be monitored by Online Temperature sensors.

Figure 12: Installation of the water sensor - 2

In order to calibrate the Detailed hydraulic model of the sewerage network, Sofiyska Voda AD maintains a network with 18 rain gauge stations (see Figure 13). The rain gauges transmit the information via GPRS connection and are visualized through a Web Platform.

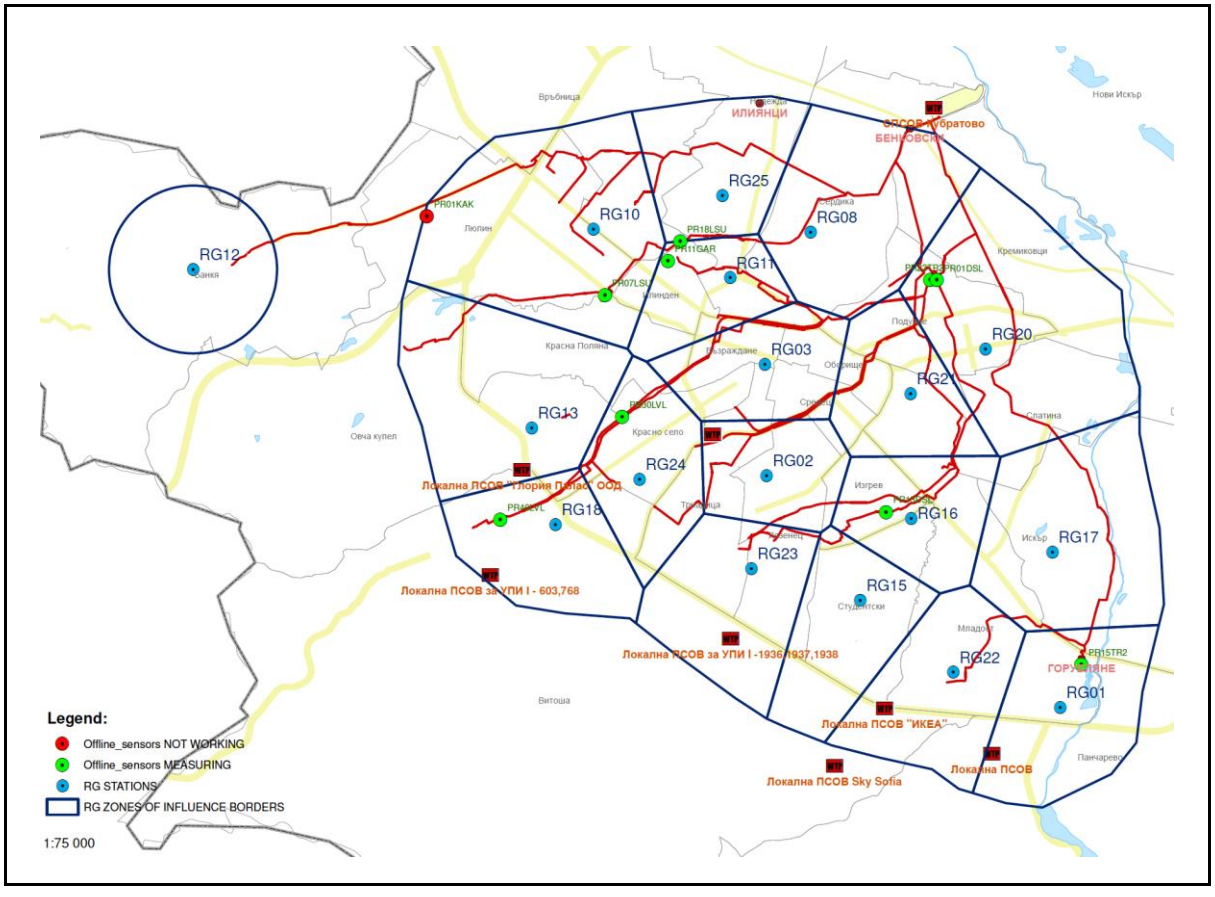


Figure 13: Location and areas of influence of the rain gauge stations in Sofia

We are searching for a solution that can combine both data (Rain Gauge metrics and the temperature of the low-cost sensor in the CSO) and tell us if the overflow happens by just using temperature and rain data.

Expected Outcome:

- A predictive model capable of predicting if an overflow is happening in a specific time.
- The predictive model should predict as fast as possible the overflow.

IV.1.1 Description of the data

The objective of the competition is to identify the overflow data due to rainfall or blockage of the network and make predictions. Probably the timestamps of the different measurements are not aligned, therefore some kind of aggregation should be put in place to compare different datasets.

Additionally, keep in mind that you should consult the CSO occurrence data that are within the temperature temporal range data of the sensor; in the example related to sensor PR07LSU, from 30.01.21 to 12.04.21. This way you can see if there is a relationship between the trend of the sensor temperature values and the CSO occurrence. We can assume that the lower time interval between the occurrence measurements (e.g., in PR07LSU would be 05.11.20) and the lower time interval of the sensor's temperature measurement (e.g., in PR07LSU would be 30.01.21), during that interval the occurrence data would not be relevant as we do not have temperature data to be able to analyse that behaviour.

On the other side, considering the upper temporal interval between occurrences (e.g., in PR07LSU would be 03.04.21) and the upper interval of temperature measurements (e.g., in PR07LSU would be 12.04.21), we can say that no CSO events occurred in that interval. However, I would not discard temperature values in this range because they may help to detect that the CSO ended on 03.04.21 as the temperature values "return to normal" (it is assumed that when a CSO occurs the temperature decreases drastically and then returns to pre-CSO values).

Keep in mind that the use of the CSV Agent facilitates the translation of the data as well as discard not needed columns.

IV.1.2 Files

The files are separated in different folder depending on the temperature sensor id:

- <Sensor ID>, folder with the information of the Temperature sensor specified by its sensor id (e.g.: PR07LSU):
    - <Sensor ID>_SelectedVariables_temperature.xlsx - The temperature sensor data provided by the sensor (e.g.: PR07LSU) in the crest in the interval 30.01.2021 – 12.04.2021
    - Column 1: Device S/N, device serial number of the corresponding sensor. It is the same value for all the cells.
    - Column 2: Date, calendar date in format YYYY-MM-DD and time in ISO 8601-1:2019 extended format (e.g.: T08:23:05) (e.g.: 2021-04-13T08:23:05).

- Column 3: Temperature Value °C, the temperature measured in Celsius degrees (e.g.: 13.558).

- <Sensor ID>_CSO_Occurrence.xlsx – The overflow occurrences detected in the system between 05.11.2020 and 03.04.2021.
    - Column 1: Date, date and time in the format MM-DD-YYYY, hh:mm:ss AM/PM (e.g.: 1/8/2021, 2:11:00 AM).
    - Column 2: Integer number, duration of the overflow event measured in minutes. A value equal to 0 indicates that the overflow event had a duration inferior to 1 minute.

- RG<number>_01_01_2021_to_01_05_2021.csv – The rain gauge data corresponding to the area in which the <Sensor ID> is located in the time interval between 01.01.2021 and 01.05.2021.
    - Column 1: Date (Month, Day, Year) (e.g.: 2/14/21)
    - Column 2: Time (Hour, Minutes, Seconds AM/PM) (e.g.: 12:58:00 PM)
    - Column 3: Generic Output (mm/h) rainfall Intensity (mm/h) (e.g.: 6.0)

Note: the PR13DSL sensor is a little bit complex, being downstream in the Sofia's catchment, it can be also influenced by rain in the RG23, RG15 and RG02, but RG16 is the main one (see Figure 11).

IV.1.3 NGSI-LD payloads

The use of the corresponding Agent (f4w-challenge-sofia[14]) facilitates communication with the FIWARE Context Broker through the creation of the corresponding publication NGSI-LD requests. The payload of those requests is represented in JSON-LD format, as can be seen in the following examples.

[14] https://github.com/flopezag/f4w-challenge-sofia/tree/python

```
{
 "id": "urn:ngsi-ld:Device:RG10",
 "type": "Device",
 "category": {
  "type": "Property",
  "value": [
   "sensor"
  ]
 },
 "controlledProperty": {
  "type": "Property",
  "value": [
   "precipitation"
  ]
 },
 "dateCreated": {
  "type": "Property",
  "value": {
   "@type": "DateTime",
   "@value": "2021-01-01T00:00:00.000000000"
  }
 },
 "value": {
  "type": "Property",
  "value": 0.0,
  "unitCode": "H67"
 },
 "name": {
  "type": "Property",
  "value": "RG10"
 },
 "@context": [
  "https://smartdatamodels.org/context.jsonld"
 ]
}
```


Table 3: JSON-LD data for rain gauge sensor

```
{
 "id": "urn:ngsi-ld:Device:10078399",
 "type": "Device",
 "dateCreated": {
  "type": "Property",
  "value": {
   "@type": "DateTime",
   "@value": "2021-01-30T00:04:43.000000000"
  }
 },
 "category": {
  "type": "Property",
  "value": [
   "sensor"
  ]
 },
 "controlledProperty": {
  "type": "Property",
  "value": [
   "temperature"
  ]
 },
 "serialNumber": {
  "type": "Property",
  "value": 10078399
 },
 "value": {
  "type": "Property",
  "value": 7.682,
  "unitCode": "CEL"
 },
 "placement": {
  "type": "Property",
  "value": "CSO"
 },
 "name": {
  "type": "Property",
  "value": "PR07LSU"
 },
 "@context": [
  "https://smartdatamodels.org/context.jsonld"
 ]
}
```


Table 4: JSON-LD data for temperature sensor

```
{
 'id': 'urn:ngsi-ld:Device:device-005A',
 'type': 'Device',
 'dateCreated': {
  'type': 'Property',
  'value': {
   '@type': 'DateTime',
   '@value': '2021-01-30T03:51:00.000000000'
  }
 },
 'category': {
  'type': 'Property',
  'value': [
   'sensor'
  ]
 },
 'controlledProperty': {
  'type': 'Property',
  'value': [
   'overflow'
  ]
 },
 'value': {
  'type': 'Property',
  'value': 55,
  'unitCode': 'MIN'
 },
 'name': {
  'type': 'Property',
  'value': 'PR13DSL
 '},
 '@context': [
  'https://smartdatamodels.org/context.jsonld'
 ]
}
```


Table 5: JSON-LD data for occurrence overflows

IV.1.4 Data Explorer

1 MB (zip format)

Link (https://drive.google.com/file/d/1QRjmR1RwnF1i73GMu-yaiBiylA3A_dd6/view?usp=sharing)[15]

IV.1.5 Validation

Outcomes validation:

Predictive model needs and priorities:

- The top priority of the model is to detect if an overflow occurs.
- False positives and false negatives should be minimized.
- The model needs to detect in real time the overflow.
- The overflow should be predicted as soon as possible.

Offline validation: How proposed solutions will be validated

The delivered models should predict considering all possible errors and be able to generalize (including not having overfitting). A set of metrics will be used to evaluate the Machine Learning models.

In case of classification predictions, the metrics will be:

- Accuracy: The proportion of correct predictions among the total number of observations.
- Precision: The fraction of positive predictions correctly predicted.
- Recall: The fraction of the positive observations successfully predicted.
- F-score: A weighted average of the precision and the recall.

Finally, if the problem requires anomaly detection, not only classification metrics will be used, but also specific AD metrics[16]. The objective is to evaluate a set of conditions:

- The anomaly must be predicted as soon as possible.
- False positives should strictly be penalized.
- Predicting the same anomaly multiple times is not important.

[15] The access of the data is under request access.
[16] https://github.com/numenta/NAB

Predictive model evaluation method:

- As a final step, to identify the model generalization capabilities, an evaluation set (not included in the database training data) will be used.
- The metrics used to evaluate the model are associated with the confusion matrix and the priorities already introduced.
- The evaluation will consist of evaluating if the model is capable of predicting the overflows correctly.
- Early predictions of overflow will also be considered during the evaluation.

Offline validation: How proposed solutions will be validated

To offline validate the results of the different solutions, participants need to deliver a docker image of the model and the pipeline of the data in a tar.gz.

The docker container must be executed using the command: docker run <image_name> <path_to_evaluation_set_file>

The evaluation set file will have the same format as the general dataset given at the beginning of the competition.

The docker execution needs to output a csv file to the same directory where the evaluation set is stored. This csv file must contain the predictions of the model (only when an anomaly is detected) in a specific format:

- Timestamp: A column indicating the timestamp of the prediction. This timestamp must match with the input register of the time series.
- Prediction: The true prediction of the model. If the anomaly to predict has different types, this should be a string specifying the type of anomaly, e.g., 'Type 1'. This column must only contain anomalous detections.
- Format example: Head: Timestamp, Prediction Row: 2020-02-23, 'blockage'.

Online validation: - Demo Day

Short demonstration of the integration of the model in the architecture. For this purpose, you can use the docker-compose file provided to you for testing the model.

IV.1.6 Help Kit

Help Kit[17]: it contains the material that is necessary to create your development environment and to validate your trained machine learning models:

- Scripts to inject validation data into a context broker[18], also see data[19].
- Docker compose files for Stellio and Orion-LD
- Scripts to easily interact with a context broker
- Documentation on actions to be performed to deploy and validate a machine learning model packaged into BentoML

IV.2. Challenge 2 - CAP

Proposed by: CAP

CAP is a large public company, which owns and manages 60 small to large wastewater treatment plants (WWTPs), serving about 2.5 million people in the peri-urban area of Milan. The WWTPs are often situated in agricultural areas.

Title: Correlation analysis of real wastewater data and laboratory data.

Domain: Wastewater treatment plant, water quality assessment.

Summary: The challenge proposed aims to find a concrete solution to explore real-time the quality of sensor data. Data quality assessment should be obtained employing periodic laboratory analyses as reference.

Description: CAP is steadily increasing the volume of wastewater monitored through online sensors. To date, within each plant, several sensors and analysers are installed. However, it is crucial to improve not only the quantity of available data but also their quality for process, safe water reuse, and compliance purposes.

Therefore, it is essential to establish a defined and continuously applied method to validate the massive amount of data with the periodic laboratory analyses. The latter would guarantee a real-time check, which would also show malfunctioning and build the bases for an optimized maintenance program.

We also believe that this challenge's results will support the deployment of several Digital Solutions developed in the Milan case of the Digital-water.city project focused on safe water reuse. Indeed, the reliability of an Early warning system for safe water reuse and the efficiency of the Match-making tool between water demand and availability heavily rely on the accuracy of the data.

Expected outcomes: The participants can work in a clustering solution to profile the different correlations observed between the real data and the laboratory data. Therefore, this task has an analytical implication

[17] https://github.com/easy-global-market/f4w-challenges
[18] https://github.com/flopezag/f4w-challenge-sofia/tree/d15702e3c15eab2091a8d713930bdcbb4ed214e5
[19] https://drive.google.com/file/d/16dhCRVjRAU_3-7OxXvmJ5T_zGMh-HH9g/view?usp=sharing

(analysis of the multiple profiles and conclusions), it is expected to get an analytical report of the different profiles/clusters found and to justify the predictions of their algorithm/algorithms.

IV.2.1 Description of the data

The objective of the competition is to calculate the Quality of Sensor Data based on a data lab and real data sensors. The challenge aims to understand whether the sensors could replace the lab data. Therefore, it seeks to check their reliability. From this standpoint, when we talked about validation and quality control of sensor data, we meant that we would like to find a correlation between them. The participants have absolute freedom to decide the best correlation methods to understand if sensor data match the lab data properly or not and create the corresponding model to analyse this information in real time. We used the index of agreement, the correlation index, t-test, and other methods but it will also be ok if other solutions are suitable.

Due to the measures having different timestamps, it is a problem if we want to make a direct data analysis. Our suggestion is to make a daily average of sensors data (from 10 a.m. to 10 a.m.) in order to compare them with lab data. This is because the lab data are collected with a sampler, which gathers wastewater for 24 hours every day; therefore, taking the daily average looked to be the best approach.

IV.2.2 Files

- lab analyses/lab_2019.xlsx, lab analyses/lab_2020.xlsx – information about the measures obtained in the laboratory. Laboratory data is the reference to monitor quality of real time data.
    - Column 1: PLANT text field with the description of the wastewater plant (e.g.: AAA).
    - Column 2: SAMPLING POINT, text field, always DISCHARGE value.
    - Colum 3: DATE, data and time of the sample in the format dd.mm.yyyy HH:MM:SS (e.g.: 10.01.2019 09:00:00).
    - Column 13: COD (Chemical Oxygen Demand) numeric values measured in mg/l. Can have measures like '----' to indicate that there is no measure or like '<15' to indicate that the measure is below 15mg/l. For the hypothesis of the analysis, we consider '<15' = MEAN(0, 15) = 7,5mg/l
    - Column 14: Total suspended solids (tss) numeric values measured in mg/l. Can have measures like '----' to indicate that there is no measure or like '<5' to indicate that the measure is below 5mg/l. For the hypothesis of the analysis, we consider '<5' = MEAN(0, 5) = 2,5mg/l
    - Column 16: Total ammonia nitrogen (as NH4) (NH4) numeric values measured in mg/l. Can have measures like '----' to indicate that there is no measure, like '<0.5' to indicate that the measure is below 0.5mg/l, and '<1' to indicate that the measure is below 1mg/l. For the hypothesis of the analysis, we consider '<0.5' = MEAN(0, 0.5) = 0,25mg/l and '<1' = MEAN(0, 1) = 0,5mg/l
    - Column 18: Nitrate (asN) (NO3) numeric values measured in mg/l. Can have measures like '----' to indicate that there is no measure, like '<1' to indicate that the measure is below 1mg/l, and '<3' to indicate that the measure is below 3mg/l. For the hypothesis of the analysis, we consider '<1' = MEAN(0, 1) = 0,5mg/l and '<3' = MEAN(0, 3) = 1,5mg/l

- Column 21: Phosphate (P-PO4) (PO4) numeric values measured in mg/l. Can have measures like '----' to indicate that there is no measure, like '<0.2' to indicate that the measure is below 0.2mg/l, and '<0.6' to indicate that the measure is below 0.6mg/l. For the hypothesis of the analysis, we consider '<0.2' = MEAN(0, 0.2) = 0,1mg/l and '<0.3' = MEAN(0, 0.3) = 0,15mg/l

- Column 4 – Column 12, Column 15, Column 17, Column 19, Column 20 - do not use the data from them.

- <Plant>_<Property>_real time_2019-2020.csv, measures of the sensors from the different Plants (e.g.: AAA, BBB, CCC, DDD, EEE, FFF, and GGG) and different Properties (e.g.: COD, NH4, NO3, PO4, and SST). Keep in mind that the SST Property corresponds to the Total suspended solids represented by tss.

  - Column 1: Data/Ora, date and time in the format of day, month, year hours, minutes and seconds (e.g., 16/06/2019 08:54:33).

  - Column 2: Valore, property value in mg/l (e.g.: 69,607).

IV.2.3 NGSI-LD payloads

The use of the corresponding Agent (f4w-challenge-milan[20]) facilitates communication with the FIWARE Context Broker through the creation of the corresponding publication NGSI-LD requests. The payload of those requests is represented in JSON-LD format, as can be seen in the following examples.

```
{
  "id": "urn:ngsi-ld:WaterQualityObserved:waterqualityobserved:WWTP:AAA",
  "type": "WaterQualityObserved",
  "dateObserved": {
    "type": "Property",
    "value": {
      "@type": "DateTime",
      "@value": "2019-05-06T09:50:38.000Z"
    }
  },
  COD: {
    "type": "Property",
    "value": 16.699,
    "unitCode": "M1"
  },
  "@context": [
    "https://smartdatamodels.org/context.jsonld"
  ]
}
```

Table 6: JSON-LD measures data for Plant AAA and property Chemical Oxygen Demand

[20] https://github.com/flopezag/f4w-challenge-milan/tree/python

IV.2.4 Data Explorer

12 MB (zip format)

Data files: Link (http://bit.ly/f4w-milan)[21]

IV.2.5 Validation

Outcomes validation:

Participants develop a clustering solution to profile different correlations. This task has an analytical implication (analysis of the multiple profiles and conclusion). It is expected to provide an analytical report of the different profiles/clusters found and to justify the predictions of their algorithm.

Offline validation: How proposed solutions will be validated

To evaluate the solution, which should assign a register into a cluster or profile, the teams need to deliver in https://fiware4water-challenges.devpost.com:

- An analytical report, explaining all the findings during the solution development and the explanation of each cluster created by the algorithm.
- A docker image, detailed below, to validate the behaviour of the algorithm.

To offline validate the results of the different solutions, participants need to deliver a docker image in a tar.gz.

The docker container must be executed using the command: docker run <image_name> <path_to_evaluation_set_file>

The evaluation set file will have the same format as the general dataset given at the beginning of the competition.

The docker execution needs to output a csv file to the same directory where the evaluation set is stored. This csv file must contain the predictions of the model (the different cluster assignation) in a specific format:

- Timestamp: A column indicating the timestamp of the prediction. This timestamp must match with the input register of the time series.
- Prediction: The cluster assignment of the register.
- Format example: Head: Timestamp, Prediction Row: 2020-02-23, 'Cluster 1'.

Online validation: - Demo Day

Short demonstration of the integration of the model in the architecture. For this purpose, you can use the docker-compose file provided to you for testing the model.

[21] The access to the data is under request access control.

IV.2.6 Help Kit

Help Kit[22]: it contains the material that is necessary to create your development environment and to validate your trained machine learning models:

- Scripts to inject validation data into a context broker[23] also see data[24].
- Docker compose files for Stellio and Orion-LD
- Scripts to easily interact with a context broker
- Documentation on actions to be performed to deploy and validate a machine learning model packaged into BentoML

IV.3. Challenge 3 - South West Water - United Kingdom

Proposed by: South West Water

Title: Identify short term water network events and longer-term trends in flow data using anomaly detection methods and time-series analysis.

Domain: Water Consumption

Summary: The objective of the competition is to calculate the short-term and long-term water network events in order to evaluate possible burst pipe, leakage, or any change in the customer water consumption to be considered. It is very important to define task forces to resolve water leakage or analyse any possible improvement in the water network distribution.

Description: The purpose of the challenge is the identification of the short-term water network events as well as any long-term trend around the provided data, using for this purpose any kind of anomaly detection methods that the participant applies over the dataset. It also means that the timeseries analysis has to be considered in the execution of the challenge. The data contains flow data measured across 50 areas between 1st April 2020 and 1st March 2021 in the South West of the United Kingdom. Areas are formally known as District Metered Areas (DMAs) and are used to measure key metrics such as water demand and leakage in small areas. In rural areas, DMAs can be as large as a town or village. Urbans areas are typically made up of many DMAs.

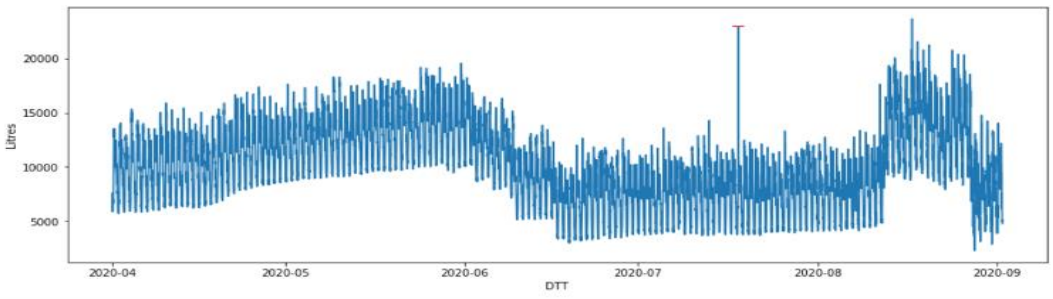


Figure 14: Flow data from District Metered Area (DMA)

[22] https://github.com/easy-global-market/f4w-challenges
[23] https://github.com/flopezag/f4w-challenge-milan/tree/6230705dbcd3594b2b821d2ea4efd1cdfd991278
[24] http://bit.ly/f4w-milan

Figure 14 displays a flow profile for DMA and represents the net volume of water used by the area. Water use is typically made up of domestic customers, commercial businesses or from leakage due to burst pipes.

Expected outcomes:

The expected output of this challenge is to identify:

- Short-term events such as large pipe bursts which normally correspond to short, steep spikes in the flow profile typically lasting hours or a few days. In Figure 14 this can be seen in 2020-08.

- Longer-term trends which normally correspond to underlying leakage from small, unrepaired bursts or changes in customer water consumption such as the completion of a new housing development. This will typically last weeks to months. In Figure 14 this can be seen between 2020-04 and 2020-06, where there has been a gradual increase in the flow profile followed by a gradual decline which may correspond to small burst pipes being fixed.

Note: Very short-term events (15 to 30 minutes) are likely to be data quality issues and should not be classified as bursts.

IV.3.1 Description of the data

The objective of the competition is to detect in real time and make a prediction of anomalies in the water consumption of a specific region in Southwest England. For this purpose, it is offered a set of files depending on the specific DMA. On those files could be possible to calculate burst or pike in the consume of water during short period of time. In order to help to identify the anomalies, a file is provided in which it was identified the number of concrete bursts for a DMA in particular in a period of time.

Due to the measures having different timestamps, it is a problem if we want to make a direct data analysis. The teams need to evaluate a procedure to clean the data and pre-process them just to allow an analysis of the information obtained from the sensors.

IV.3.2 Files

Different files have been provided:

- Areas Flow Data 1 to 25, measures of water consumption
    - DMA, text value, the area of measurement (e.g.: 201D05).
    - DT, Date and Time value, Day of flow measurement (e.g.: 01/04/2020 00:00).
    - Period, numeric value, 15 minutes period of flow measurement (e.g.: 1).
    - DTT, Date and time value, datetime of flow measurement. Can be obtained from the others two columns (e.g.: 01/04/2020 00:15)
    - Litres, float number separated by ".", volume of water that flowed through the meter in a 15 minutes period (e.g.: 3576.0).

- Areas Flow Data 26 to 50, measures of water consumption
    - DMA, text value, the area of measurement (e.g.: 201D05).
    - DT, Date and Time value, Day of flow measurement (e.g.: 01/04/2020 00:00).
    - Period, numeric value, 15 minutes period of flow measurement (e.g.: 1).
    - DTT, Date and time value, datetime of flow measurement. Can be obtained from the others two columns (e.g.: 01/04/2020 00:15)
    - Litres, float number separated by ".", volume of water that flowed through the meter in a 15 minutes period (e.g.: 3576.0).
- Water Mains Burst Count By Area, total number of bursts found on each DMA
    - DMA, text value, the area of measurement (e.g.: 607D03).
    - BurstCount, number of bursts found in a specific DMA zone in the period of time (e.g.: 23).

IV.3.3 NGSI-LD Payload

The use of the corresponding Agent (f4w-challenge-sww[25]) facilitates communication with the FIWARE Context Broker through the creation of the corresponding publication NGSI-LD requests. The payload of those requests is represented in JSON-LD format, as can be seen in the following example.

```
{
  "Id": "urn:ngsi-ld:WaterQualityObserved:<DMA>",
  "type": "WaterQualityObserved",
  "dma": {
    "type": "Property",
    "value": <DMA>
  },
  "litres": {
    "type": "Property",
    "value": <Litres>,
    "observedAt": <DTT>,
    "unitCode": "LTR",
    "period": {
      "type": "Property",
      "value": 900,
      "unitCode": "SEC"
    }
  }
}
```

Table 7: JSON-LD data for DMA data

[25] https://github.com/easy-global-market/f4w-challenges-sww

IV.3.4 Data Explorer

11MB (zip format)

Data files: Link (http://bit.ly/f4w-sww)

IV.3.5 Validation

Outcomes validation:

A successful solution will:

- Be efficient, responsive, and scalable; SWW have over 1000 DMAs and need to respond as quickly as possible to burst events. Any solution might be run multiple times during the same day.
- Not classify very short flow changes (15-30 minutes) as anomalies. These are likely to be data quality issues
- Have a user-friendly interface which:
    a. Alerts users of short-term events (hours to days), providing the time of the event and the DMA. SWW would respond by issuing pipe repair work orders to the problem area.
    b. Suggests DMAs where there has been a significant change in longer term trends (weeks to months). SWW would respond by investigating the DMA using leakage detection methods.

Predictive model needs and priorities:

- The top priority of the model is to detect if a leak occurs.
- False positives and false negatives should be minimized.
- The model needs to detect in real time the leaks.
- The leak should be predicted as soon as possible.
- The leak needs to be diagnosed, classifying if it is a burst pipe or a long-term leak.

Offline validation: How proposed solutions will be validated

To validate the different predictive models developed during the challenge, the participants need to deliver them:

- The solution must be delivered as a docker image.
- The docker image must accept by parameter a csv file, which in this case is going to be the validation set.

Participants must write a csv file with two columns: “Register Index”, “Model Prediction”. “Register Index” is the register number predicted from the validation set received, and “Model Prediction” is the output of the trained machine learning model.

The delivered models should predict considering all possible errors and be able to generalize (including not having overfitting). A set of metrics will be used to evaluate the Machine Learning models.

In case of classification predictions, the metrics will be:

- Accuracy: The proportion of correct predictions among the total number of observations.
- Precision: The fraction of positive predictions correctly predicted.
- Recall: The fraction of the positive observations successfully predicted.
- F-score: A weighted average of the precision and the recall.

Finally, if the problem requires anomaly detection, not only classification metrics will be used, but also specific AD metrics[26]. The objective is to evaluate a set of conditions:

- The anomaly must be predicted as soon as possible.
- False positives should strictly be penalized.
- Predicting the same anomaly multiple times is not important.

Predictive model evaluation method:

- As a final step, to identify the model generalization capabilities, an evaluation set (not included in the database training data) will be used.
- The metrics used to evaluate the model are associated with the confusion matrix and the priorities already introduced.
- The predictions will be evaluated in two steps. First, evaluate if the model is capable of predicting the leaks correctly, and second, evaluate the type of leak predicted.
- Early predictions of overflow will also be considered during the evaluation.

To offline validate the results of the different solutions, participants need to deliver a docker image in a tar.gz.

The docker container must be executed using the command: docker run <image_name> <path_to_evaluation_set_file>

The evaluation set file will have the same format as the general dataset given at the beginning of the competition.

[26] https://github.com/numenta/NAB

The docker execution needs to output a csv file to the same directory where the evaluation set is stored. This csv file must contain the predictions of the model (only when an anomaly is detected) in a specific format:

- Timestamp: A column indicating the timestamp of the prediction. This timestamp must match with the input register of the time series.
- Prediction: The true prediction of the model. If the anomaly to predict has different types, this should be a string specifying the type of anomaly, e.g., 'Type 1'. This column must only contain anomalous detections.
- Format example: Head: Timestamp, Prediction Row: 2020-02-23, 'pipe burst'.

Online validation: - Demo Day

Short demonstration of the integration of the model in the architecture. For this purpose, you can use the docker-compose file provided to you for testing the model.

IV.3.6 Help Kit

Help Kit[27]: it contains the material that is necessary to create your development environment and to validate your trained machine learning models:

- Scripts to inject validation data into a context broker[28] also see data[29].
- Docker compose files for Stellio and Orion-LD
- Scripts to easily interact with a context broker
- Documentation on actions to be performed to deploy and validate a machine learning model packaged into BentoML

V. Registration Process and the Devpost Platform

The FIWARE Foundation provided OIEau with all the details of the registration form linked in the guidelines and the web content to be used as the first filter for the applicants https://www.fiware4water.eu/smes-challenges. The page is currently informing that the challenges are already closed.

[27] https://github.com/easy-global-market/f4w-challenges
[28] https://github.com/easy-global-market/f4w-challenges-sww/tree/d948df4ece2aaac49a4a3eb136afc08169bbdfd2
[29] http://bit.ly/f4w-sww

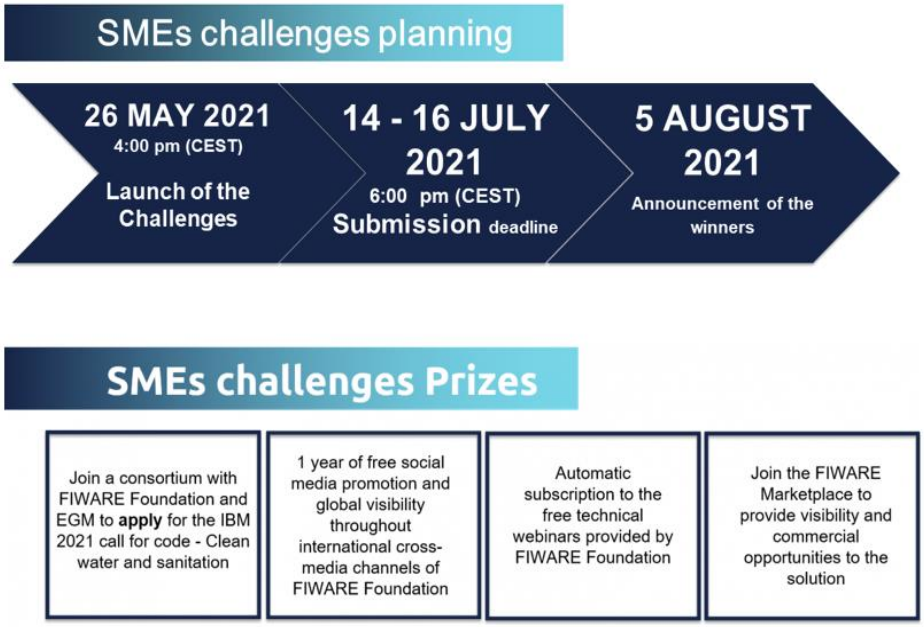


Figure 15: FIWARE4Water Challenge calendar overview

Applicants should upload their solutions in Devpost (formerly ChallengePost). A platform that helps software engineers participate in software competitions (hackathons[30]). The platform is defined as the home for hackathons. A place to build products, practice skills, learn technologies, win prizes, and grow networks. The team in charge of evaluating the challenges added all the information required for the challenges in the platform.

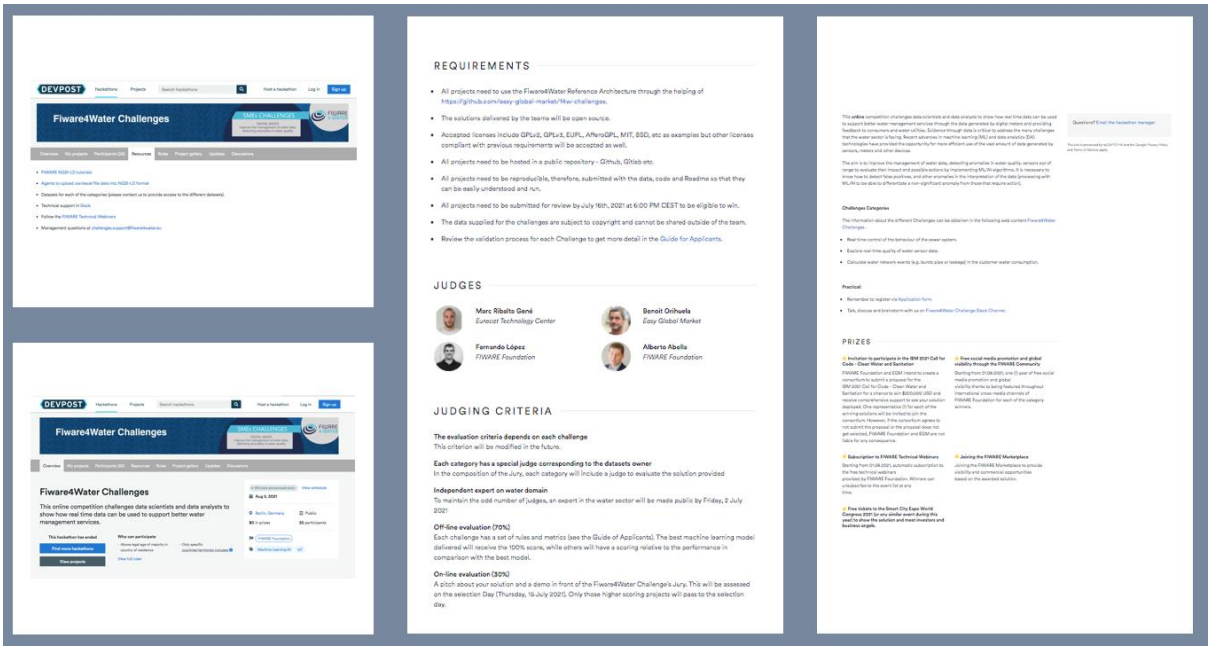


Figure 16: FIWARE4Water Challenge Devpost content

[30] https://en.wikipedia.org/wiki/Hackathon

VI. Communication and Dissemination

The specific promotion of the FIWARE4Water challenges has been done considering the whole project communication. That means to position FIWARE in the water sector highlighting specific capabilities of the platform and how these capabilities can make water services as generic and transferable as possible. In that sense, thanks to the FIWARE technical sessions and training already available, those experts working with or producing water quality sensors and smart meters can transform their devices to become FIWARE-compliant, interoperable with the Fiware4Water Reference Architecture and part of the FIWARE Marketplace. The FIWARE Foundation is also building Impact stories in a dynamic, compelling way, showcasing the community's experience with our technologies with the final purpose to increase the community of experts working in the water sector.

Several presentations, conference calls, surveys, meetings, and workshops have been held in order to identify possible issues and proposals from the water sector, specifically Fiware4Water Demo Cases, sister projects inside DW2020 Synergy Group, utilities, and other organizations in the FIWARE Ecosystem related to water. All of them have been asked to share data sheets and propose relevant challenges with social impact to be solved by the main target audiences.

General communication and dissemination activities can be summarised as follows:

- Promotion of the specific capabilities of FIWARE platform for the water sector.
- Provide knowledge about how water quality sensors and smart meters can be FIWARE-compliant and FIWARE-Ready to be included inside the FIWARE Marketplace.
- FIWARE Impact Stories, peer-to-peer conversations, presentations, case studies, video testimonials, press releases, media interviews, analyst interviews and briefings, speaking engagements, advertisements.
- Engagement with the FIWARE Ecosystem and FIWARE iHubs regarding the water sector using the Fiware4Water Technology.
- Collaboration in the definition of Challenge objectives, budget available, tentative prize structure, innovation, and growth opportunity.
- One to one meeting to recap the sharing datasets from WP1 results in order to evaluate the possible participation in the Fiware4Water Challenges.
- Collaboration in the definition of Fiware4Water Challenges scope.
- Collaboration in the definition of the challenges, terms and conditions, legal basis & contest rules, eligibility criteria & evaluation process.

The impact of the actions under this task on SMEs and other organizations can be overseen on these specific results:

- General audience from events:
    - Reach through webinars and workshops: 288 attendees

- Reach through FIWARE Water Day Event: +325 attendees / views

- Estimated audience profile: 2% cities - 6,2% Gov - 4,6% iHubs - 10% large - 3% NGO - 22% R&D - 30'5% SMEs - 15% Univ. -7.1% Utilities

- Audience from the FIWARE Ecosystem:

  - Reach through emails and newsletters: +3.8K

  - Reach through publications, white papers: FIWARE Ecosystem (+12k)

- Estimated audience profile:

Industries	Profiles
Information Technology and Services 21.82%	Engineering 25.49%
Program Development 13.06%	Business Development 19.12%
Research 5.89%	Marketing 11.93%
Higher Education 5.25% Telecommunications 4.78%	Information Technology 7.84%
Internet 4.46%	Research 7.19%
Computer Software 4.3%	Support 4.9%
Executive Office 3.66%	Community and Social Services 4.74%
Machinery 2.87%	Program and Project Management 2.94%
Professional Training & Coaching 2.55%	Education 2.78%
	Operations 2.61%

Table 8: Estimated audience profile

- Contributors to Smart Water Data Models: 13 (SMEs, Research institutions and Universities, Cities)

- 21 FIWARE iHubs: 5 of them including Smart Water among their offerings and services. Expected new 5 iHubs by end of 2021

- FIWARE Marketplace: 188 solutions, platforms, IoT devices and services (planned grow in smart water solutions)

VI.1. Communication Activities

Specific content development and communication activities are detailed in the next table:

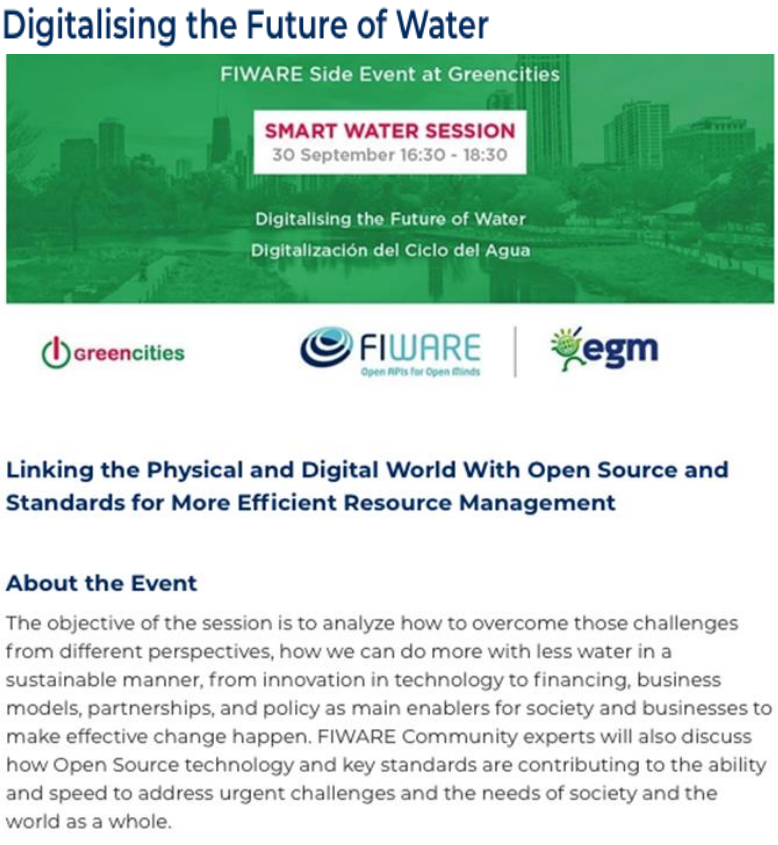
Challenges Launch
Guide for applicants
Application form
Web Design Briefing
_ Intro text
_description of the three challenges
_promotional banner
_Help desk email set up and slack channel
Promotion
Social Media Activation
Emails
Event Promotion - FIWARE Smart Fest
Blog Posting

Table 9: Communication activities

VI.1.1 Events Promotion

Ecosystem Building Context

Digitalising the Future of Water - event organization, and specific workshop under the Greencities Event umbrella. Sept. 2020.



- Link to Event page
- 17 Registrations
- 70 views in YouTube - Link

Figure 17: FIWARE4Water Challenge on Greencities event

FIWARE Water Day, FIWARE Community event organization. Sept. 2020.

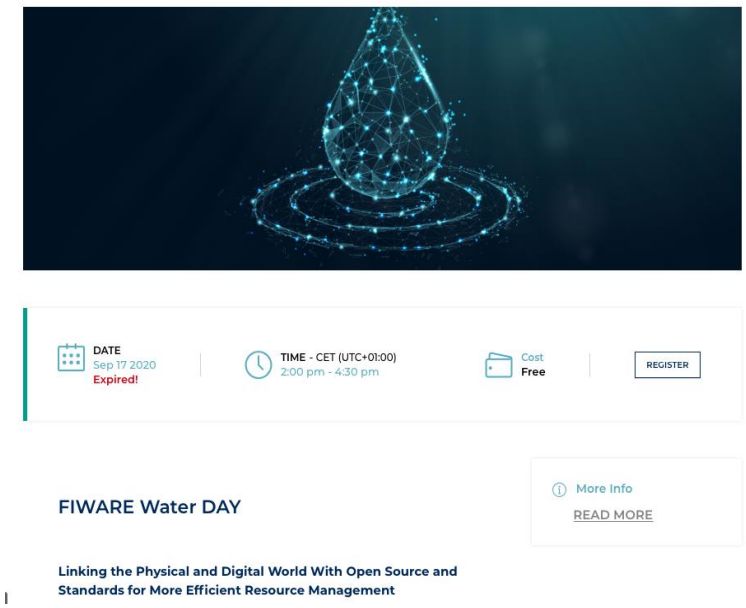
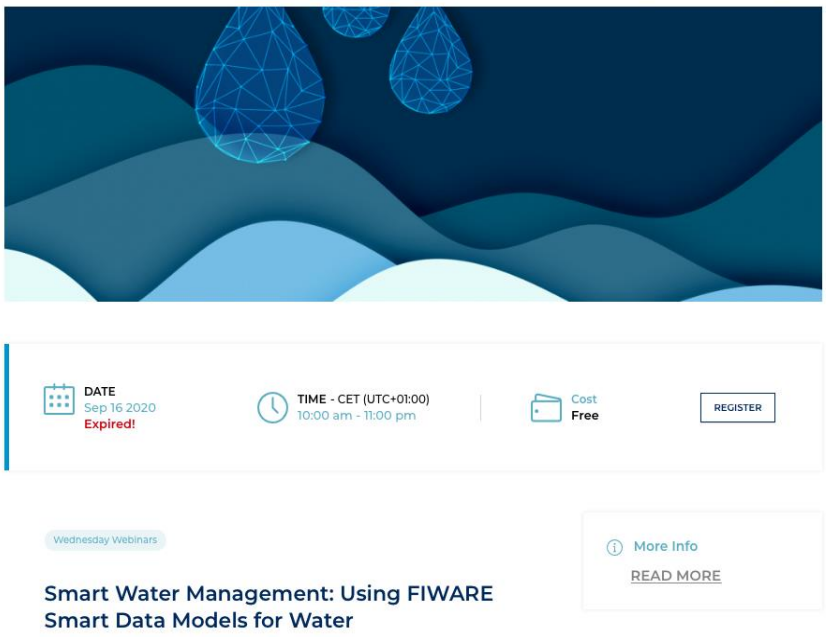


Figure 18: FIWARE4Water Challenge on FIWARE WATER DAY

- Link to Event page
- 182 Registrations
- 197 views in YouTube - Link

Smart Water Management: Using FIWARE Smart Data Models for Water, event organization. Sept. 2020.



- Link to Event page
- 56 registrations
- 371 views in YouTube - Link

Figure 19: FIWARE4Water Challenge data models on FIWARE WATER DAY

Challenges Promotion

FIWARE Fest Opening and Deep Dive in Smart Water

Figure 20: FIWARE4Water Challenge on FIWARE Smart Fest

- 200 attendees Opening
- 90 attendees Smart Water Session
- YouTube Link

SimHydro 2021 conference, June 2021

Figure 21: FIWARE4Water Challenge on SimHydro - 1

During the SymHydro conference held in June 2021 in Sophia Antipolis - Nice (FR), where EGM presented some of the activities of the FIWARE4Water project, EGM made the promotion of the FIWARE4Water challenges, in the form of announcements during the conferences, and also by exposing some posters in different places of the conference:

Figure 22: FIWARE4Water Challenge on SimHydro - 2

VI.2. Online Promotion

This section will elaborate the online promotion activities developed during the execution of the project per each partner. We have categorized the tables with the columns:

- Date, the precise date in which the online promotion was published.
- Type, the corresponding type of online promotion (Website, Blogpost, Whitepaper, Twitter, LinkedIn, Facebook, etc.).
- URL, the correct link of the concrete online promotion
- Reach, the total number of individuals who can see our content.

In some cases, for example in Fiware4Water website, make no sense to put this number therefore the column is dismissed. In other cases, it is not relevant to put this number of individuals, for example send an email to a university, because we cannot put a reliable reach number in that case due to internal dissemination. In that case, we put N/A to indicate Not Applicable. Last but not least, we need to mention that the Reach figures changes steadily. The current figures were obtained to the edition of this document.

VI.2.1 Fiware4Water website

Date	Type	URL
25.05.21	Website	https://www.fiware4water.eu/smes-challenges

Table 10: Online promotion, Fiware4Water Website

VI.2.2 Partners website

Date	Type	URL
21.06.21	Blogpost	https://www.fiware.org/2021/06/21/fiware4water-challenges-for-data-scientists-and-data-analysts
21.06.21	Blogpost	https://www.fiware.org/2021/06/21/fiware4water-challenges-for-data-scientists-and-data-analysts
01.09.20	Whitepaper	https://www.fiware.org/wpcontent/uploads/White_Paper_FIWARE_Our_Future-Water.pdf
17.09.20	Blogpost	https://www.fiware.org/2020/09/17/future-cities-smart-resilientinclusive-and-sustainable-the-fiware-our-future-water-white-paper-is-out
21.08.20	Blogpost	https://www.fiware.org/2020/08/21/challenges-to-the-water-sector-andways-forward
14.02.20	Blogpost	https://www.fiware.org/2020/02/14/fiware-to-deliver-the-standardsfor-the-creation-of-next-generation-digital-solutions-for-water
08.07.19	Blogpost	https://www.fiware.org/2019/07/08/moving-towards-the-smart-city-of-thefuture-through-digital-water-data-sharing-interoperability-and-open-standardarchitecture

Table 11: Online promotion, partners website

VI.2.3 Social media

Date	Type	URL	Reach
31.08.21	Twitter	https://twitter.com/Water_share/status/1432712927631626241	880
30.08.21	LinkedIn	https://www.linkedin.com/feed/update/urn:li:activity:6838479584162385920	931
12.07.21	LinkedIn	https://www.linkedin.com/feed/update/urn:li:activity:6819224212612374528/	403

01.07.21	LinkedIn	https://www.linkedin.com/posts/centre-for-water-systems_there-has-been-a-change-of-program-activity-6818162263493550080-oFZH	485
25.06.21	Twitter	https://twitter.com/FIWARE/status/1408366631181561860	515
25.06.21	LinkedIn	https://www.linkedin.com/feed/update/urn:li:activity:6814133161073623040	396
25.06.21	Facebook	https://www.facebook.com/permalink.php?story_fbid=4259353850788466&id=251366491587242	207
23.06.21	Twitter	https://www.twitter.com/FIWARE	5074
23.06.21	LinkedIn	https://www.linkedin.com/showcase/34704093	339
21.06.21	Twitter	https://twitter.com/FIWARE/status/1406916326556307456	532
18.06.21	Twitter	https://twitter.com/FIWARE/status/1405809568396029952	495
18.06.21	LinkedIn	https://www.linkedin.com/feed/update/urn:li:activity:6811576190982209536	146
18.06.21	Facebook	https://www.facebook.com/eu.fiware/posts/4240629582660893	129
14.06.21	LinkedIn	https://www.linkedin.com/feed/update/urn:li:activity:6810117544582643713	122
14.06.21	Facebook	https://www.facebook.com/eu.fiware/posts/4230201023703749	138
14.06.21	Twitter	https://twitter.com/FIWARE/status/1404352646937522177	1.330
11.06.21	Twitter	https://twitter.com/FIWARE/status/1403322751906103299	732
11.06.21	LinkedIn	https://www.linkedin.com/feed/update/urn:li:activity:6809090892108972032	204
11.06.21	Facebook	https://www.facebook.com/eu.fiware/posts/4222886967768488	455
08.06.21	Twitter	https://twitter.com/FIWARE/status/1402284950045532162	438

01.06.21	LinkedIn	https://www.linkedin.com/posts/cmakro_smes-challenges-activity-6808054324015464449-G_bO	>500
01.06.21	LinkedIn	https://www.linkedin.com/posts/centre-for-water-systems_only-20-days-left-to-register-to-the-activity-6810680307851808769-o4Aw	485
01.06.21	LinkedIn	https://www.linkedin.com/posts/gonzalo-meschengieser-1ba5a014_water-digitalization-data-activity-6810322663932760064-88Bh	>500
01.06.21	LinkedIn	https://www.linkedin.com/posts/joshua-pocock-103a8983_fiware4water-is-boosting-innovation-in-the-activity-6803726681950437376-hIX5	89
28.05.21	Twitter	https://twitter.com/FIWARE/status/1398217875958157312	1.233
27.05.21	Twitter	https://twitter.com/FIWARE/status/1397915272703451149	1.052
27.05.21	LinkedIn	https://www.linkedin.com/posts/fiware_watermanagement-activity-6803660395992125440-1JXp	253
27.05.21	Twitter	https://www.twitter.com/FIWARE	5074
27.05.21	LinkedIn	https://www.linkedin.com/showcase/34704093	339
26.05.21	Twitter	https://twitter.com/digitalwater_eu/status/1397443995689697283	289
26.05.21	LinkedIn	https://www.linkedin.com/posts/digital-water-city_digitalwater-innovation-water-activity-6803211260524576768--f3R	866
26.05.21	Twitter	https://www.twitter.com/FIWARE	5074
26.05.21	LinkedIn	https://www.linkedin.com/showcase/34704093	339
25.05.21	Twitter	https://www.twitter.com/FIWARE	5074
25.05.21	LinkedIn	https://www.linkedin.com/showcase/34704093	339
16.07.20	Twitter	https://twitter.com/Fiware4Water/status/1283676568175480833	NA
16.07.20	LinkedIn	https://www.linkedin.com/showcase/34704093	339

Table 12: Online promotion, social media

VI.2.4 Newsletters

Date	Type	URL	Reach
01.08.21	FIWARE Newsletter	https://mailchi.mp/116c624d418d/fiware-newsletter-august-2021	5.258
01.07.21	FIWARE Newsletter	https://mailchi.mp/47b310dc2b5f/fiware-newsletter-july-2021	5.201
21.06.21	Newsletter List - Exclusive emailing	https://mailchi.mp/7ab7521e8927/take-part-in-the-fiware4water-challenges-for-data-scientist-and-data-analysts	5.201
01.06.21	FIWARE Newsletter	https://mailchi.mp/105f367099d7/its-time-for-your-monthly-dose-of-fiware	4.956

Table 13: Online promotion, newsletters

VI.2.5 Emailing

Date	Type	URL	Reach
25.06.21	Email	University of Cantabria (Masters Data)	N/A
25.06.21	Email	University of Salamanca	N/A
23.06.21	Email	University Juan Carlos Primero (Masters Data)	N/A
22.06.21	Email	Companies - FIWARE iHub Canary Island	N/A
21.06.21	Mailchimp	https://mailchi.mp/7ab7521e8927/take-part-in-the-fiware4water-challenges-for-data-scientist-and-data-analysts	5.201
21.06.21	Email	Our Future Water (https://www.ourfuturewater.com) asking for promotion of the Challenge	N/A
21.06.21	Email	University of Valencia	N/A
21.06.21	Email	FIWARE Zone in Andalucía	N/A
21.06.21	FIWARE Marketing Round-up Email	https://docs.google.com/presentation/d/1mKTn6pfDlodp2cAWbTQrCEuy6N6SEjGKTLCNYtz6K3A/edit?usp=sharing	FIWARE Members
16.06.21	Email	University of Cantabria	N/A
10.06.21	Email	University Rey Juan Carlos (Masters Data)	N/A
10.06.21	Email	Centre for Water Systems, UNEXE	N/A
10.06.21	Email	GW4 Water Security Alliance	N/A

Table 14: Online promotion, emailing

VI.2.6 Other activities (or channels)

Date	Type	URL	Reach
30.08.21	Activities through the Watershare collaboration network (www.watershare.eu)	https://www.watershare.eu/watershare-news/the-fiware4water-challenge-has-a-winner/	N/A
23.06.21	FIWARE Marketing Round-up Call	https://docs.google.com/presentation/d/1mKTn6pfDlodp2cAWbTQrCEuy6N6SEjGKTLCNYtz6K3A/edit?usp=sharing	N/A
22.06.21	Conference Call	with Polytechnic University of Madrid	N/A
22.06.21	Conference Call	FIWARE Zone in Andalucía	N/A
14.06.21	Content sent to OIEau (Maxime & Natacha) to be promoted through f4w channels	https://docs.google.com/document/d/1iyOasNi8qvMz1L3hqSJXejoO_PQP7-5wbJ4Vmu7DcNI/edit?usp=sharing	N/A
08.06.21	FIWARE Smart Fest	Presentation in the opening and in the Smart Water session	> 200

Table 15: Online promotion, other activities

VII. Assessment of the submitted challenges

As a result of the submitted challenges. This section tries to offer an analysis of the different participants as they are registered in Devpost. We provide an analysis of the participation and the solutions finally submitted as well as a brief description of the final submitted solutions for the Challenge.

VII.1. Total Applications & Submissions

Although the number of questions related to the FIWARE4Water Challenges reflect bigger numbers, we considered that these figures are more suitable to make an analysis due to the fact that they were really working on a solution for the challenge. Following are the final reports of the applications.

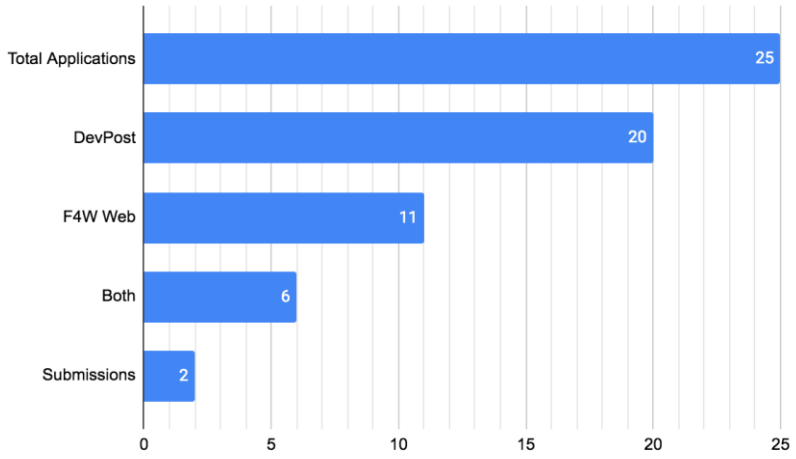


Figure 23: FIWARE4Water Challenge, total applications and submissions

VII.2. Total Countries

We can observe that the dissemination of the Fiware4Water achieves a huge visibility around the world as we can see from the third countries in the number of participants (India). The main country contributor to the challenge was Spain with a total of 26,1% of the participants. The analysis by continents shows us that the majority of participants (69,6%) were from Europe31 with 69,6% of them, followed by North and South America with 17,4% and Asia with 13%.

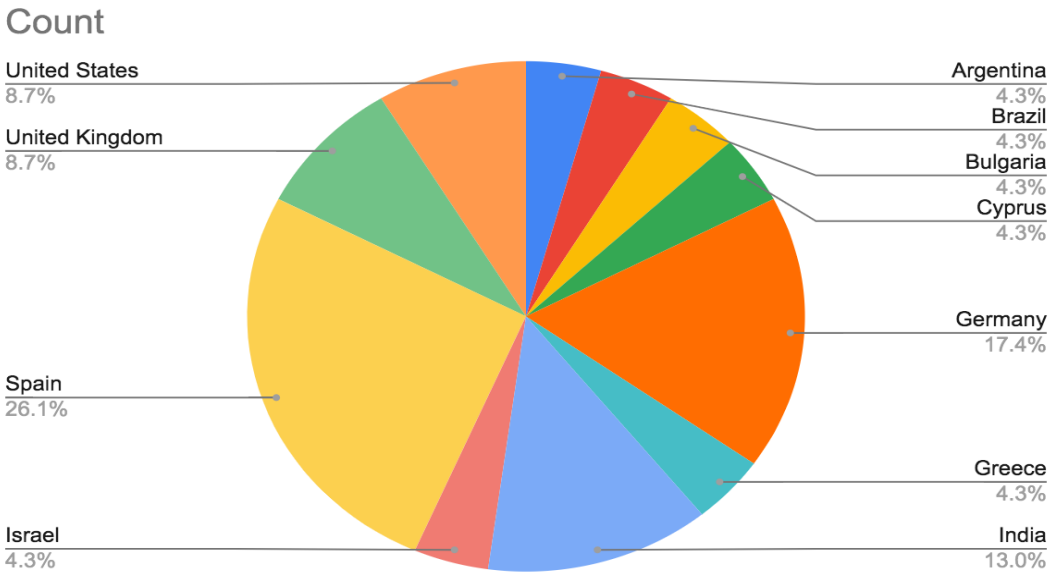


Figure 24: FIWARE4Water Challenge, distribution by countries

VII.3. Applications per Challenge

Regarding the analysis per challenge, we could see that the interest was more or least distributed between the 3 cases with a special interest in the Challenge 1 - Sofia with 6 participants. From the total number of participants registered, we can observe that only 48% informed really in which Challenge they were working. From the other 52%, we cannot say that they were not working on the Challenge because some of them requested access to the data, but they finally did not develop a solution.

On the other hand, from these six participants the 16,67% could develop a solution on time to be submitted for the Challenge, distributed one per Challenge 1 - Sofia and the other for Challenge 2 - CAP.

[31] We consider in this categorization Israel as an European country

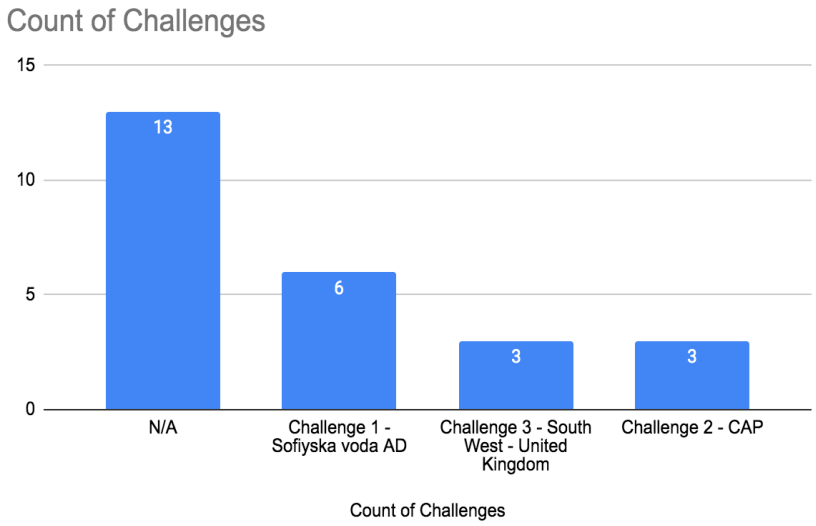


Figure 25: FIWARE4Water Challenge, distribution submitted solutions

VII.4. Description of the challenges solution

The selected winning solutions will be integrated into the FIWARE platform, demonstrating the flexibility to add new smart data models and the scalability of the platform towards a great variety of possible solutions. To integrate them, the submissions need to implement the connectors specified in the guide for applicants and offer smart data models of great quality.

The evaluation consisted of two phases: An offline technical evaluation of the requirements that the implementation must meet, and an online demonstration where the execution of the proposed solution is shown to the jury.

The submission SewageR[32] was a candidate in the Challenge 1 - Sofiyska voda AD, providing a smart data model to predict overflow in any section of the sewer system, using climate data as input features. It runs a binary classification model in the background and uses the weather and rainfall data as the features. The solution implemented has tried to expand the data and move average to obtain more useful data. The main problem of this challenge was that the data collected was not symmetric and therefore it complicated a lot the pre-processing of the data. It needed the application of some unconditional pre-processing techniques to get the shape of the provided data into action. For this purpose, it was needed to run some data analysis and try some techniques to get the data useful. Finally, a binary classifier in order to encapsulate into the Fiware4Water Reference Architecture. However, the predictions of the model weren't accurate, and the required connectors to import the model to FIWARE weren't implemented.

[32] https://devpost.com/software/sevager

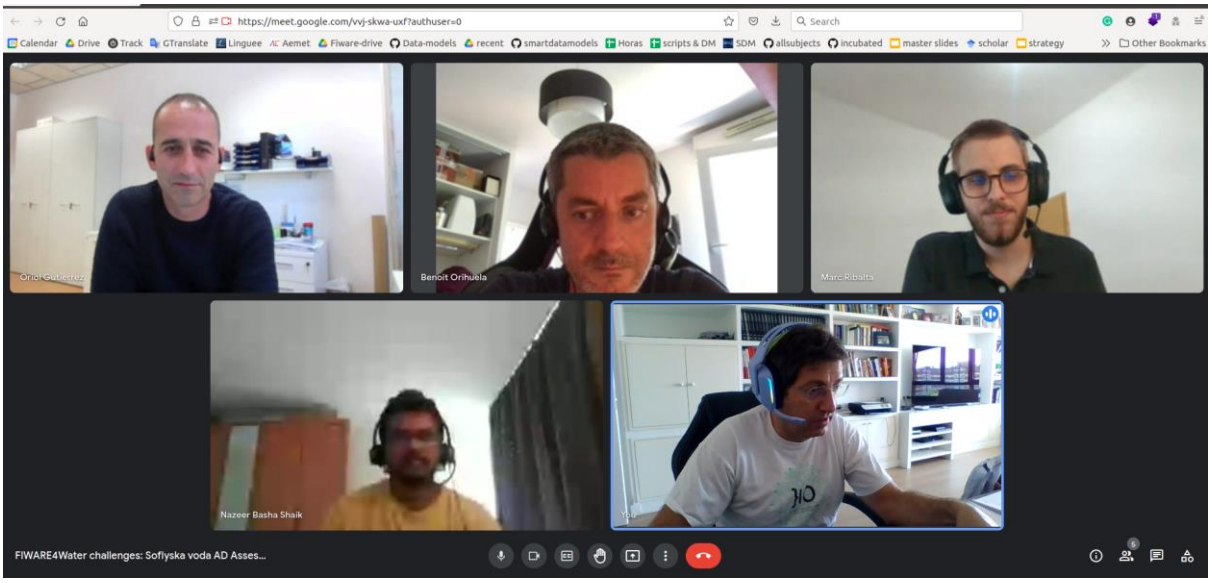


Figure 26: FIWARE4Water Challenge, review Sofia candidate

The second submission[33] offered a solution for Challenge 2 - CAP, presenting a clustering algorithm to classify different water behaviour profiles. This solution also provided an analytical document with some discussion points of great help for the water utility. The team created a Machine Learning Model to take the Pearson's correlation coefficient between lab data and sensor data from the chosen plant related to the feature, along with the mean of the difference between lab data and sensor data and the standard deviation of the given property. It helps to identify which sensors are working properly. Afterwards the use of clustering techniques is used to differentiate between behaviours and not sliding windows due to data lab is not continuous and therefore data are quite irregular. The predictions of the model were accurate, and the model could be deployed to the platform. This second submission is the winner of the challenge.

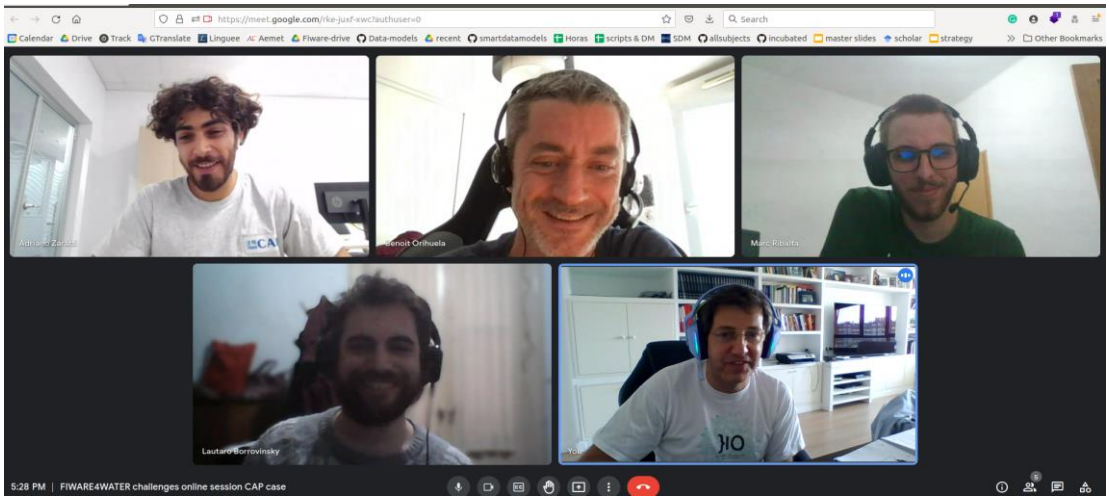


Figure 27: FIWARE4Water Challenge, review CAP candidate

[33] https://devpost.com/software/correlations-and-clustering

VII.5. FIWARE integration

The trained ML model is then exported, packaged, and embedded inside a BentoML container[34]. Thanks to the works already performed as part of the FIWARE4Water project, this container can be easily deployed into any cloud enabled architecture and natively interacts with any NGSI-LD compliant context broker. Consequently, the BentoML container is able to automatically instruct the FIWARE context broker of this newly available AI model. It also automatically subscribes to any user registration to use the ML model it is embedding:

Figure 28: FIWARE4Water Challenge, integration of the solution - 1

When notified of such a subscription, it will listen to any new data coming in from the registration and run the ML model on it. The results of the processing made by the ML model are then published back into the context broker to make them available to any authorized user:

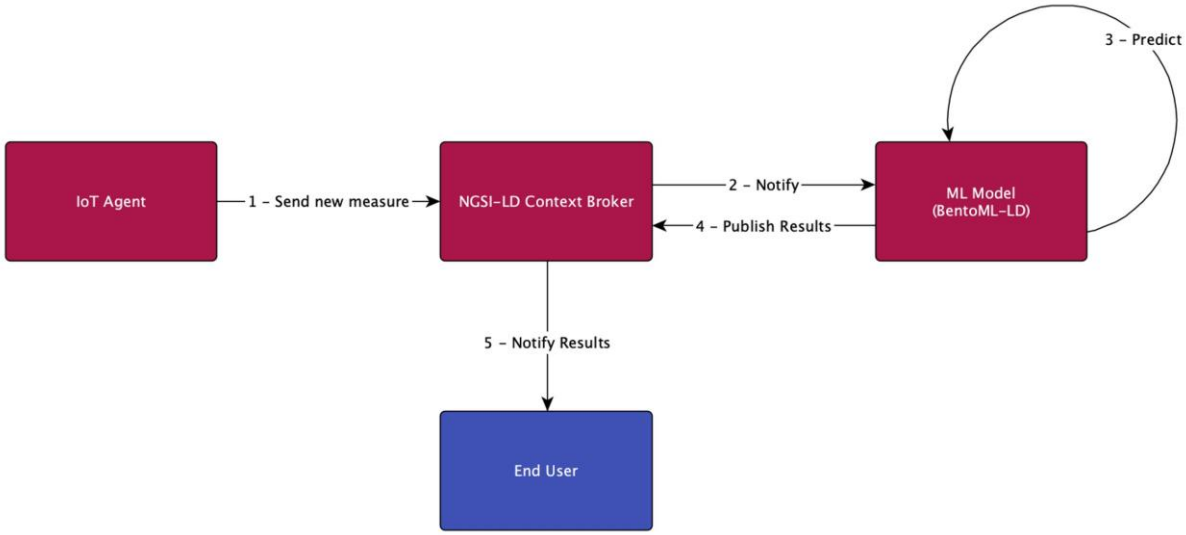


Figure 29: FIWARE4Water Challenge, integration of the solution - 2

[34] https://www.bentoml.ai

VIII. Promotion of the Challenges Results

VIII.1. IBM Call for Code

IBM's call for code[35] is the natural evolution for the winner of the FIWARE4WATER challenge. It is a contest to fight against the most pressing global issues while building development skills. This contest has a section specific for water challenges where the winners of the FIWARE4WATER challenge have participated together with these partners Eurocat, EGM and FIWARE Foundation. The submitted project needs to be open source to participate and to use some of the technical resources of IBM. Winner opts to a 200.000$ prize

In order to prepare the submission and the different elements were created:

1) A link to a GitHub repository where the technical elements (data + software) were available (https://github.com/albertoabellagarcia/call4code2021).

2) A 3-minutes video: https://www.youtube.com/watch?v=DyTIg84r9iw

Figure 30: FIWARE4Water Challenge, presentation of the solution submitted

Presentation to create the video:

https://docs.google.com/presentation/d/1rPPJBj_QqPBiFdQUXlaJZtkMcdH1INznAhO0HdgfI6g/edit?usp=sharing

3) A summary of the development

[35] https://developer.ibm.com/callforcode

4) A roadmap of the solution. Available in https://docs.google.com/document/d/1UH5FW4n7-upqAinW3IUUrfjfIqwVykdjhkISJiRyXko/edit?usp=sharing.

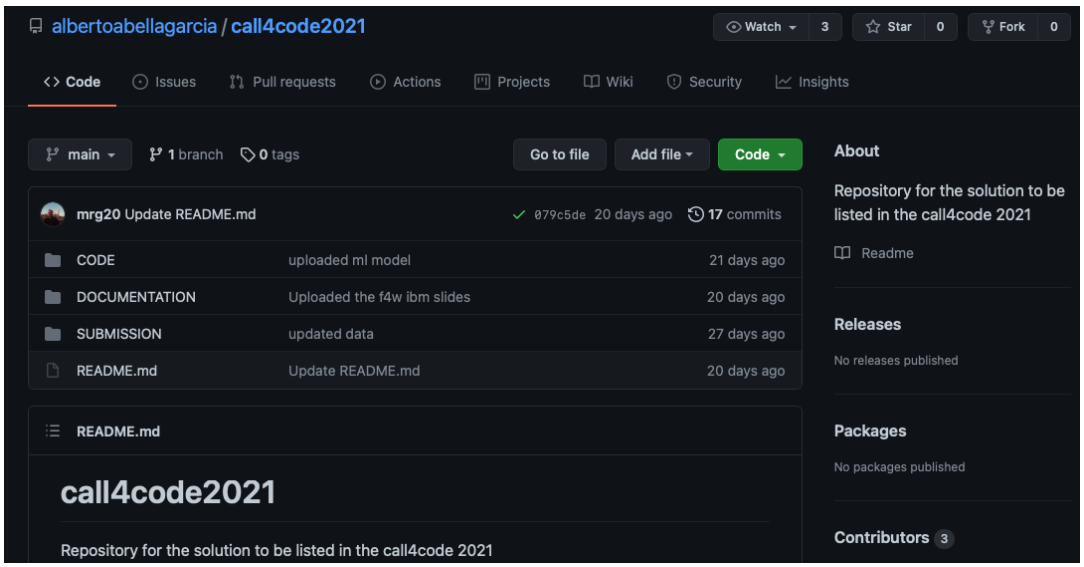


Figure 31: FIWARE4Water Challenge, repository of the solution submitted

VIII.2. Aqua360

The combination of climate change, population growth, urbanisation, emerging demand, ageing infrastructure, declining resources, and pollution has increased the pressure in water and environment management. To tackle these challenges, digitalisation has presented a promising opportunity to enhance the effectiveness and efficiency of water management. The Digital Water Transition Roundtable Forum, co-organised by Fiware4Water, aqua3S, ICT4Water and Watershare, was held alongside the AQUA≈360, organised by UNEXE, to facilitate the discussion among multidisciplinary stakeholders. The conference is targeting an audience from developing countries such that the Forum will also bridge the EU and non-EU countries to exchange the latest technologies worldwide.

The Forum aims to bring together world-leading experts in water research and services, ICT technologies, data sciences, policies, regulations, and business to share the insight of the state-of-the-art digital water practice. The Forum will focus on challenges and opportunities related to technologies, policies, and social engagement to identify the needs in both technical solutions and strategic planning to create a roadmap for enhancing the management in the water sector in digital transition to achieve better management of resources, improved performance of services, promoted health and well-being of communities, environmental sustainability, and resilience of society to disasters. The winner of Fiware4Water Challenge also showcased the concept to an international audience.

AQUA≈360 Digital Water Transition Roundtable Forum

Time: 1245 - 1430 BST, 1 September 2021
Registration: http://aqua360.net

Agenda

1245 - 1250	**Opening** Dr Kate Baker, Centre for Water Systems, University of Exeter
1250 - 1300	**Science-policy interactions and standardisation in the water sector** Dr Philippe Quevauviller, European Commission
1300 - 1330	**Panel discussion: standardisation, data & innovation** Dr Anastasios Karakostas, Centre for Research and Technology Hellas Dr Franck Le Gall, Easy Global Market Aitor Corchero, Eurecat Technology Centre Dr Valerie Naidoo, Water Research Commission
1330 - 1340	**Comfort break**
1340 - 1350	**F4W Challenge Winner showcase presentation**
1350 - 1420	**Panel discussion: cybersecurity, strategies, and social engagement** Dr Theodora Tsikrika, Centre for Research and Technology Hellas Dr Richard Elelman, Eurecat Technology Centre Dr Natacha Amorsi, Office International de l'Eau Gonzalo Meschengieser, Agua y Saneamientos Argentinos
1420 - 1430	**Future roadmap for filling gaps between techniques and policies**

Table 16: Aqua360 Digital Water Transition Roundtable Forum

A presentation of the winner was introduced during the congress showing the integration of ML models with the Fiware4Water architecture. You can access to the presentation (https://drive.google.com/file/d/1f_e0jpaZP5_joyMSz9xsZ9f4Wsx3fMu8/view?usp=sharing)

Figure 32: FIWARE4Water Challenge, presentation in the Aqua360 event

VIII.3. SCEWC'21

The Smart City Expo World Congress is the world leading smart city event, where the most innovative and influential smart city thinkers, including global, national and regional representatives, academic institutions, research centers, incubators, investors and top corporations.

The FIWARE Foundation will participate in this event together with more than 10 co-exhibitors including members of the FIWARE Foundation and partners. A 200 sqm stand will showcase how FIWARE is powering Smart Cities with connected mobility, highlighting various domains and their interactions, with a clear focus on mobility, environment and water among others.

A dedicated working station will showcase the results of the FIWARE challenge and integration with the FIWARE architecture. Inside the FIWARE booth, more than 25 Smart Data Models for water, together with more than 600 (and growing) in different sectors will be also showcased with interactive demos.

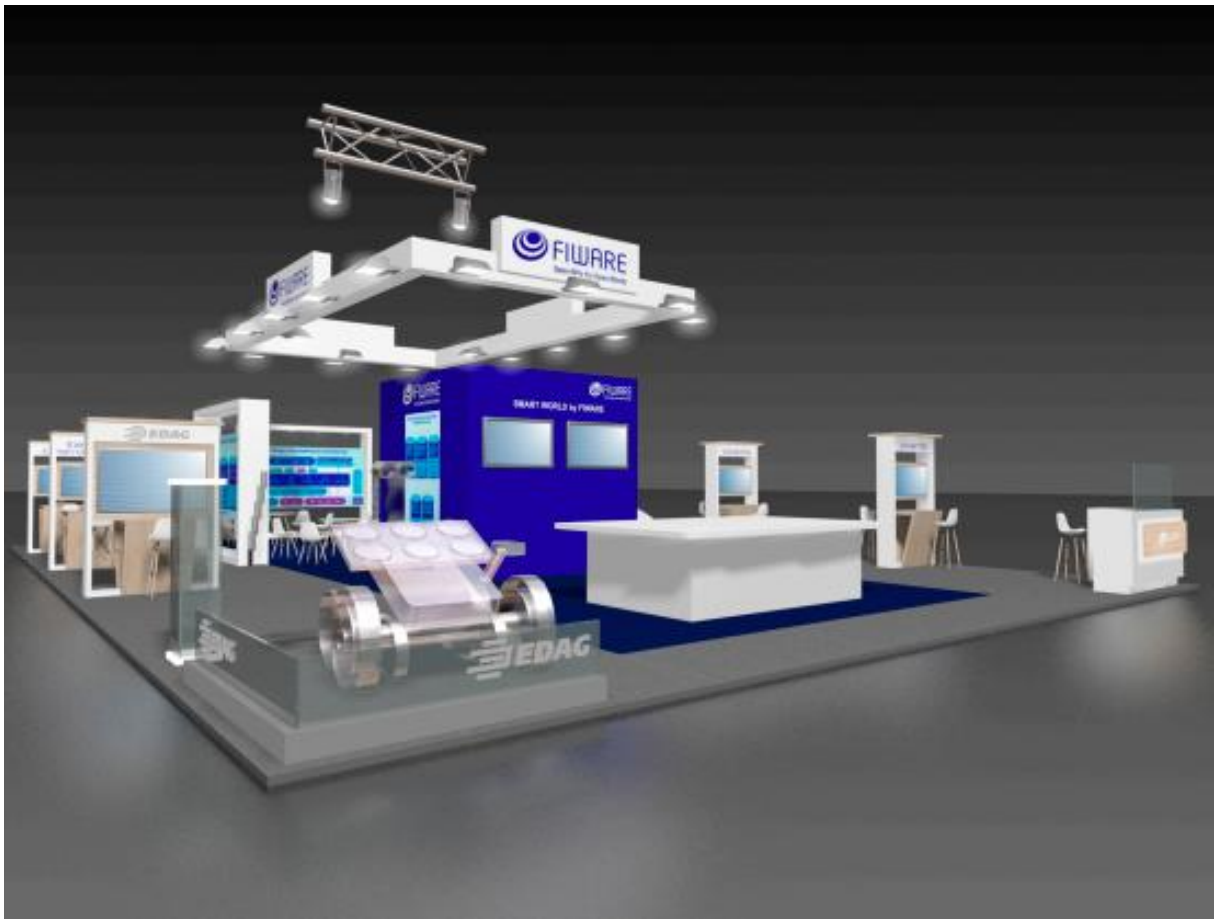


Figure 33: Booth design for the SCEWC

IX. Conclusions

The FIWARE4Water challenge has been a remarkable opportunity for the collaboration between ICT4WATER Cluster of projects. It currently has forty active project members. Their members were contacted to provide some of the challenges to be included in the FIWARE4Water Challenge.

Consequently, two of the offered challenges belonged to a project outside the Fiware4Water project. It is also true that the global challenge had a balance between offering many challenges (that will reduce the competition between different options) or to concentrate into a single case that will allow an active competition but with a poor scope of challenges. The final decision was to have three challenges and allow one of the use cases to be external to the Fiware4Water project.

Therefore, the use cases provided a good geographic coverage across Europe (United Kingdom, Italy, and Bulgaria) and quite different technical challenges.

Although the use of the platform Devpost will ease the launch of some of the dissemination parts of the challenge, the cleansing of the data to make it available for the challenges was a really time-consuming task. Finally, the promotion of the FIWARE4Water challenge faced strong competition with other simultaneous challenges, and only the connection with the **IBM Call for Code** made it popular enough to draw the attention of the participants.

The results are presented in previous sections and the potential of the FIWARE platform was clearly stated for their use in the water sector with the water specific problems. But it is also true that some lessons were learnt during the execution of this task. It is worth to be mentioned that:

1. The arrangement for the challenge took longer than expected due to the interlinked nature of the tasks. Especially, it took longer than expected to define the use case's needs and to adapt them to a feasible challenge. Therefore, a larger amount of time for the preparation should have been allocated.

2. The awards that do not attract the expected public. A monetary price is a clear standard on most of the challenges. Only the alignment of the competition with the IBM Call 4 Code allowed somehow to cover this gap.

3. Process and rules to participate are maybe too complex (guide for applicants had more than fifty pages!), something like "get ready to work on the data in 5 minutes" could have been motivating for the participant.