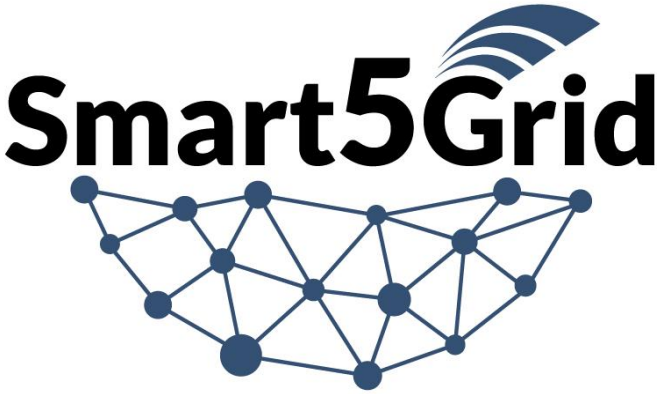

Demonstration of **5G** solutions for
SMART energy **GRID**s of the future

Deliverable **7.4**

Dissemination, Communication, Preliminary Exploitation and Standardization report

Version **0.1** - Date **23/12/2022**

The 5G Infrastructure Public Private Partnership

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D7.4 – Dissemination, Communication, Preliminary Exploitation and Standardization report

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Revision History

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Executive summary

This deliverable reports Smart5Grid dissemination and communication activities, project's interaction with the 5G-PPP and other 5G-PPP research projects, a deeper market analysis, and a more coherent preliminary exploitation plan and the all the current standardization activities, during the second year of the project.

In specific, communication channels, communication activities and interactions are described in detail and evaluated against the goals that were set in D7.2 *'Plans for Dissemination and Communication, Standardisation and Interaction with 5G-PPP'*, delivered in M3 of the project's lifetime.

Regarding communication channels, in the D7.4, the reader will find all the updates which took place in all the media. In more detail, website and social media are a continuous effort, with weekly updates highlighting all the activities of the project but also communicating news about 5G-PPP community and other related scientific information (e.g articles). The Newsletters follow the same path, with issues that are released quarterly, providing an important and cumulative information about project's endeavours. Other means of communication, like Projects' introductory leaflet and poster were updated in order to reflect better the project and the consortium, and one more leaflet which communicates the Smart5Grid community was developed. Finally, in the means of communication, the 'Join our Community' form was added. The aim of this form is to create a community of engaged subscribers.

During the 2nd year of the project, the project's publications, presentations and other organised events, were intensified targeting SME's and 5G business, academic and scientific target audiences. The partners were very active and contributed to the continuous dissemination of the project according to the plan. This year, the partners were present in conferences including the AiAi2022, IEEE Smart Cities, EuCNC and InfoCom 2022. The project participated also in events like ENLIT and additionally organised a webinar and organised or co-organised workshops and special sessions. Moreover, the partners initiated and contributed to nine (9) publications.

Finally, this document presents control mechanisms, results evaluation, social media and website statistics, as well as the impact of the second's year performed dissemination activities, while dissemination goals and plans for the activities of the final period of the project are set in accordance.

Regarding collaboration activities in this deliverable, we report the main activities of the 6G-IA / 5G PPP Projects/ NetWorld Europe WGs which are relevant to the project, as well as the Smart5Grid contributions to them during the second year of the project. Information related to the collaboration with other on-going phase 3 projects is also provided.

Furthermore, as identified in the market analysis, Energy Utilities face a set of near and long-term challenges due to growing demand for electricity, changing mix of energy sources, introduction of renewables and pressure towards sector sustainability. Sector digitalization, enabled by 5G technology and Network Applications could help address these challenges as discussed in several use cases. The sector digitalization is transforming the traditional linear value chain towards a circular value chain with increased number of stakeholders. In such a complex and dynamic environment, business modelling for ecosystems is more appropriate instead of single-firm business modelling.

While the consortium partners are following their individual exploitation plans, we are also focusing on opportunities for cooperative exploitation of the project's innovations.

Regarding involvement to standardization activities during Y2, several partners of the consortium have continued monitoring activities of some selected ESOs dealing with 5G-related challenges, including: (i) 3GPP TSG SA WG2 (SA2); (ii) OpenSource MANO; (iii) ETSI ISG MEC, and; (iv) ETSI ENI ISG. The scope has been relevant to: (I) the potential correspondence of – or correlation to – Smart5Grid's essential architecture to the wider 5G scope as the latter promoted by 3GPP's activities; (ii) correlation of the project activities to the broader OSM context and framework of reference; (iii) assessment of and possibilities for inclusion of MEC's features in the proposed Smart5Grid solutions, and; (iv) potential inclusion of enhanced network intelligence features, especially with the aim of supporting network management activities. More specifically, based on the progress of the technical work of the Smart5Grid context, specific contributions have been provided to ETSI ISG MEC and to OSM. As trials have been initiated and are mainly planned for Y3, further results and/or contributions are expected in course of the project.

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1. Introduction

1.1. Scope of the document

The scope of D7.4 is to present and evaluate the Dissemination and Communication activities, the interactions and collaborations with the 5G-PPP Programme and related research projects and WGs, to provide additional insights about Market Aspects and Exploitation Activities, and report the advancement of the Standardisation process, during the second year of its lifetime (Reported period M12-M23 due to the fact that D7.3 reported until M11).

The document is kept on the point and is composed of five main sections:

- Communication and Dissemination Report
- Monitoring, Control and Evaluation Report
- Interaction with 5G-PPP plan
- Market Aspect and Preliminary Exploitation Activities
- Standardization Activities

1.2. Notations, abbreviations and acronyms

Item	Description
3G	The Third Generation of Mobile Communications
3GPP	The Third Generation Partnership Project
4G	The Fourth Generation of Mobile Communications
5G	The Fifth Generation of Mobile Communications
5GAA	5G Automotive Association
5G NSA	5G Non-Standalone
5G SA	5G Standalone
5G-ACIA	5G Alliance for Connected Industries and Automation
5G-IA	5G – Infrastructure Association
5G-MAG	5G – Media Action Group
5G-PPP	5G – Public Private Partnership
6G	The Sixth Generation of Mobile Communications
6G-IA	6G - Infrastructure Association
ADR	AI, Data and Robotics
AE	Analytics Engine
AI	Artificial Intelligence
AIAI	Artificial Intelligence Applications and Innovations
API	Application Programming Interface
AR	Augmented Reality
B5G	Beyond 5G
BVME	Business Validation, Models, and Ecosystem
CAM	Connected and Automated Mobility
CEPT	European Conference of Postal and Telecommunications

CF	Cell-Free
CfP	Call for Papers
CNF	Cloud Network Function
CSP	Communications Service Provider
DC	Data Centric
DE	Decision Engine
DRES	Distributed renewable energy sources
DSO	Distribution System Operator
E2E	End-to-End
ECESCON	Electrical and Computer Engineering Students Conference
EC	European Commission
ECC	Electronic Communications Committee
EDGE	Enhanced Data rates for GSM Evolution
EDSO	European Distribution System Operators for Smart Grids (non-profit association)
EEGI	European Electricity Grid Initiative
eMBB	enhanced Mobile Broadband
EMEA	Europe - Middle-East - Africa
EMF	Electric and Magnetic Fields
ENI	Experiential Networked Intelligence
ENTSO-E	European Network of Transmission System Operators for Electricity
EPIA	European Photovoltaic Industry Association
ESO	European Standards Organization
ESOA	Europe-Middle East-Africa Satellite Operators Association
ESP	Energy Security Project
ETP	European Technology Platform
ETSI	European Telecommunication Standards Institute
EU	European Union
EuCNC	European Conference on Networks and Communications
EUTC	European Utilities Telecom Council
EWEA	European Wind Energy Association
E-UTRAN	Evolved UMTS Terrestrial Radio Access Network
GA	Grant Agreement
GERAN	GSM EDGE Radio Access Network
GDPR	General Data Protection Regulation
GNSS	Global Navigation Satellite System
GSM	Global System for Mobile Communications
GUI	Graphics User Interface
H2020	Horizon 2020
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
ICECET	International Conference on Electrical, Computer and Energy Technologies
ICT	Information and Communication Technology
IEEE	Institute of Electrical and Electronic Engineers

IEEE SA	Institute of Electrical and Electronic Engineers Standards Association
IETF	Internet Engineering Task Force
IMS	IP Multimedia Sub-system
IoT	Internet of Things
IP	Internet Protocol
ISG	Industry Specification Group
ISG	Industry Support Group
IT	Information Technology
ITU	International Telecommunication Union
ITU-R	International Telecommunication Union - Radiocommunication Sector
KPI	Key Performance Indicator
LBS	Location Based Service
LCM	Life Cycle Management
LTE	Long Term Evolution
LV	Low Voltage
MANO	Management and Orchestration
MEC	Mobile Edge Computing
MEC	Multi-access Edge Computing
ML	Machine Learning
mMTC	massive Machine Type Communications
MNO	Mobile Network Operator
MoM	Minutes of Meeting
MRP	Market Representation Partner
MS	MicroSoft
MS	Monitoring System
MSI	Member States Initiatives
MV	Medium Voltage
MWC	Mobile World Congress
NAC	NetApp Controller
NAO	Network Application Orchestration
NetApp	Network Application
NFV	Network Function Virtualization
NFVCL	Network Function Virtualization Convergence Layer
NG	Next Generation
NGMN	Next Generation Mobile Network
NG-RAN	Next Generation - Radio Access Network
NI	Network Intelligence
NS	Network Service
NS	Network Slice
NSMF	Network Slice Management Function
O-RAN	Open Radio Access Network
OSM	Open Source MANO

OSR	Open Service Repository
OSS	Operation Support System
PAS IEC	Publicly Available Specification
PDC	Phasor Data Concentrator
PMU	Phasor Measurement Unit
PoC	Proof of Concept
PSCE	Public Safety Communication Europe
PS&A	Portfolio Structuring and Analysis
R&D	Research and Development
R&I	Research and Innovation
RAN	Radio Access Network
RES	Renewable Energy Source
RIS	Reconfigurable Intelligent Surfaces
RT	Real-Time
RTD	Research and Technology Development.
SA	System Architecture
SDN	Software-Define Network
SG	Sub-working Group
SLA	Service level Agreement
SME	Small- and Medium-sized Enterprise
SNVC	Societal Needs and Value Creation
SNS	Smart Network and Service
SNS-JU	Smart Networks and Services – Joint Undertaking
SNSV	Smart Networks and Services Vision
T&D	Transmission and Distribution
TB	Technology Board
TCCA	The Critical Communications Association
TSDSI	Telecommunications Standards Development Society, India
TSG	Technical Specifications Group
TSG SA	Technical Specifications Group Service and System Aspects
TSO	Transmission System Operator
TST	Testing Scenario Template
T&L	Transport and Logistics
UC	Use Case
UE	User Equipment
UIC	International Union of Railways
UMTS	Universal Mobile Telecommunications System
URL	Uniform Resource Locator
URLLC	Ultra-Reliable and Low Latency Communiactions
UTRAN	UMTS Terrestrial Radio Access Network
V&V	Verification and Validation
VNF	Virtual Network Function

VR	Virtual Reality
vRAN	virtualized Radio Access Network
WAM	Wide Area Monitoring
WG	Working Group
WiTaR	Women in Telecommunications and Research
WP	Work Package
WRC	World Radiocommunication Conference
WWW, www	World Wide Web

Table 1: Acronyms list

2. Dissemination and Communication

2.1. Introduction

The main goal of Smart5Grid Communication and Dissemination Action Plan, as already described in *D7.2 Plans for Dissemination and Communication, Standardisation and Interaction with 5G-PPP*, is to create and spread the awareness of the project and its results to the widest possible audience and to attract potential users and customers. In D7.3 all the communication and dissemination activities of Y1 (M1-M11) were reported thoroughly and the scope of D7.4 is to continue the report and update the reader about the project's advancements.

2.2. Target Audience

This year's consortium's activities targeted, as already defined by *D7.2 Plans for Dissemination and Communication, Standardisation and Interaction with 5G-PPP*, the following audiences.

- SMEs is a key target stakeholder in Smart5Grid. Industry Manufacturers, Telecom Operators and Power Grid Operators, as well as SMEs, the 5G-PPP actors, 5G IA members, industrial organizations actively involved in 5G, DSOs/TSOs and ESPs.
- Researchers both in academia and industry.
- Incubators, Associations, Digital Innovation Hubs.
- 5G-PPP Actors and Projects.
- Standardisation Bodies and Open-Source Communities.
- Public Authorities, Initiatives and Policy Makers.
- Citizens / General Public.
- General Press.

2.3. Means of Outreach Activities

The communication channels and the means of dissemination were thoroughly presented in D7.2 and D7.3, so in order to avoid being repetitive and facilitate the reader, in this section we will present only the updates that have been done during Y2 (reported period M12-M23).

2.3.1. Communication Channels

2.3.1.1. Website

Smart5Grid website is the main channel of communication and interaction with all the project's stakeholders. Smart5Grid's website https://smart5grid.eu is divided into 9 menu sections, namely: Home, The Project, Use Cases, Architecture, Partners, Communication, Dissemination, Contact us and Join our community.

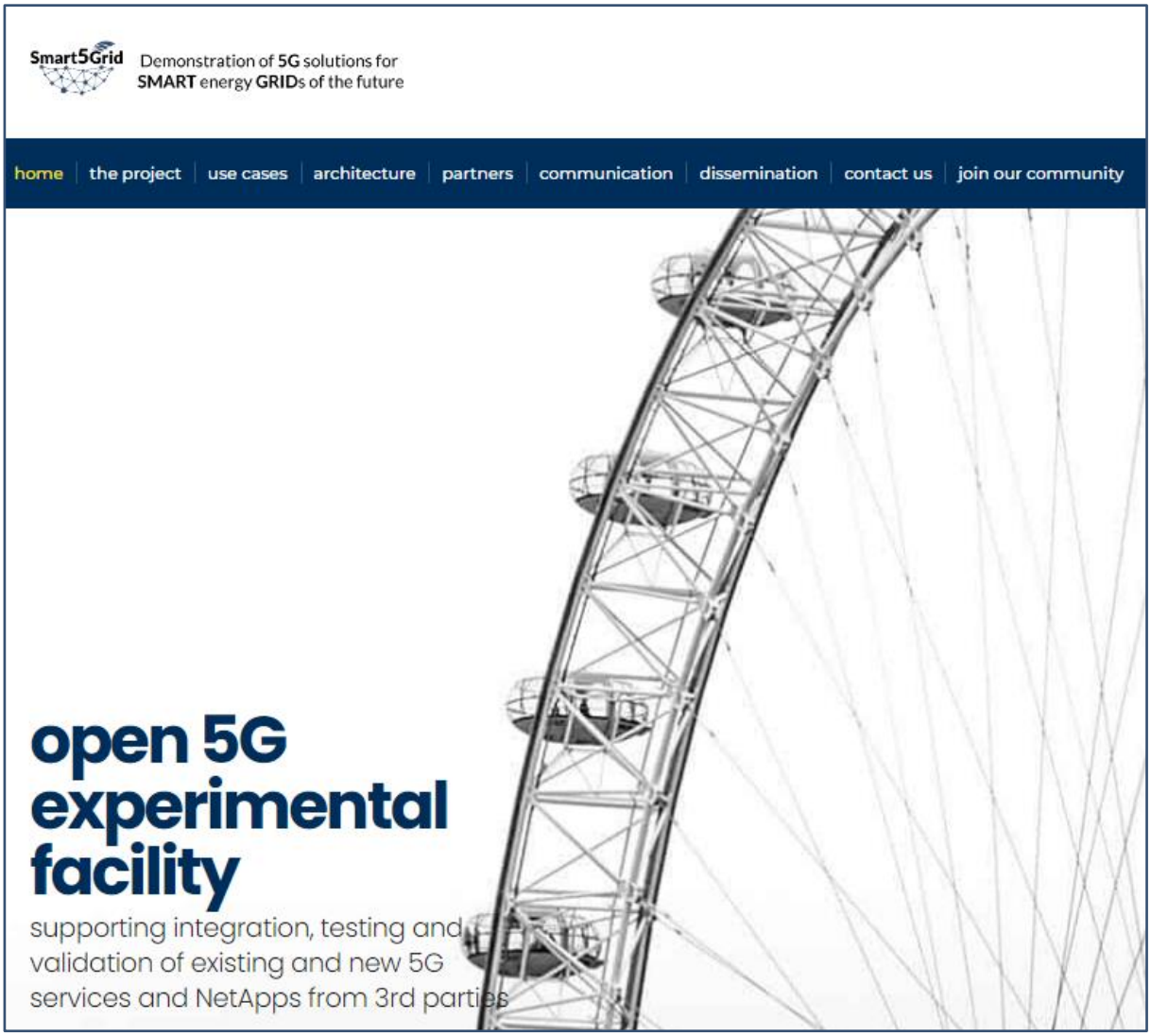


Figure 1: Smart5Grid Website

All Y1 and Y2 Communication and Dissemination Activities are uploaded to the website to keep the community informed about the project's activities, news, and achievements. The website's updates are ongoing according to the project's ventures.

As already mentioned, detailed analysis of the website has been provided in D7.1, D7.2 and D7.3 and only the updated Webpages during Y2 to be presented below. The updates reflect both suggestions from the 1st Project Review and the needs derived as the project advanced.

THE PROJECT TAB

The Project webpage (https://smart5grid.eu/the-project/)

The **Project Section** was merged with the **In Brief** Section as the content was repetitive. As a result, the Brief Tab was deleted permanently. So now there is a single page which includes all the information about the project.

Figure 2: The project webpage

The Synergy webpage (https://smart5grid.eu/the-project/)
The **Synergy sub-menu** was updated with all the current interactions with 5G-PPP projects.

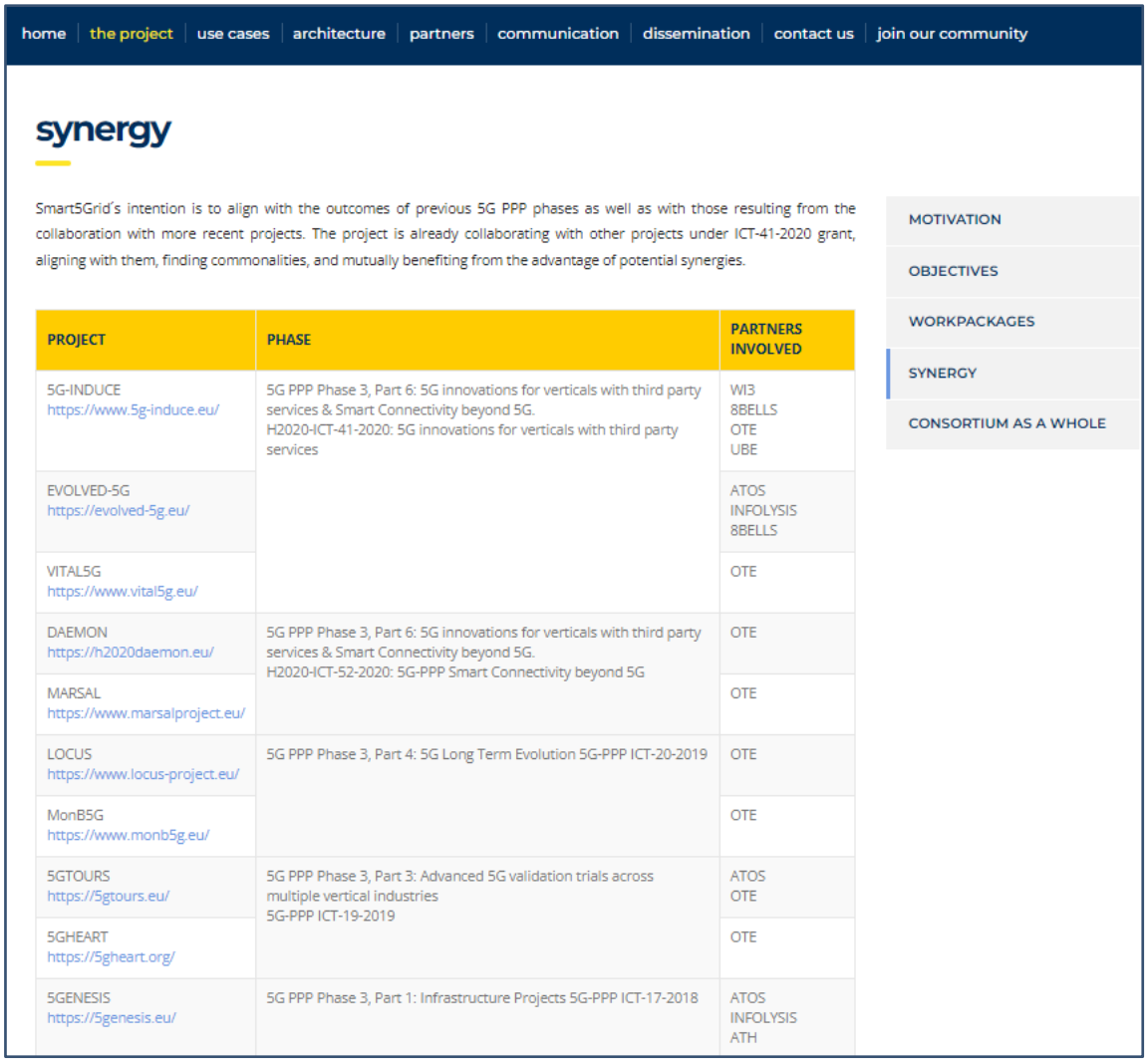


Figure 3: The Synergy sub-menu webpage

USE CASES TAB

Use Cases webpage (https://smart5grid.eu/use-cases/)

Use Cases Section content was already updated in Y1, as the technical pillars of the project had been further elaborated and finalized. This year the updates on this page realised in order to facilitate the navigation. In the previous edition, the Use Cases Menu presented the 4 Use Cases by number (e.g Use Case 1). So now in the scroll menu, the 4 Pilots are presented with their title (e.g Automatic Power Distribution Grid Faul Detection) in order the visitor to directly understand the principle of each Use Case. Furthermore, the images of the Use Cases were updated and were enabled with zoom function and the content of each Use Case description was elaborated as the project advanced.

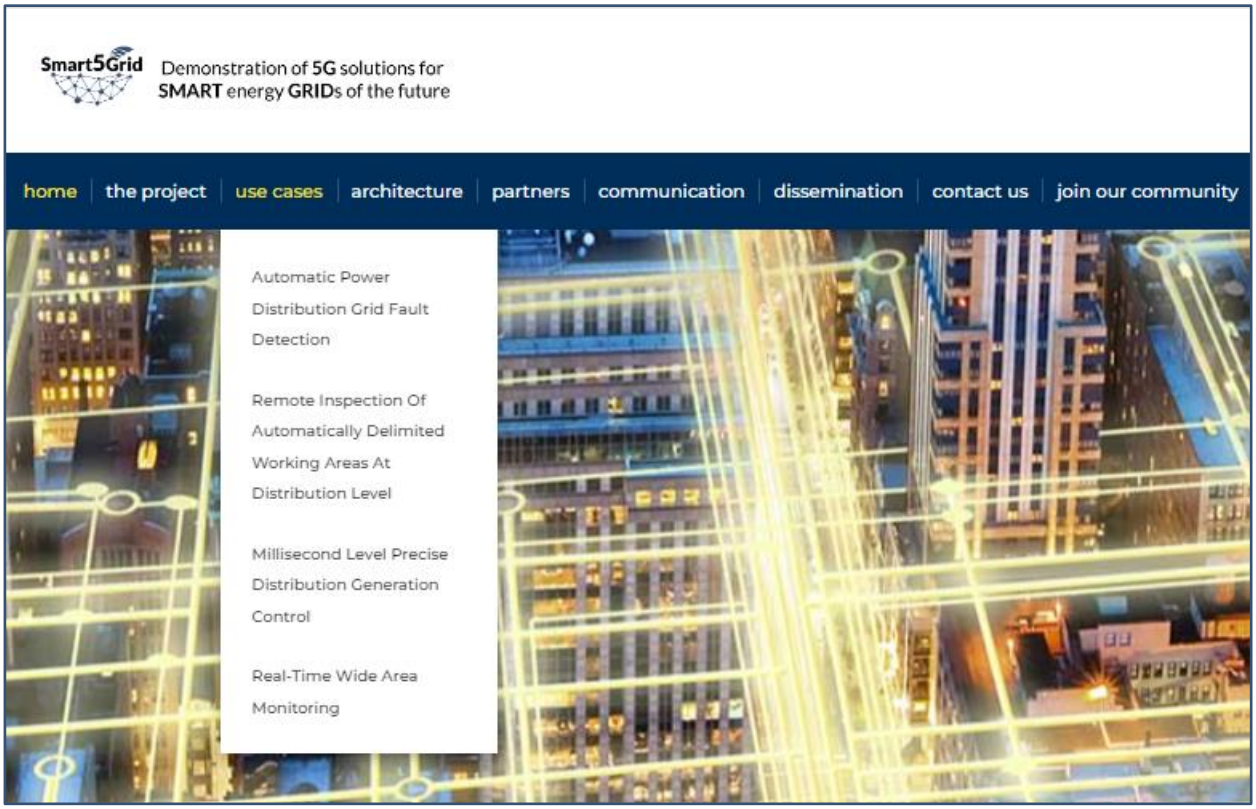


Figure 4: Use Cases Tab Scroll Menu

Figure 5: Use Case 4 (Real-time Wide Area Monitoring) Page

ARCHITECTURE TAB

Architecture webpage (https://smart5grid.eu/architecture/). The architecture page was added in order to give more detailed information about the project and the components.

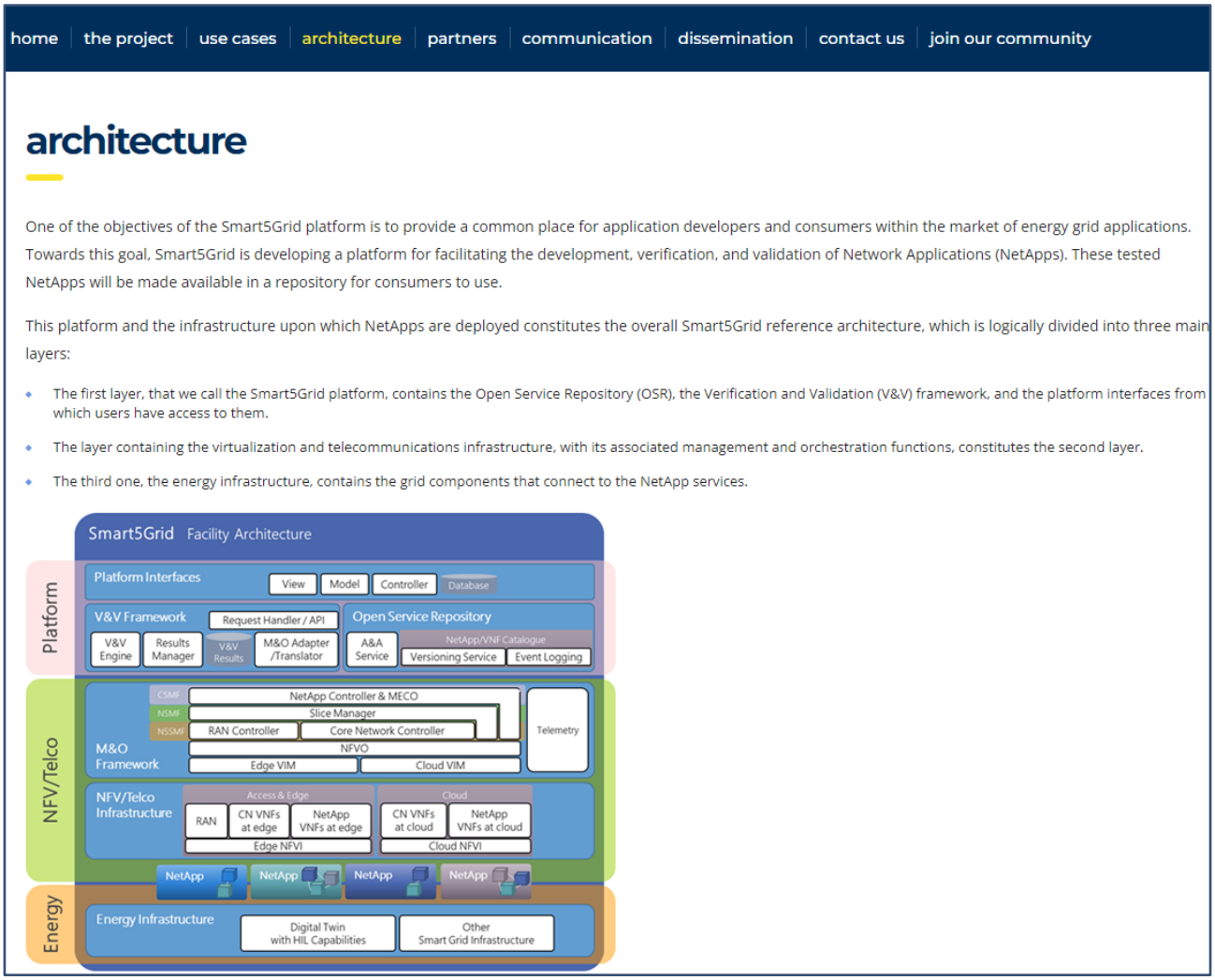


Figure 6: Architecture Page

JOIN OUR COMMUNITY TAB

Join our Community webpage (https://smart5grid.eu/join-our-community/)

The "Join our Community" section was also added in order to "enrich" our list of stakeholders who are interested in the framework of the Smart5Grid Project. The subscription form invites the subscriber to fill-up 8 different fields with personal and respective legal entity's data as well as to choose what kind of information he/she wishes to receive. There are two choices and both can be selected, that is: Smart5Grid News and Expression of interest in the experimentation platform. This initiative assists the goals of WP7 ("Exploitation and Impact Creation") and WP2 (T2.4 "Alignment with previous 5G-PPP and roadmap for 3rd party experimentation"). More about this initiative can be found in the Join our Community Form

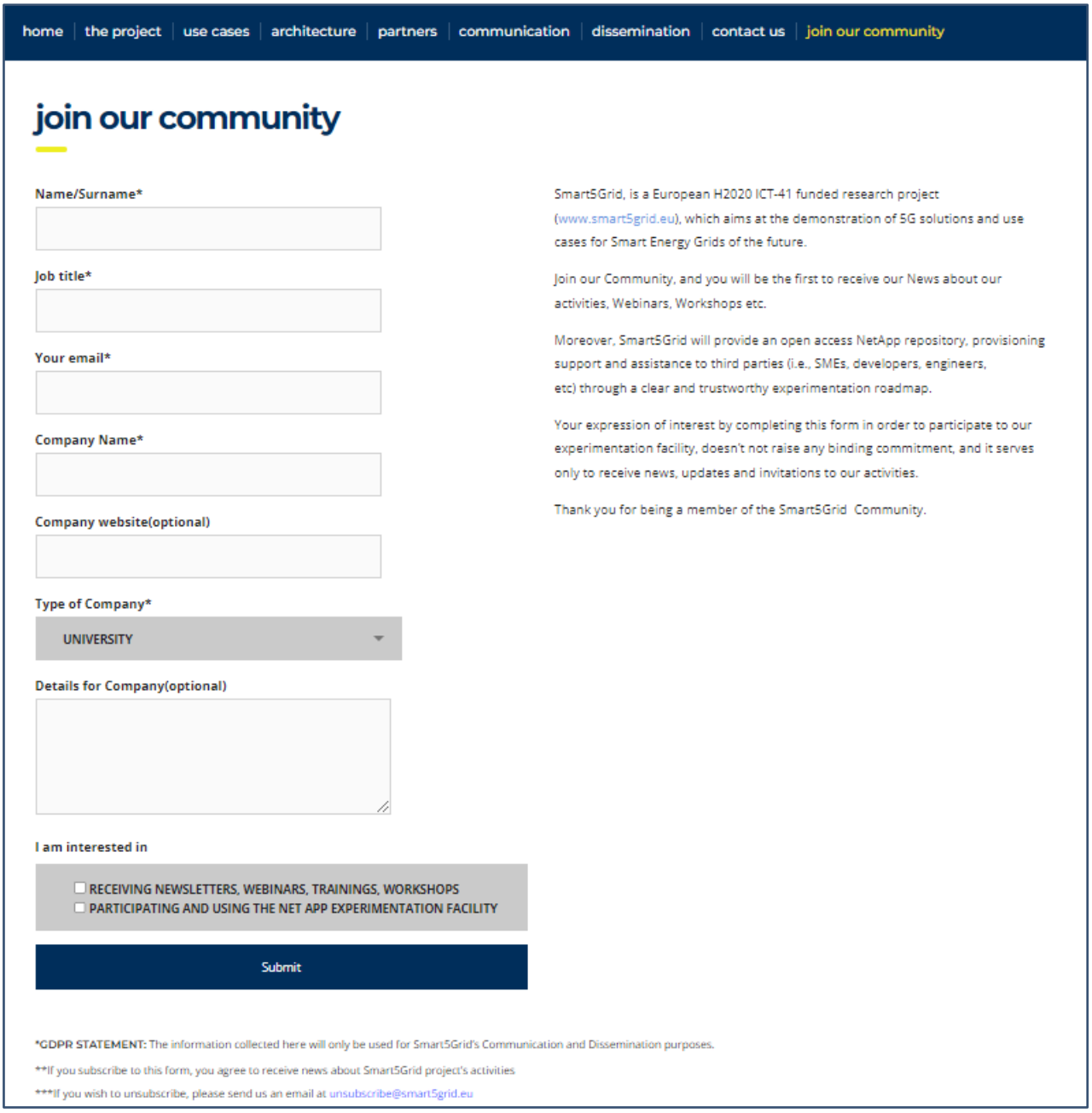


Figure 7: Join our Community page

DISSEMINATION TAB

Workshops, Special Sessions, Seminars webpage (https://smart5grid.eu/dissemination-activities/workshops-special-sessions-webinars/

This additional menu was created in order to report all the organized and co-organized events from the Smart5Grid Project.

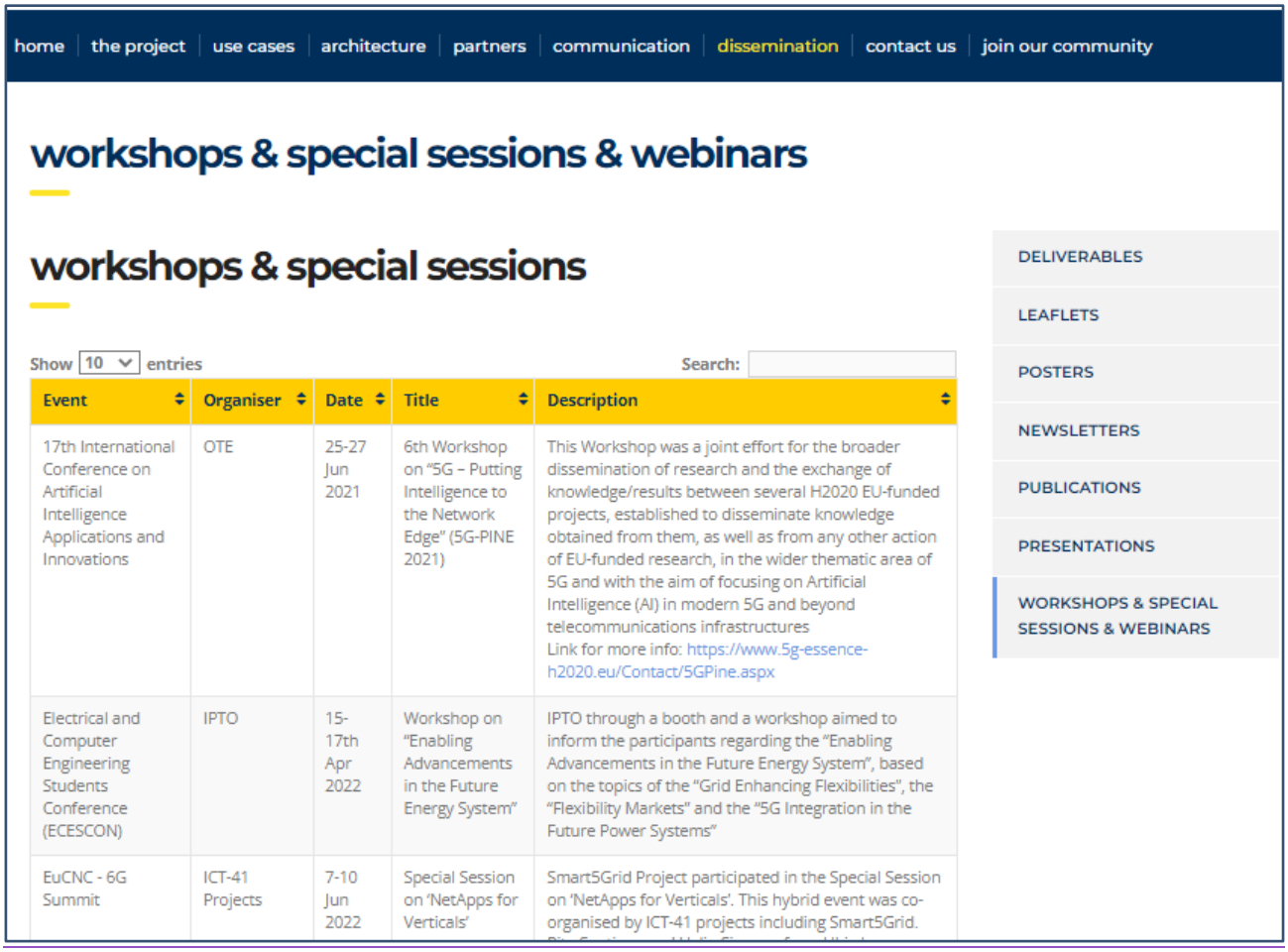


Figure 8: Workshops, Special Sessions and Webinar page

Presentations webpage (https://smart5grid.eu/dissemination-activities/presentations/**)**
The update on this webpage comprises uploading of related partners' presentations in the form of [.pdf] files, to allow any visitor to have access to the project's material.

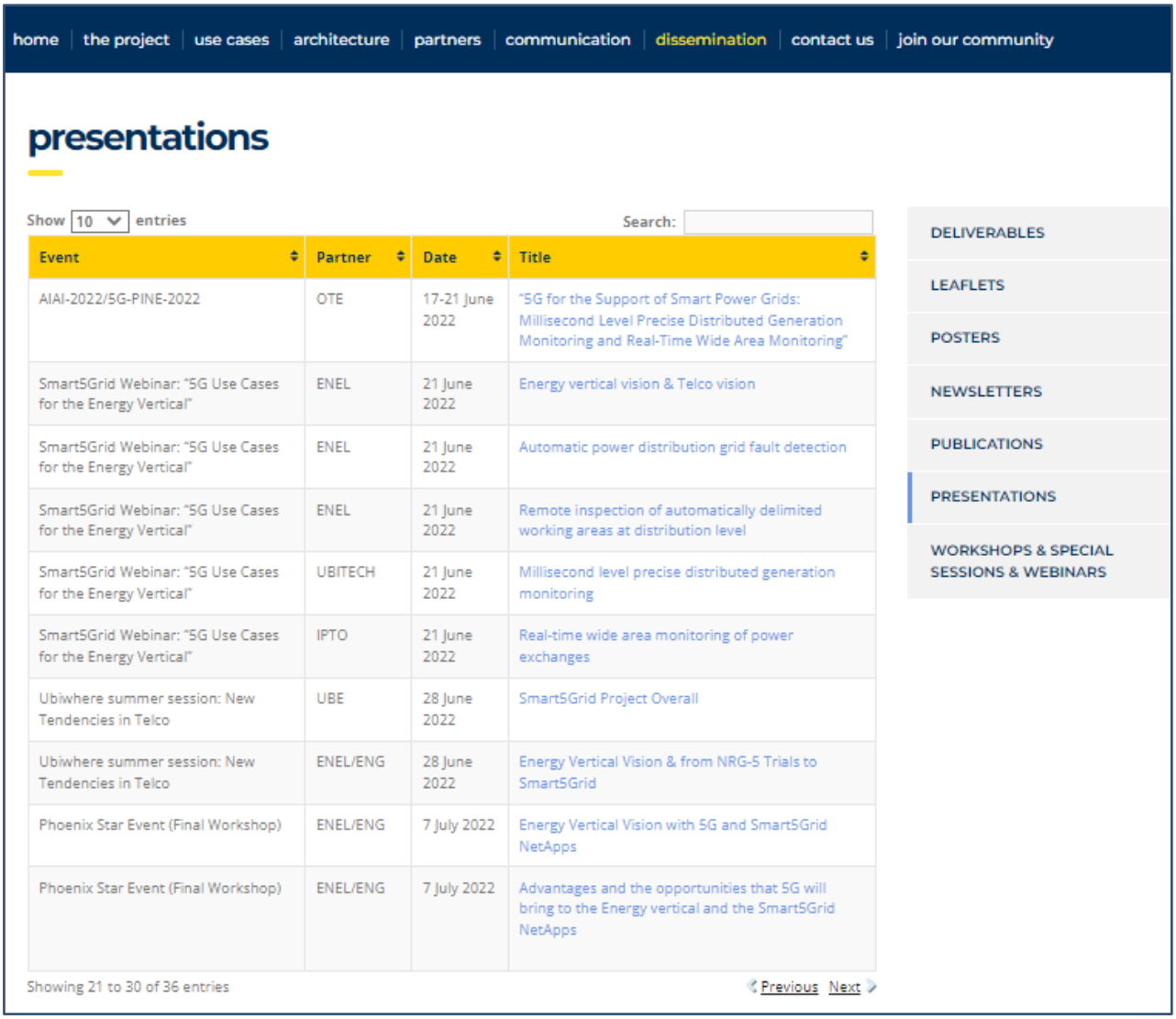


Figure 9: Presentations page

Leaflets and Posters webpage (https://smart5grid.eu/dissemination-activities/leaflets/, https://smart5grid.eu/dissemination-activities/posters/). The initial Project Leaflet and Poster were updated and one more was added in order to communicate and draw attention to our community. The files can be downloaded in .pdf files here poster and here leaflet.

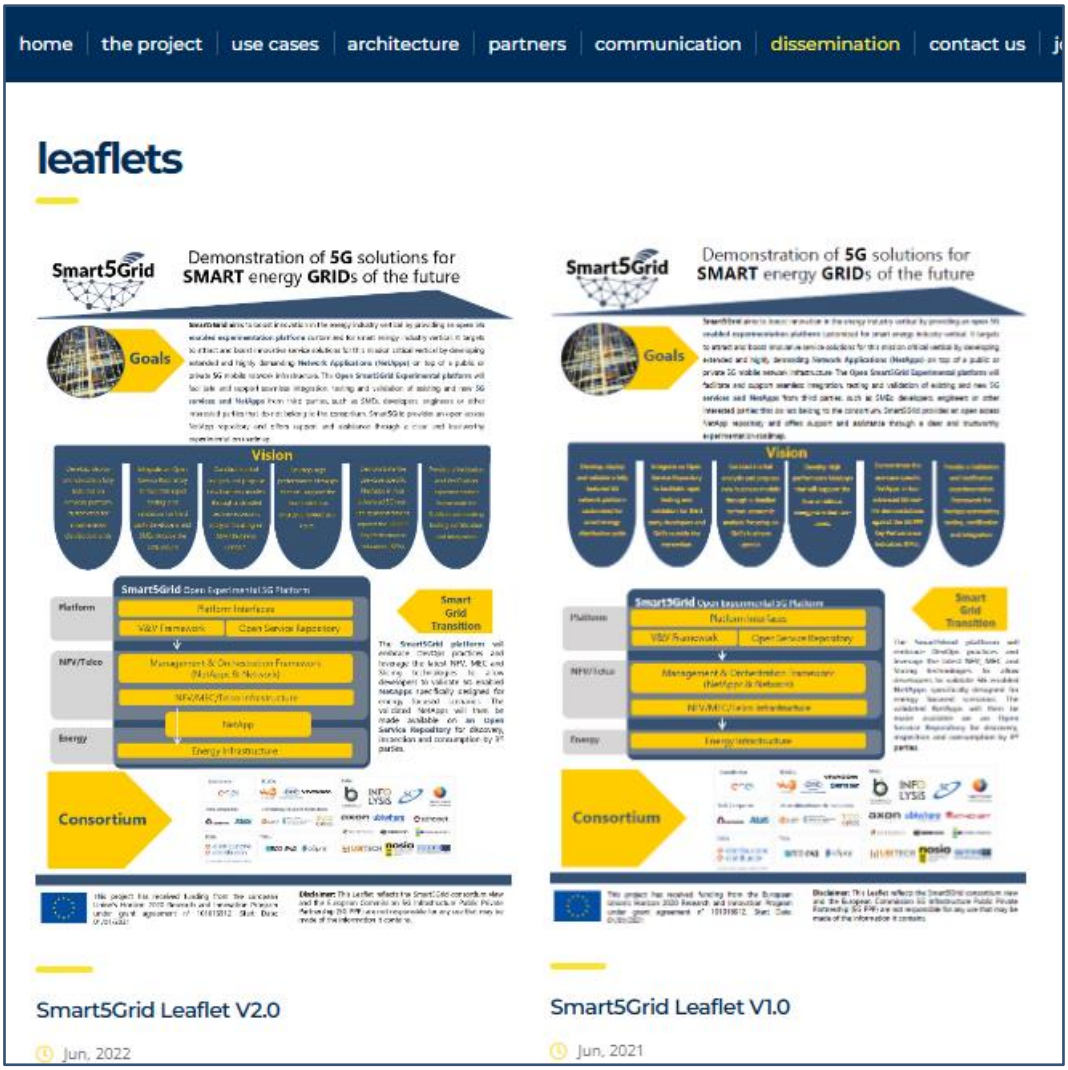


Figure 10: Leaflets Page

2.3.1.2. Social Media Channels

Since M1, the Smart5Grid Project has been active on the most widely used platforms, where it posts updates on its activities, events, and accomplishments at least twice a week. Furthermore, the content which is communicated includes articles related to the Smart5Grid project and the 5G-PPP activities, relevant industry news and important European events within a broader framework. As already reported in previous deliverables, the project continues to use the hashtag **#LearnAboutSmart5Grid**, and groups all the relevant Smart5Grid posts under a common Smart5Grid umbrella, thus promoting important activities of the project and differentiating it from other posts. Additional hashtags, **#smart5grid, #innovation** and **#research** are also used to provide the core essence of the project; the hashtags **#5G and #5G-PPP** are used in order to "reference" the 5G-PPP and engage the 5G community with the Smart5Grid project.

To facilitate any potential reader of this deliverable, the Smart5Grid social media channels are the following:

a. **LinkedIn:** smart5Grid Project (https://www.linkedin.com/in/smart5grid-project/)

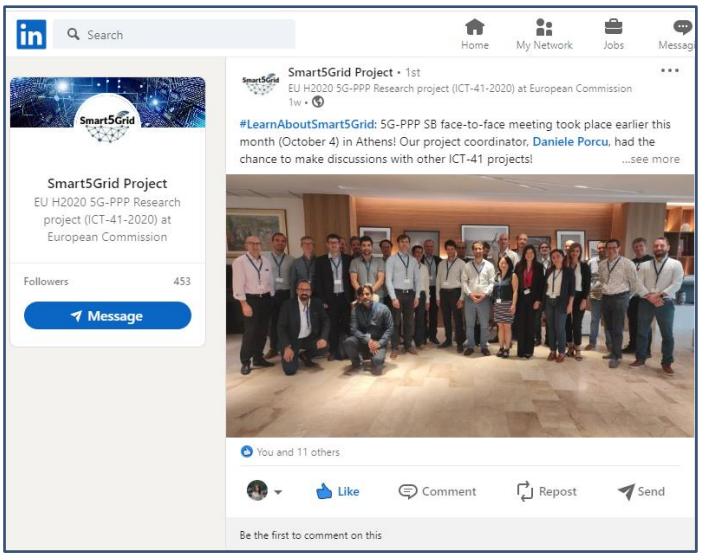


Figure 11: LinkedIn Page

b. **Twitter:** @smart5grid (https://twitter.com/smart5grid)

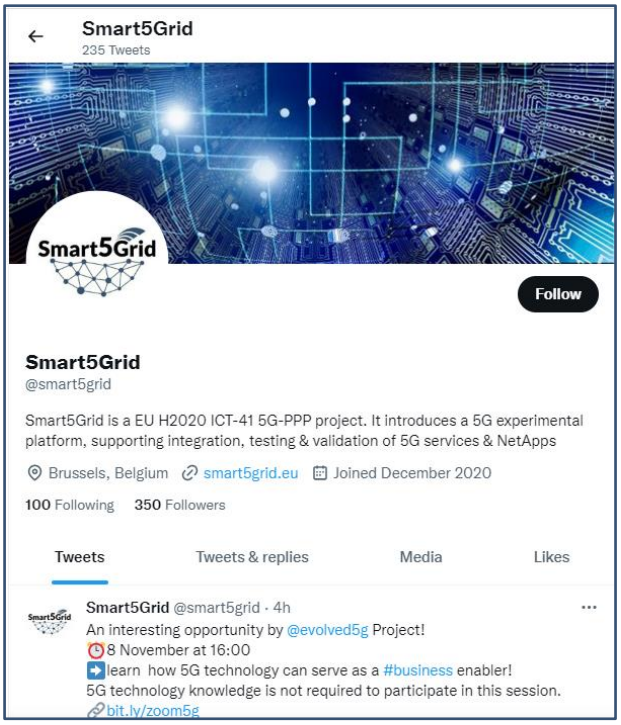


Figure 12: Twitter Page

c. **Facebook:** Smart5Grid (https://www.facebook.com/smart5grid)

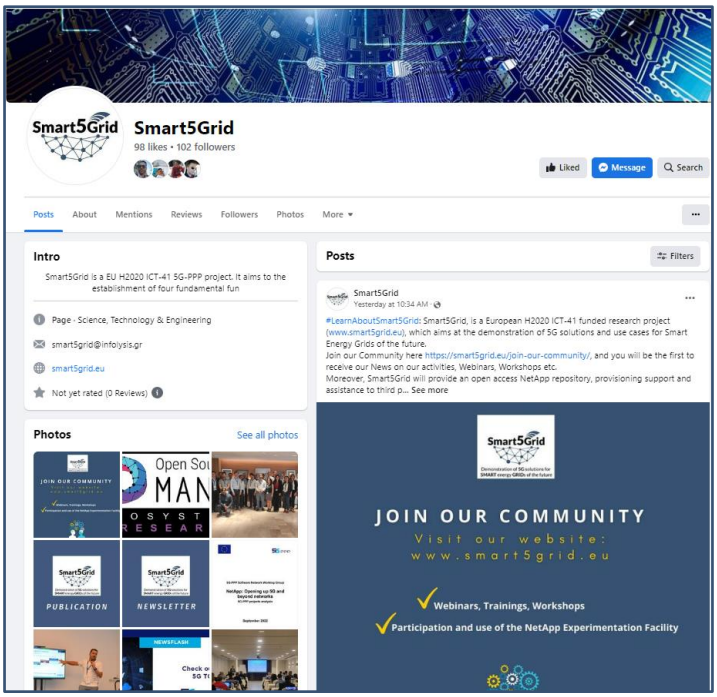


Figure 13: Facebook Page

d. **Instagram:** smart5grid (https://www.instagram.com/smart5grid/)

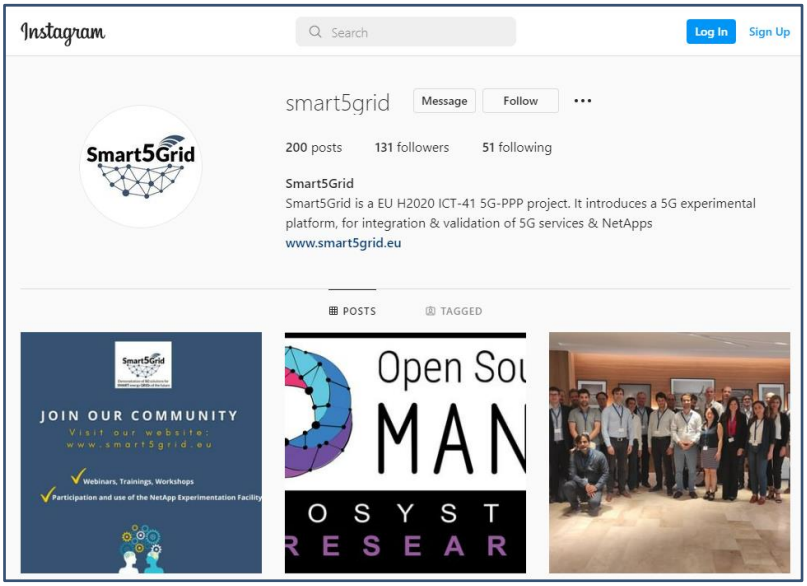


Figure 14: Instagram Page

e. **YouTube:** Smart5Grid Project https://www.youtube.com/@smart5gridproject)

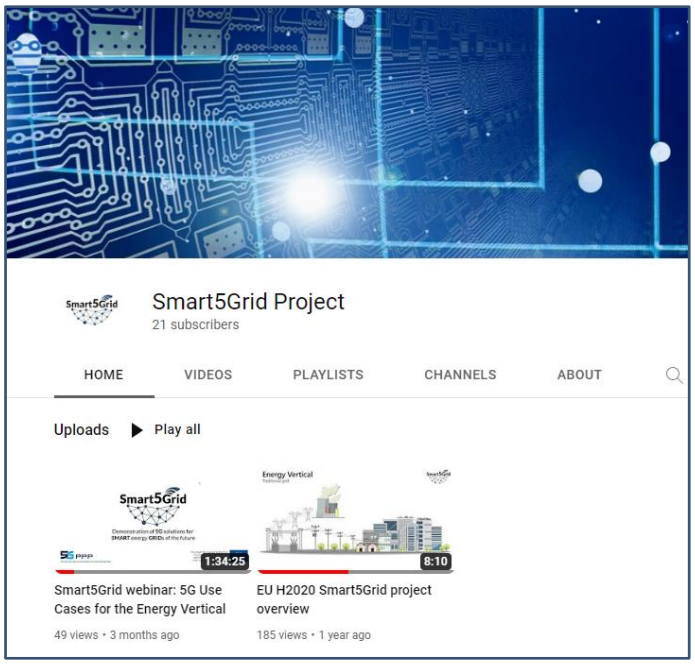


Figure 15: YouTube Page

2.3.1.3. Newsletters

Newsletters are issued quarterly as reported in previous Deliverables (I.e.: D7.2 and D7.3). In total, 7 Newsletters have been released, from which 3 of them in Y2, covering news and activities of the project throughout the 3 first trimesters of the present year. The 8th Newsletter which covers the last trimester of 2022 will be released early in January 2023. Newsletters are a crucial tool for communication since they compile and convey all the events and high points of a certain time period. The structure consists of three permanent sections, that is "Communication & Dissemination Activities", "5G-PPP activities" and "Deliverables". The last 2 newsletters advertise in their last page our "Join our Community" form and call all interested parties to procced to subscription. When a Newsletter is released, it is communicated primarily to the partners of the Smart5Grid consortium and then in the Social Media Website, as well as to the project's Community list and to the 5G-PPP Comms mailing list. You may find all the Newsletters here https://smart5grid.eu/dissemination-activities/newsletters/

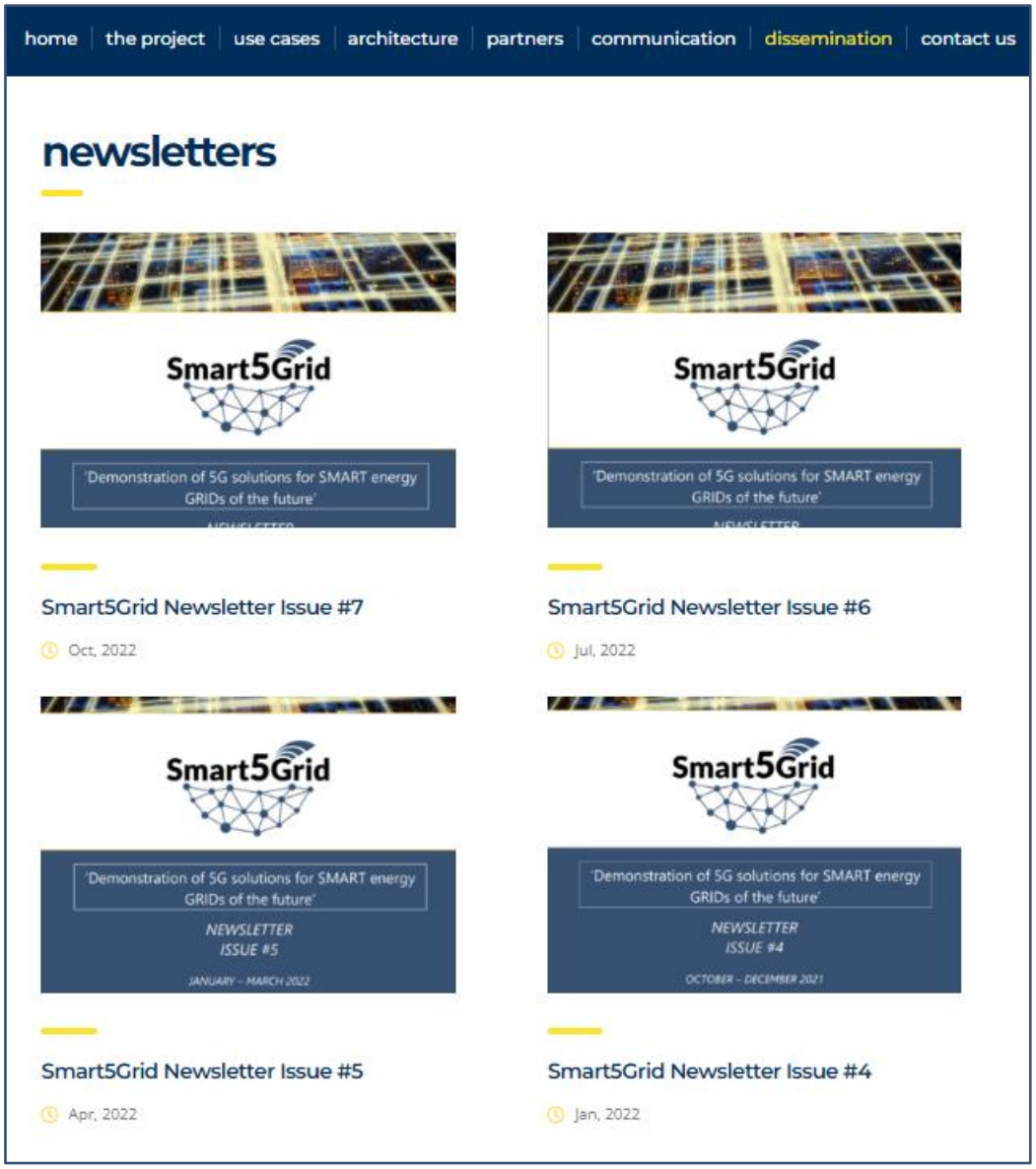


Figure 16: Newsletters Page

2.3.1.4. Posters

A Smart5Grid poster (https://smart5grid.eu/dissemination-activities/posters/) was designed and became available to the Consortium partners in M6, with the aim of representing the project in conferences and other events. As the poster conveys the general concept of the Smart5Grid, in Y2 the poster had only a small update regarding 2 partners' logos, which were changed (i.e., the cases of Athonet and Vivacom).

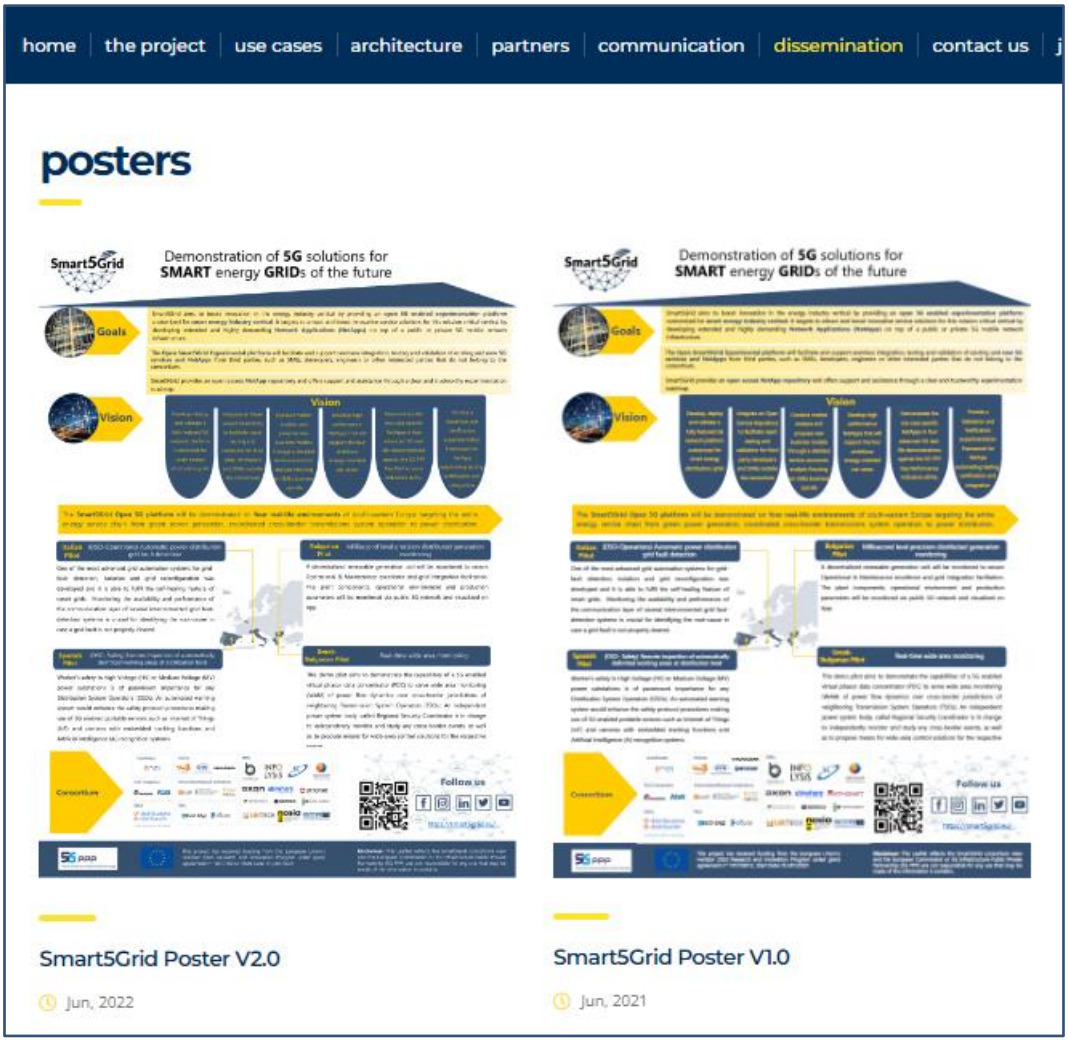


Figure 17: Posters Page

2.3.1.5. Leaflets

Similarly, to the poster the introductory Smart5Grid leaflet (2-page leaflet in A4 size), was designed and became available to the partners in M6. In Y2 few updates took place. Apart from the 2 logos (Athonet and Vivacom), the word 'NetApp' was added in the Open Experimentation 5G platform scheme and the image of the UC 1 – Italian pilot was replaced by a new one which was considered more appropriate to reflect the specific Use Case. Complementary to these leaflets, one more leaflet A3 size, was developed in order to be used by the partners in various events, and to support their effort to attract interested parties to Smart5Grid Community. You may find all the leaflets here https://smart5grid.eu/dissemination-activities/leaflets/

Figure 18: Leaflet Page

2.3.1.6. Video

This year, additionally to the introductory Smart5Grid YouTube video, a new video has been developed to provide an overview of the project, coming from the dedicated Smart5Grid webinar which was held on the 21st of June 2022, on *"5G Use cases for the Energy Vertical"*. This video has, until now, 60 views, approximately. The upcoming year more videos will be created towards more technically-oriented content.

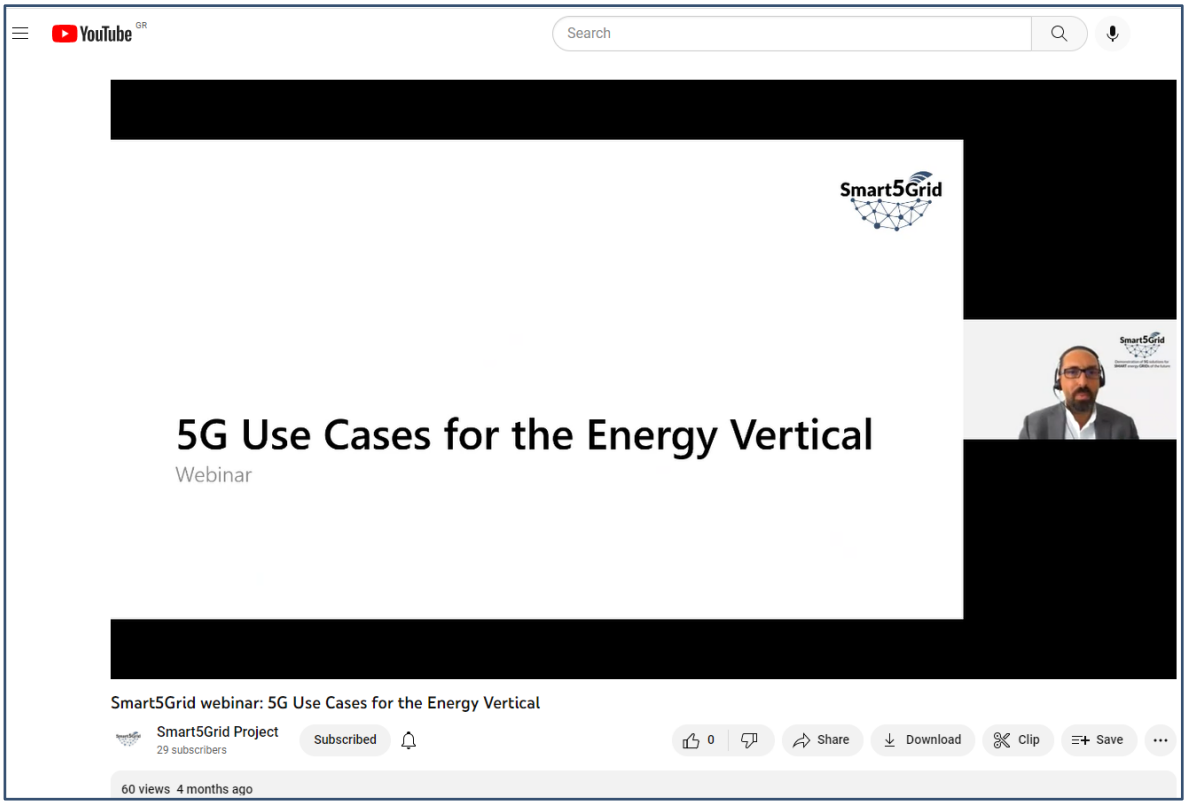


Figure 19: YouTube Channel

2.3.1.7. Join our Community Form

The "Expression of Interest" Form (https://smart5grid.eu/join-our-community/), renamed for communication purposes, as "Join our Community" which serves two "drives" was initiated in D7.3 and was developed in the M16. The first drive was to create an engaged database from the broader target audience who are interested in the Smart5Grid Project and have agreed to receive project's news on different activities (related to WP7 activities). The second drive was to attract 3rd party stakeholders (i.e., SMEs, developers, engineers, etc.) for experimentation purposes and, once the open access Network App repository is ready, to invite them to participate to the project context related to the dedicated T2.4 activities ("Alignment with previous 5G-PPP and roadmap for 3rd party experimentation"). The form was developed in a way for the project to receive the most essential information about the corresponding interested party. There are 5 obligatory fields to be completed such as: "Name/Surname", "Job Title", "Email", "Company Name" and "Type of Company" and 2 optional such as "company's website" and "Details for Company". Finally, there are 2 fields to be ticked to "reflect" the kind of interest of the subscriber. The first option is about receiving the news from the Smart5Grid project, and the second option can be selected in case the subscribers wish to participate and use the experimentation facility. At the end of the form, there are the following 3 statements to cover the GDPR policy.

***GDPR STATEMENT:** The information collected here will only be used for Smart5Grid's Communication and Dissemination purposes.
**If you subscribe to this form, you agree to receive news about Smart5Grid project's activities
***If you wish to unsubscribe, please send us an email at admin@smart5grid.eu

In each email sent, there is always the note at the end *'You are receiving this email, because you have subscribed to Smart5Grid Community. If you wish to unsubscribe, please send us an email at admin@smart5grid.eu'*.

For the time being the Subscribers' Profiles are the following: University, IT Developer/Integrator, Telecommunication equipment vendor, Research Institute, EU Programme managing authority.

Only the WP7 Leader (8BELLS) and the T7.1 Leader (INF) have access to such data. This sort of data will all be deleted after the end of the project and following to the completion of the communication activities.

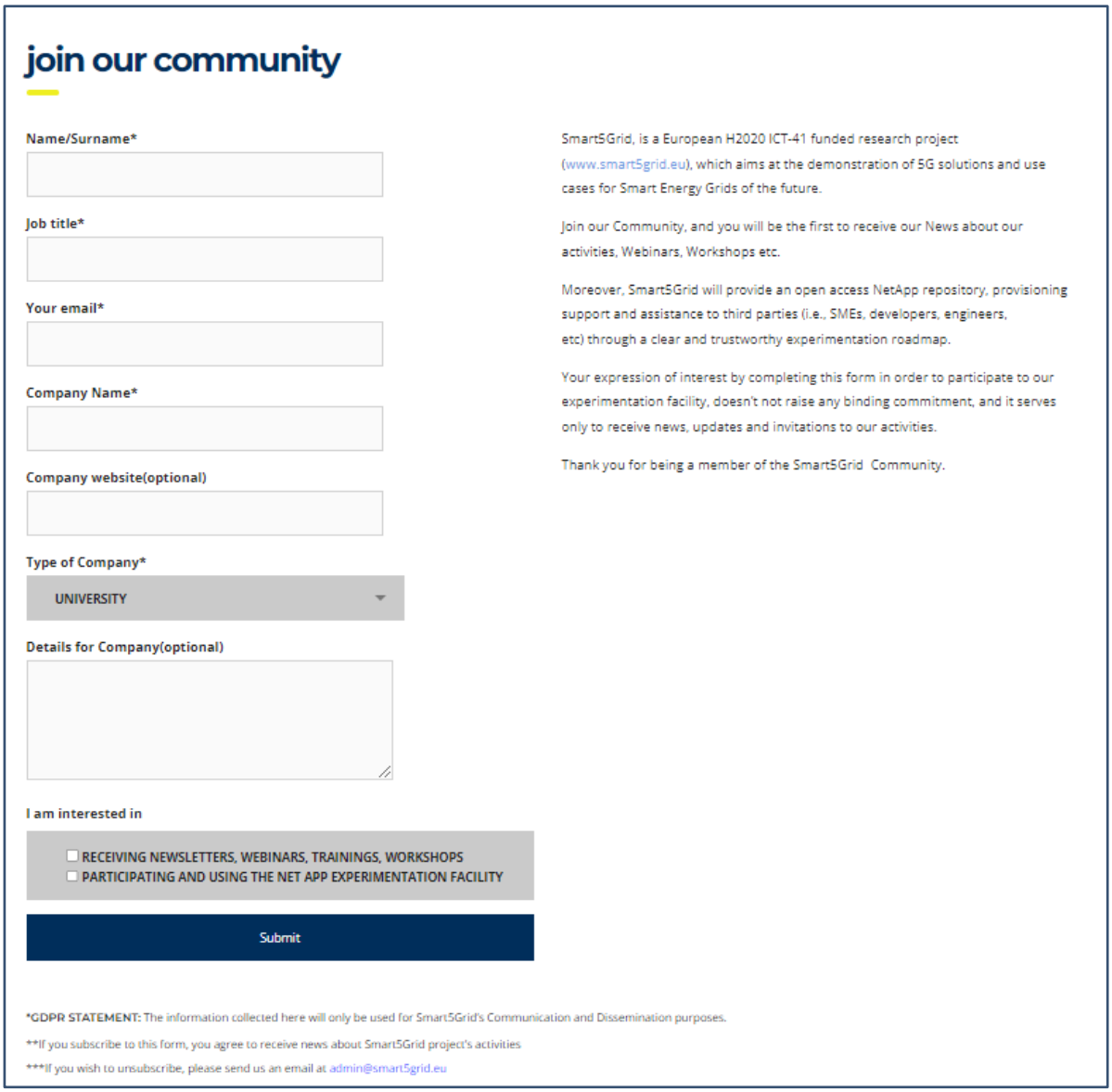


Figure 20: Join our Community Form

2.3.2. Dissemination Means

Hereby, we present briefly the Dissemination Means which have already been used or they will be used in the upcoming month and until the end of the project in order to efficiently disseminate it.

For more details about second year's performed activities the reader can proceed in Outreach Activities – Year 2

2.3.2.1. Publications in journals, Workshops, Conferences, 5G-PPP and White Papers

Smart5Grid partners, as expected in Y2, have participated with publications in Conferences Workshops and a Special Session. As already reported and with the aim of ensuring a proper dissemination process and the file preservation even after the end of the project, a Zenodo repository Smart5Grid account and its corresponding community have been created (https://zenodo.org/communities/smart5grid/). As per the time this report was under editing, the project has been involved in seven (7) Conference and Workshop papers, in one (1) 5G-PPP paper and in one (1) Journal Paper.

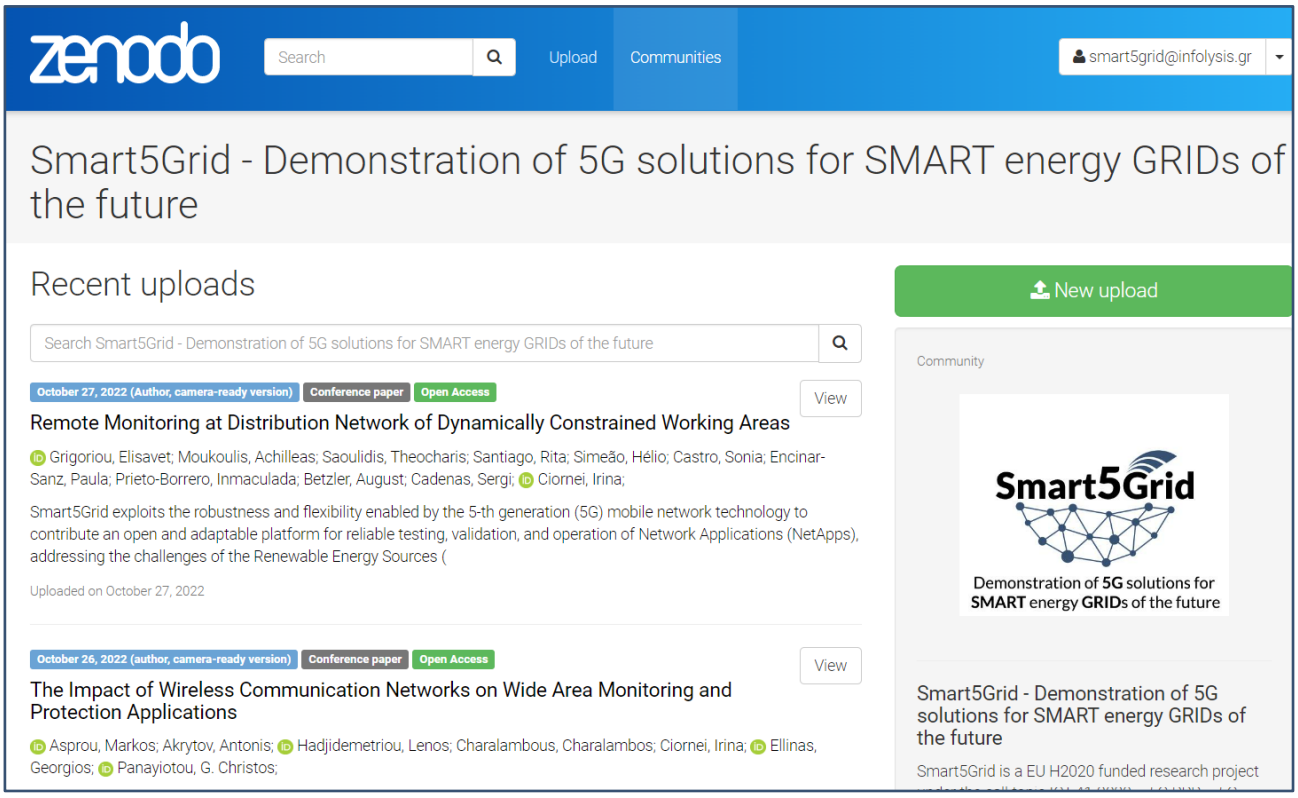


Figure 21: Smart5Grid Zenodo Account and Community

2.3.2.2. Presentations in Workshops, scientific events and fora.

To reach the industrial and academic community as well as the pertinent business sector and to disseminate findings and outcomes as the project develops and matures, presentations at workshops, conferences, and other scientific and business-related events are crucial. Until M23, Smart5Grid partners had contributed with 34 presentations in various events including EuCNC, AiAi 2022, ENLIT, IEEE International Smart Cities Conference and Sustainable Places 2022.

2.3.2.3. Field Trials and Showcases

Field Trials and Showcases were scheduled to start their planning during Y2 and to be organized by the different Smart5Grid partners until the end of the project, targeting to attract potential users and to enable the dialogue among researchers and the market sector. Following to the technical advances of the project, the Field Trials and Showcases KPIs will be all meet in Y3.

2.3.2.4. Exhibitions in industrial and scientific events

Aiming to attract the interest of the general public, especially audiences with technical interests and experts from industry, SMEs, and academics, participation in scientific and industrial events is highly important by giving the project the opportunity to increase its visibility and showcase outcomes. This year the project was present in two events. In ENLIT 2022 and in Smart Cities Expo World Congress.

2.3.2.5. Organization of events (workshops/seminars/webinars):

Apart from spreading the word about the project, events like workshops, conferences, seminars and webinars are crucial in order to attract all the relevant stakeholders. In Y2 several activities took place, like Special Sessions, Webinar and Workshops and these are described in detail in the Dissemination Means.

2.3.2.6. Active participation in 5G-PPP and NetworldEurope activities.

Active participation in 5G-PPP/6G-IA-SNS and NetworldEurope ETP Activities is a continuous effort and Smart5Grid partners are well aware of their commitment to these bodies. They acknowledge the roles and commitments of the European Commission (EC), the PPP partnership board, 5G-PPP WGs, the NetworldEurope through SME WG, the 5G Infrastructure Association [1] (5G-IA), the 6G Infrastructure Association (6G-IA) and commit to productive interactions with these bodies.

2.3.2.7. Other Events, Press Articles and other publications

In Y2, Smart5Grid participated in 2 other public events (Uptime event & MWC 2022). This year most of the partners who contributed to activities used the social media and the website of their companies to communicate and as a result we don't have the additional press releases or articles, compared to the 1st year.

2.4. Means for Coordinating, Monitoring, and Controlling Outreach Activities

As already stated in previous deliverables, a set of tools is used for securing the efficient and continuous monitoring and evaluation of communication channels as well as for activities and corrective actions to be applied whenever necessary. These coordinating, monitoring and controlling mechanisms are in place since the project's initiation and are constantly reviewed, adapted, and updated to the latest needs of the project and its partners.

2.4.1. MS TEAMS file sharing portal

Since M1 Microsoft team platform (Figure 22), is the main online repository tool for sharing material and content. As already stated in previous deliverables different sections-folders and subfolders have been created and they are regularly updated in order to preserve and enhance the good collaboration and the alignment among the partners. The dedicated folders were created per dedicated Work Package and Task and they include, among others, project material for public use, like Templates, Communication material etc, Task Presentations, MoM, Deliverables, files which record or inform about Dissemination and Communication Activities.

[1] For further details also see: https://5g-ppp.eu/5g-infrastructure-association/

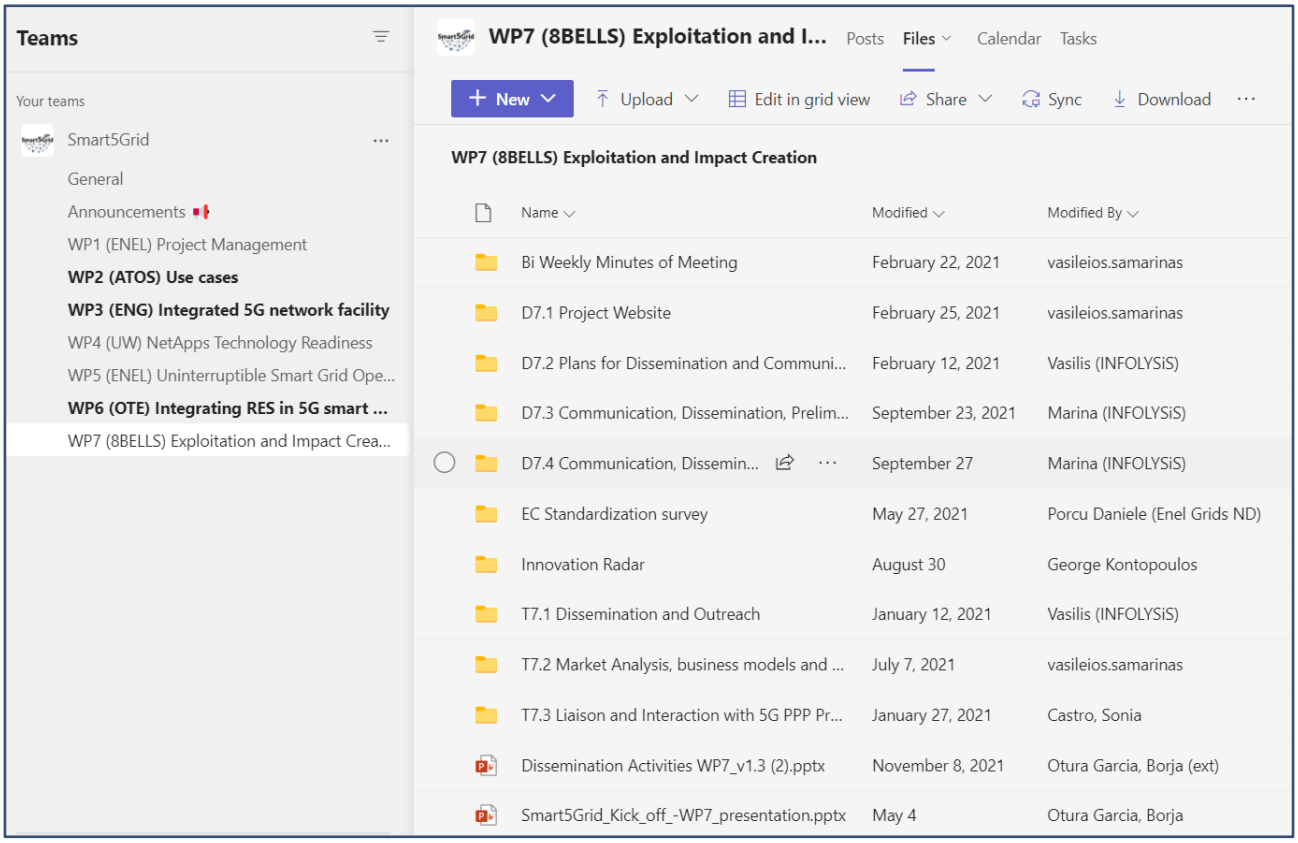
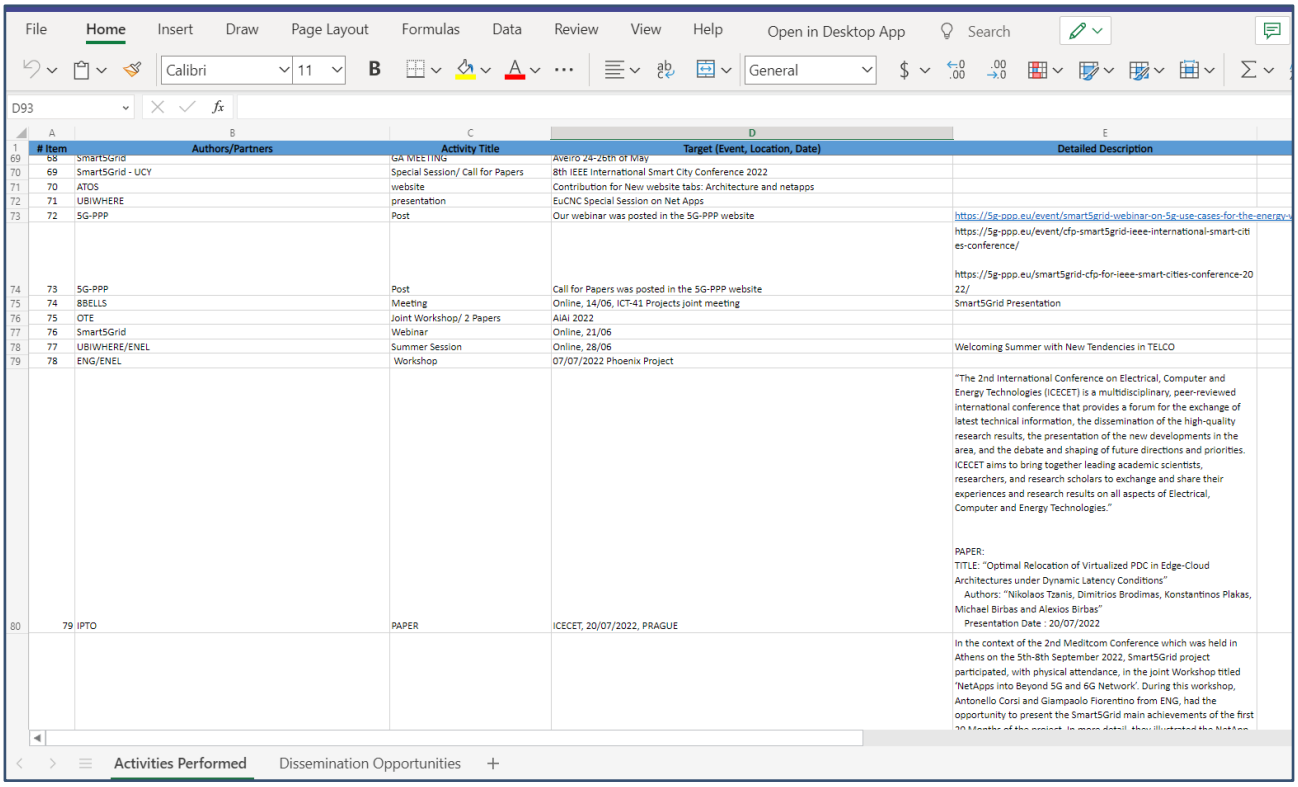


Figure 22: MS TEAMS Online repository

2.4.2. WP7 activities reporting file and Dissemination opportunities tracking file

As already stated, WP7 folder residing in the MS TEAMS repository, consists of different folders and the activities that the Smart5Grid partners performed or planned to perform are reported in an excel file with the distinctive title "WP7 activities Reporting". All project partners have access to this excel file and it is regularly updated with material from presentations, conferences and other activities where the Smart5Grid project participated or plans to participate. The WP7 activities' excel file contains two Tabs, one under the name "Activities Performed" and the other under the name "Dissemination opportunities". Pieces of information of each of the documented activities contain the title of the activity, information about who is involved, the date and the location of the activity as well as additional information regarding it (e.g., a URL link).



# Item	Authors/Partners	Activity Title	Target (Event, Location, Date)	Detailed Description
68	Smart5Grid	GA MEETING	Aveiro 24-26th of May	
69	Smart5Grid - UCY	Special Session/ Call for Papers	8th IEEE International Smart City Conference 2022	
70	ATOS	website	Contribution for New website tabs: Architecture and netapps	
71	UBIWHERE	presentation	EuCNC Special Session on Net Apps	
72	5G-PPP	Post	Our webinar was posted in the 5G-PPP website	https://5g-ppp.eu/event/smart5grid-webinar-on-5g-use-cases-for-the-energy-v
73	5G-PPP	Post	Call for Papers was posted in the 5G-PPP website	https://5g-ppp.eu/event/cfp-smart5grid-ieee-international-smart-cities-conference/ https://5g-ppp.eu/smart5grid-cfp-for-ieee-smart-cities-conference-2022/
74	BBELLS	Meeting	Online, 14/06, ICT-41 Projects joint meeting	Smart5Grid Presentation
75	OTE	Joint Workshop/ 2 Papers	AIAI 2022	
76	Smart5Grid	Webinar	Online, 21/06	
77	UBIWHERE/ENEL	Summer Session	Online, 28/06	Welcoming Summer with New Tendencies in TELCO
78	ENG/ENEL	Workshop	07/07/2022 Phoenix Project	
79	IPTO	PAPER	ICECET, 20/07/2022, PRAGUE	"The 2nd International Conference on Electrical, Computer and Energy Technologies (ICECET) is a multidisciplinary, peer-reviewed international conference that provides a forum for the exchange of latest technical information, the dissemination of the high-quality research results, the presentation of the new developments in the area, and the debate and shaping of future directions and priorities. ICECET aims to bring together leading academic scientists, researchers, and research scholars to exchange and share their experiences and research results on all aspects of Electrical, Computer and Energy Technologies." PAPER: TITLE: "Optimal Relocation of Virtualized PDC in Edge-Cloud Architectures under Dynamic Latency Conditions" Authors: "Nikolaos Tzanis, Dimitrios Brodimas, Konstantinos Plakas, Michael Birbas and Alexios Birbas" Presentation Date : 20/07/2022
				In the context of the 2nd Meditcom Conference which was held in Athens on the 5th-8th September 2022, Smart5Grid project participated, with physical attendance, in the joint Workshop titled 'NetApps into Beyond 5G and 6G Network'. During this workshop, Antonello Corsi and Giampaolo Fiorentino from ENG, had the opportunity to present the Smart5Grid main achievements of the first

Figure 23: MS TEAMS WP7 Activities performed file and Dissemination Opportunities

2.4.3. Smart5Grid Social Media and Website Statistical Dashboards

INF, as T7.1 leader, is responsible for the collection, processing and visualization of the social media and website's data. Data from those sources are collected and then are processed and visualized with the use of Google Data Studio on a monthly basis. The statistical dashboards are distributed internally via email every trimester to the Smart5Grid WP7 mailing list. More details on the reported period's Smart5Grid social media and website dashboards are provided in 2.6.1, in 2.6.2 and in 2.6.3

2.4.4. WP7 telcos

The WP7 dedicated Telcos take place biweekly and give the opportunity to the partners to present their dissemination activities, the progress of different WGs, exchange ideas of collaboration with other 5G-PPP projects, propose dissemination opportunities, so far as well as the next steps to be taken towards their planned actions which will help WP7 to advance.

2.4.5. WP7 mailing list/emails

As already stated, the WP7 mailing list is used in order to coordinate the activities of the partners as well as promote, align and coordinate various dissemination activities, such as papers, newsletter issues, leaflets, deliverables etc.

2.4.6. GA Meetings

One last mean to coordinate activities among partners are the Smart5Grid GA Meetings. This year Smart5Grid organised the following two.

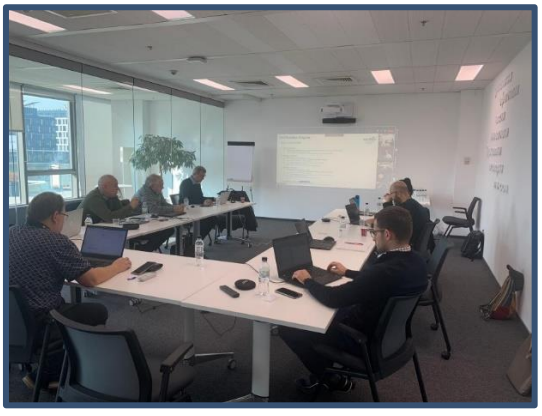
2.4.6.1. GA Meeting – Aveiro Portugal

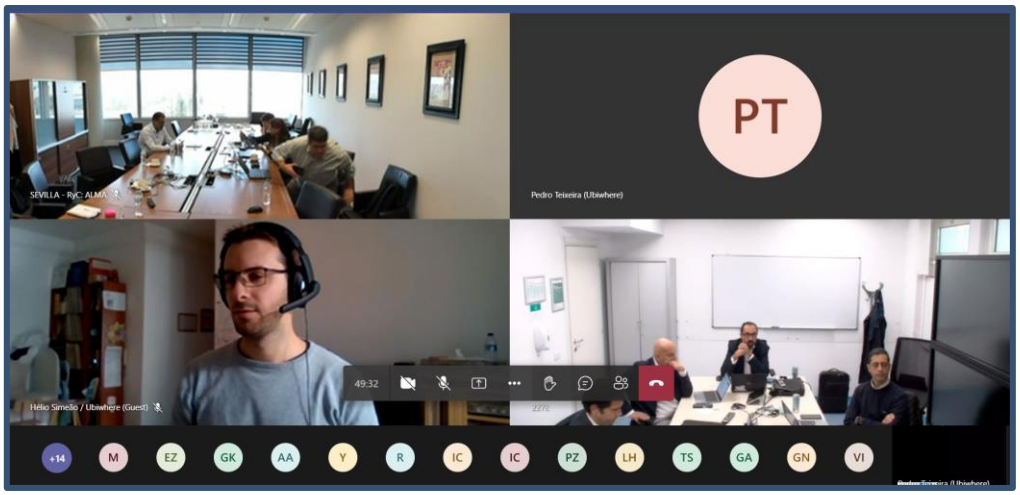
On the 24th-26th of May, the 1st hybrid General Assembly Meeting of the Smart5Grid Project was held in Ubiwhere headquarters, in Aveiro, Portugal. This, so expected meeting by all partners, ran for 3 days and fruitful discussions and presentations took place, advancing further core project's activities and achievements.

During the meeting, WPs progress, deliverable status, upcoming activities as well as the update on the communication and dissemination processes were discussed.

2.4.6.2. GA Meeting – 4 hubs meeting

On the 10th of November, Smart5Grid Consortium organised a GA Meeting by creating 4 different hubs in Athens, Spain, Italy and Bulgaria in order to host the hybrid meeting. During this meeting, The discussions on this GA meeting were about the Work Packages, technical current status of the project and upcoming activities.





2.5. Outreach Activities – Year 2

This section focuses on the Activities performed, related metrics and relevant information, which took place from M12 to M23 (D7.3 focused on period M1-11 as it was finalised and delivered before the end of Y1).

As per Smart5Grid Communication and Dissemination plan (Ref: D7.2), three (3) Communication and Dissemination stages have been identified in order to frame the communication effort and give guidance for the dissemination activities which will lead to successful impact.

- Stage 1 (M01-M06): Awareness Creation and Marketing Foundation
- Stage 2 (M06-M12): Community Outreach and Engagement Bootstrap
- Stage 3 (M12-M36): Showcasing and Global Outreach

Furthermore, as was already mentioned, the intensity of Smart5Grid's dissemination activities changes as the project progresses. The distribution operations will be split and carried out in three main annual stages in order to better monitor the intensity and establish the corresponding goals per time period.

- Phase 1: Y1.
- Phase 2: Y2.
- Phase 3: Y3 and after project ends.

As a result, a split ratio percentage of **20/30/50 approximately** is used for setting the minimum planned goals per phase and set achievable goals.

In the following Table 2 the overall project quantitative goals set the dissemination framework and form the criteria of dissemination and communication activities during the 3 years of the project (as already defined at D7.2).

PLANNED DISSEMINTATION ACTIVTIES	METRICS	TARGET	TIMELINE	Y1	Y2	Y3
Publications in journals, conferences, white papers and 5GPPP papers	Number of publications	**>20**	Publications: M06-M36 (and after the end of the project)	**10%**	**40%**	**50%**
Presentations in scientific events and workshops	Number of presentations	**>20**	Presentations: M01-M36	**20%**	**35%**	**45%**
Field Trials/Showcases	Number of trials/showcases	**>5**	Exhibitions/Workshops/Events: M12-M36	**-**	**30%**	**70%**
Exhibitions in industrial and scientific events	Number of exhibitions/booths	**>5**	Demonstrations/ Showcases: M12-36	**-**	**30%**	**70%**
Organisation of events (workshops/seminars/training/poster sessions/webinars)	Number of events	**>10**	Events: M06-M36	**20%**	**35%**	**45%**
Other Events, Articles/Brochures etc	Number of events/ publications		Publications: M03-M36 (and after the end of the project)	**-**	**-**	**-**

Table 2: Smart5Grid metrics for the Dissemination Activities

2.5.1. Summary of Dissemination Activities

This section focuses on reporting Smart5Grid dissemination activities performed from M12 to M23. Table 3 summarizes all the successfully performed Smart5Grid's dissemination and communication activities in relation with the targets set in the D7.2; the related activities are further described in the next sessions.

PLANNED DISSEMINTATION ACTIVTIES	METRICS	PROJECT TARGET	TIMELINE	Y2	Activities Y2 Target (M12-M23)	Activities performed up to M23
Publications in journals, conferences and white papers.	Number of publications	**>20**	Publications: M06-M36 (and after the end of the project)	**40%**	**8**	**9**
Presentations in scientific events and workshops	Number of presentations	**>20**	Presentations: M01-M36	**35%**	**7**	**34**
Field Trials/Showcases	Number of trials/showcases	**>5**	Exhibitions/Workshops/Events: M13-M36	**30%**	**2**	**-**
Exhibitions in industrial and scientific events	Number of exhibitions/booths	**>5**	Demonstrations/Showcases: M13-36	**30%**	**2**	**2**

Organisation of events (workshops/seminars/training/poster sessions/webinars)	Number of events	**>10**	Events: M06-M36	**35%**	**4**	**8**
Other Events, Press Releases, Articles etc	Number of Events/articles	**As many**			**-**	**2**
TOTAL			M-M11		**23**	**56**

Table 3: Smart5Grid metrics for the Dissemination Activities in Y2

2.5.1.1. Publication in journals, conferences, White Papers and 5GPPP papers

Smart5Grid project has successfully submitted 7 papers, published 1 Journal Paper and contributed in 1 5G-PPP White Paper in Y2 in the context of various important conferences.

On January 24th, the journal paper entitled as *"Demonstration of 5G Solutions for Smart Energy Grids of the Future: A Perspective of the Smart5Grid Project"* was published in the special issue of 'Energies'* (ISSN 1996-1073*)*. This paper was a joint effort of several Smart5Grid partners.

The first 2 conference papers were submitted and presented in the *18th International Conference on Artificial Intelligence Applications and Innovation (AIAI-2022)*[2]), a hybrid conference which took place from 17th – 20th of June in Crete, Greece. In both papers, apart from OTE several other partners also contributed.

The title of the first paper is *'"Fundamental Features of the Smart5Grid Platform Towards Realizing 5G Implementation"'*. The paper was presented by Dr. Ioannis Chochliouros, from OTE, during the context of the 7th Workshop on "*5G – Putting Intelligence to the Network Edge*" (*5G-PINE 2022*).

Furthermore, at the same conference and workshop, the paper entitled as *"5G for the Support of Smart Power Grids: Millisecond Level Precise Distributed Generation Monitoring and Real-Time Wide Area Monitoring"* was presented by Mr. Michalis Rantopoulos.

Moreover, in the proceedings of the ICETEC 2022 which was held in Prague on the 20th-22nd of June, IPTO partner submitted a paper entitled as "*Optimal Relocation of Virtualized PDC in Edge-Cloud Architectures under Dynamic Latency Conditions'"*

Additionally, on the 26th-29th of September, in the IEEE International Smart Cities Conference 2022 and in the context of the Special Session organised by Smart5Grid on *5G for smart cities and smart grids*, 3 papers were submitted by UCY and SID with the contribution of several partners too. The 3 papers were entitled as" The *Impact of Wireless Communication Networks to Wide Area Monitoring and Protection Applications", "Remote Monitoring at Distribution Network of Dynamically Constrained Working Areas'"*and *"Remote Monitoring at Distribution Network of Dynamically Constrained Working Areas"*.

Furthermore, UCY partner, submitted a conference paper entitled as "*Ground directional protection assessment in inverter dominated distribution networks"* in the Proceedings of the *IEEE* ISGT (IEEE PES

[2] https://ifipaiai.org/2022/

Innovative Smart Grid Technologies), which took place in Novi Sad, Serbia, on the 10th-12th of October.

Finally, the Smart5Grid partner ENG, was the lead partner for the project's contribution in the 5G-PPP White paper "*NetApp: Opening up 5G and beyond networks*"" under the umbrella of Software Network Working Group.

In the following Table 4, there is a detailed list with all publications.

TITLE	JOURNAL/ CONFERENCE	Date/ Location /issue	Accepted preprint version Download Link and DOI
Demonstration of 5G Solutions for Smart Energy Grids of the Future: A Perspective of the Smart5Grid Project	'Energies' Journal	24 January 2022	https://doi.org/10.3390/en15030839
Fundamental Features of the Smart5Grid Platform Towards Realizing 5G Implementation	18th AIAI 2028	17-20/06/2022 Hybrid Conference	https://doi.org/10.1007/978-3-031-08341-9_12
5G for the Support of Smart Power Grids: Millisecond Level Precise Distributed Generation Monitoring and Real-Time Wide Area Monitoring	18th AIAI 2028	17-20/06/2022 Hybrid Conference	https://doi.org/10.1007/978-3-031-08341-9_1
Optimal Relocation of Virtualized PDC in Edge-Cloud Architectures under Dynamic Latency Conditions	Computer and Energy Technologies (ICECET)	20-22/07/2022, Prague	https://doi.org/10.1109/ICECET55527.2022.9872789
NetApp: Opening up 5G and beyond networks	5G-PPP, Software Network WG	September 2022	https://5g-ppp.eu/wp-content/uploads/2022/10/5G-PPP-Software-Network-White-Paper-V9.pdf
Wide area control of distributed resources through 5G communication to provide frequency support	IEEE International Smart Cities Conference 2022	26-29/09/2022, Paphos, Cyprus	https://doi.org/10.1109/ISC255366.2022.9921934
The Impact of Wireless Communication Networks to Wide Area Monitoring and Protection Applications	IEEE International Smart Cities Conference 2022	26-29/09/2022, Paphos, Cyprus	https://doi.org/10.1109/ISC255366.2022.9922326
Remote Monitoring at Distribution Network of Dynamically Constrained Working Areas	IEEE International Smart Cities Conference 2022	26-29/09/2022, Paphos, Cyprus	https://doi.org/10.1109/ISC255366.2022.9922368

Ground directional protection assessment in inverter dominated distribution networks	IEEE PES Innovative Smart Grid Technologies (ISGT) Europe	10-12/10/2022, Novi Sad, Serbia	https://smart5grid.eu/wp-content/uploads/2022/10/20221012_UCY_ISGT_Serbia-paper_CF_LH.pdf

Table 4: Smart5Grid Submitted Papers and White Paper contribution

2.5.1.2. Presentations in scientific events and workshops

During the months M12-M23, Smart5Grid partners, participated in various events such conferences, workshops, webinars, industry events etc presenting Smart5Grid.

The Table 5 below, shows all presentations along with their dates followed by a short description of each event. This year, many of the events were either hybrid or have requested for physical presence, so Smart5Grid partners disseminated the project both with physical attendance and online presence.

In the following Table 5, there is a detailed presentations list.

	EVENT	Partner	Date/ Location	Title
1	Transnational Workshop on Smart Energy Management Systems and Smart Grids by JAUNTY	Sidroco	1/12/2021	Skills and Trends for Smart Energy Management Systems
2	Second Winter School of Energy and Climate	Entra Energy	13/01/ 2022	General introduction to Smart5Grid project and a more detailed one on the Bulgarian USE Case
3	MEC-empowered service provisioning and integration in 5G networks (SEMANTIC training event)	Nearby Computing	26/01/ 2022	Introduction to Edge Computing
4	5G Programmability Training Workshop	ATOS	22/03/2022	Smart5Grid NetApp Specification
5	5G Programmability Training Workshop	ENEL	22/03/2022	Smart5Grid project overview
6	Electrical and Computer Engineering Students Conference	IPTO	15-17 April 2022	General idea of the Smart5Grid project and its four use cases, mainly focusing on the Real-Time Wide Area Monitoring use case
7	NBU Event	Entra Energy	12 May 2022	Smart5Grid - 5G Driver of the Future?
8	UTILITIES Career Forum	Entra Energy	19 May 2022	Smart5Grid Presentation
9	EuCNC & 6G Summit 2022	Ubiwhere	7-10 June 2022	Special Session on 'Network Apps for Verticals
10	AIAI-2022/5G-PINE-2022	OTE	17-21 June 2022	"Fundamental Features of the Smart5Grid Platform Towards Realizing 5G Implementation"

11	AIAI-2022/5G-PINE-2022	OTE	17-21 June 2022	"5G for the Support of Smart Power Grids: Millisecond Level Precise Distributed Generation Monitoring and Real-Time Wide Area Monitoring"
12	Smart5Grid Webinar: "5G Use Cases for the Energy Vertical"	ENEL	21 June 2022	Energy vertical vision & Telco vision
13	Smart5Grid Webinar: "5G Use Cases for the Energy Vertical"	ENEL	21 June 2022	Automatic power distribution grid fault detection
14	Smart5Grid Webinar: "5G Use Cases for the Energy Vertical"	ENEL	21 June 2022	Remote inspection of automatically delimited working areas at distribution level
15	Smart5Grid Webinar: "5G Use Cases for the Energy Vertical"	UBITECH	21 June 2022	Millisecond level precise distributed generation monitoring
16	Smart5Grid Webinar: "5G Use Cases for the Energy Vertical"	IPTO	21 June 2022	Real-time wide area monitoring of power exchanges
17	Ubiwhere summer session: New Tendencies in Telco	Ubiwhere	28 June 2022	Smart5Grid Project Overall
18	Ubiwhere summer session: New Tendencies in Telco	ENEL/ENG	28 June 2022	Energy Vertical Vision & from NRG-5 Trials to Smart5Grid
19	Phoenix Star Event (Final Workshop)	ENEL/ENG	7 July 2022	Energy Vertical Vision with 5G and Smart5Grid Network Apps
20	Phoenix Star Event (Final Workshop)	ENEL/ENG	7 July 2022	Advantages and the opportunities that 5G will bring to the Energy vertical and the Smart5Grid Network Apps
21	The 2nd International Conference on Electrical, Computer and Energy Technologies (ICECET)	IPTO	20 July 2022	"Optimal Relocation of Virtualized PDC in Edge-Cloud Architectures under Dynamic Latency Conditions"
22	IEEE International Mediterranean Conference on Communications and Networking	ENG	5-8 September 2022	Demonstration of 5G solutions for SMART energy GRIDs of the future – Smart5Grid - WS2. Network Apps into Beyond 5G and 6G Networks
23	Sustainable Places 2022	ESO-EAD	6-9 September 2022	Smart5Grid Solutions for Enhanced TSO Grid Observability and Manageability in Massive RES Penetration Environment
24	IEEE International Smart Cities Conference - Smart5Grid Special Session	University of Cyprus (UCY)	26-29 September 2022	The Impact of Wireless Communication Networks on Wide Area Monitoring and Protection Applications
25	IEEE International Smart Cities Conference - Smart5Grid Special Session	Sidroco	26-29 September 2022	Remote Monitoring at Distribution Network of Dynamically Constrained Working Areas

26	IEEE PES Innovative Smart Grid Technologies	UCY	10-12 October 2022	Ground directional protection assessment in inverter dominated distribution networks
27	WG Trials Plenary Meeting	UCY	24 October 2022	Smart5Grid Open Experimentation Platform, NetApp concept & particularities in Smart5Grid, NetApp controller, Pilots progress
28	ENLIT	ENEL	29 November 2022	The Smart5Grid project: presentation at Enlit 2022
29	5G ITALY	ENG	30th November 2022	Smart5GGrid as a revolution in the distribution network through 5G and NetApp connectivity
30	INFOCOM	OTE	29 November 2022	Smart5Grid: Towards an Efficient Demonstration of 5G Solutions for the Smart Energy Grids of the Future
31	INFOCOM	IPTO	29 November 2022	Vertical Use Case: Real-time Wide Area Monitoring between Greece and Bulgaria – Opportunities and Challenges for DSOs/TSOs
32	INFOCOM	OTE	29 November 2022	Vertical Use Case: Real-time Wide Area Monitoring between Greece and Bulgaria – Developing a Modern Network Interconnection Scheme by the 5G Operators
33	INFOCOM	Entra Energy	29 November 2022	Vertical Use Case: Millisecond Level Precise Distributed Generation Monitoring-Distributed Energy Operation and Maintenance in RES Installations
34	INFOCOM	OTE	29 November 2022	Essential Components and Core Features of the Smart5Grid Platform for Implementing the 5G Perspective

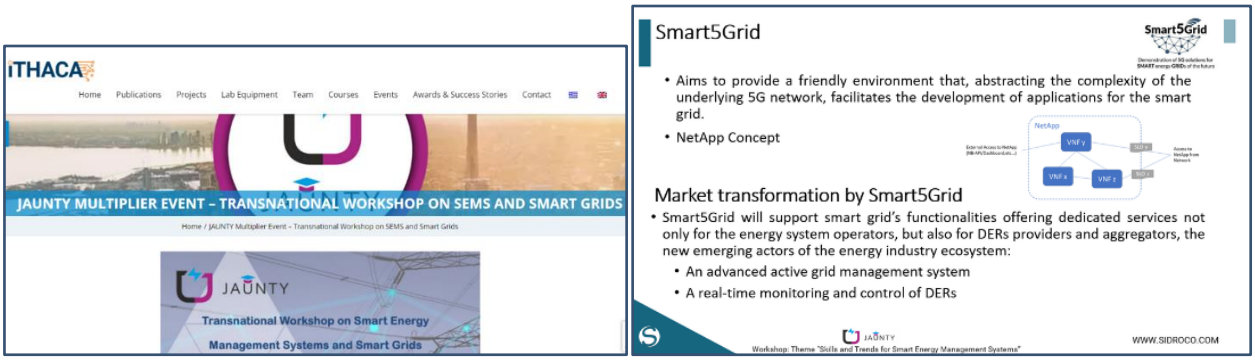
Table 5: Smart5Grid Project presentations

Below there is a more detailed description of each event.

2.5.1.2.1. TRANSNATIONAL WORKSHOP ON SMART ENERGY MANAGEMENT SYSTEMS AND SMART GRIDS BY JAUNTY

Dr. Grigoriou from Sidroco attended the third theme "Skills and Trends for Smart Energy Management Systems" on December 1st, which was organized as part of JAUNTY, an Erasmus+

strategic partnership project aimed at developing Joint Undergraduate Courses between Higher Education Institutes for Smart Energy Management Systems. During her presentation, Dr. Grigoriou described the required skills that need to be developed in the Smart Grid & Smart Energy Management domain and how they should be related with training/educational programmes. She also presented the forecasts about the transformation of the market around the developments in Smart Energy Management Systems, highlighting the Smart5Grid approach. More specifically, Dr. Grigoriou presented how the market will be transformed by the Smart5Grid Network Apps that will be developed during the project.

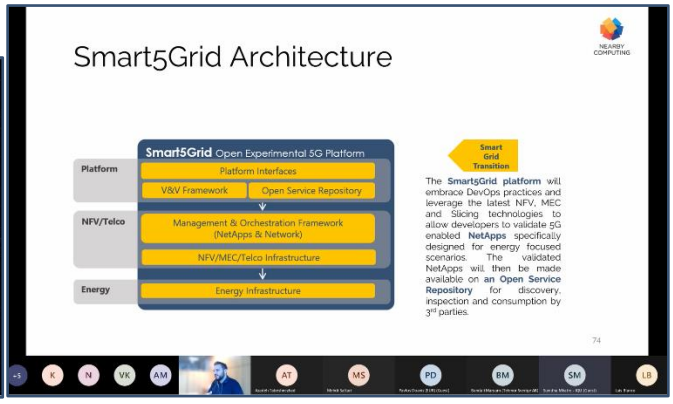


2.5.1.2.2. 2ND WINTER SCHOOL OF ENERGY AND CLIMATE

On the 13th of January, Mr. Teodor Bobochikov from Entra Energy (EE), gave a lecture to the Second Winter School of Energy and Climate, hosted by local professional energy media - Utilities. The event aimed at students in their Bachelor's, Master's and Doctoral degrees in different energy fields. Mr. Bobochikov spoke about energy sectors transformation and digitalization and how projects such as Smart5Grid contribute to that purpose. There was a general introduction to the Smart5Grid project and a more detailed one on the Bulgarian Use Case.

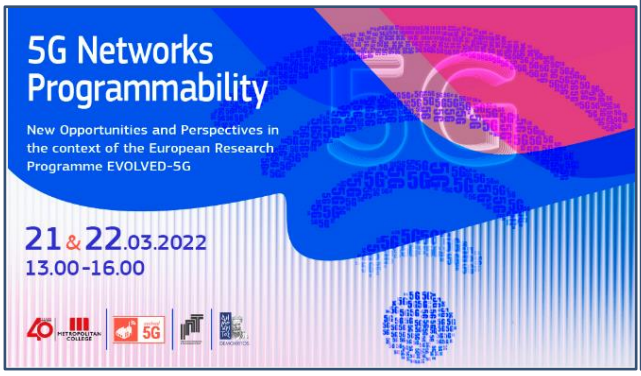
2.5.1.2.3. SEMANTIC TRAINING EVENT

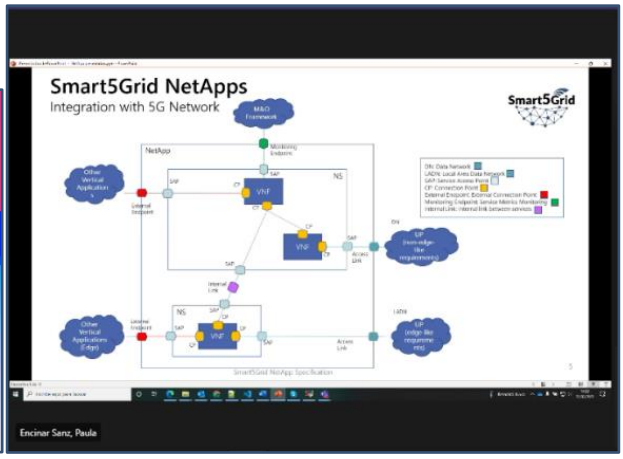
On the 26th of January, Dr. Antonopoulos, R&I Director of Nearby Computing, was invited by the SEMANTIC consortium (https://www.semantic2020.eu) to present a tutorial in the framework of the SEMANTIC training event *"MEC-empowered service provisioning and integration in 5G networks"*.
In the context of his talk *"Introduction to Edge Computing: Fundamentals, Standardization and Analytical Tools"*, Dr. Antonopoulos had the opportunity to present the general idea of Smart5Grid project, the four use cases and the role of NearbyOne orchestrator in the onboarding and lifecycle management of Network Applications of the energy sector.



2.5.1.2.4. 5G PROGRAMMABILITY TRAINING WORKSHOP

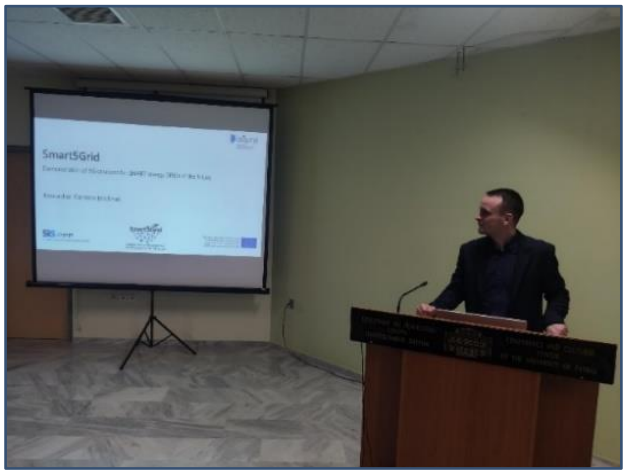
On the 21st-22nd of March, Smart5Grid project was invited to participate in the EVOLVED-5G Project Training Workshop in collaboration with the Computer Science department of Athens Metropolitan College. The Training Workshop was entitled as *"5G Networks Programmability"* and new opportunities and perspectives were presented in the context of the European research project EVOLVED-5G. The 100 attendees of the first day and the 80 attendees of the second day were mainly undergraduate and postgraduate students of the Computer Science department. On the 2nd day, Mr. Daniele Porcu from ENEL and Ms. Paula Enricar from ATOS, delivered two presentations regarding Smart5Grid Project and the Network Apps Approach.

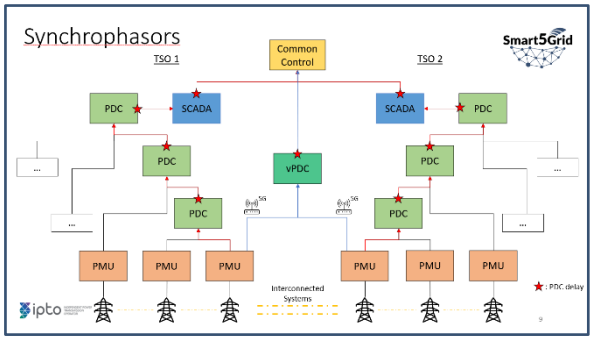




2.5.1.2.5. ELECTRICAL AND COMPUTER ENGINEERING STUDENTS CONFERENCE

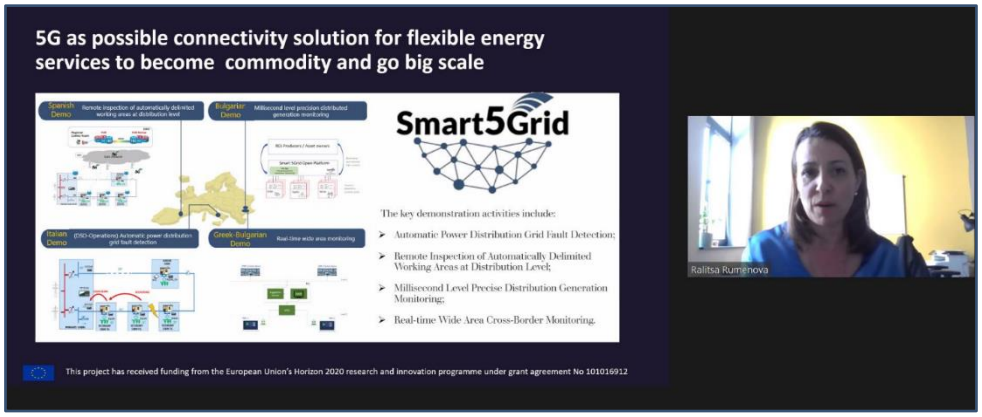
On April 15th-17th 2022, IPTO's Department of Research Technology and Development participated as a major sponsor in the Electrical and Computer Engineering Students Conference (ECESCON).
In the context, of the workshop *"Enabling Advancements in the Future Energy System"* the researcher Mr. Dimitrios Brodimas presented the general idea of the Smart5Grid project and its four use cases, mainly focusing on the Real-Time Wide Area Monitoring use case where IPTO has a leading role.





2.5.1.2.6. UTILITIES EVENT

On the 19th of May 2022, Entra Energy participated in a career forum organized by Utilities (one of the largest professional energy medias in Bulgaria). The aim of the event was to showcase what different companies in the sector are working on and how graduating energy specialists could become part of it.
In this context, Ms. Ralitsa Rumenova from EE presented Smart5Grid project and H2020 projects as an opportunity to work on interesting and innovative technologies and solutions.
For more info see: https://events.utilities.bg/events/energy-utilities-career-2022/

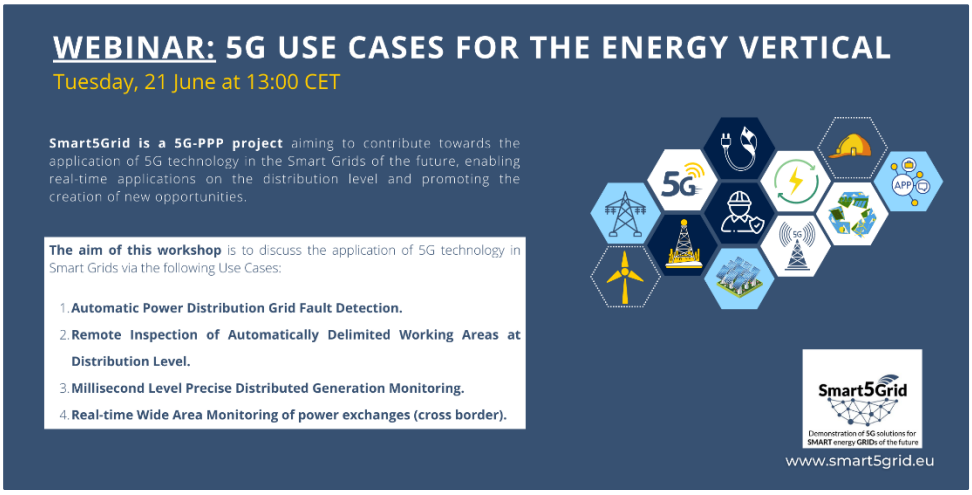


2.5.1.2.7. EUCNC JOINT WORKSHOP

In the context of EuCNC 2022, the Smart5Grid Project participated in the co-organised Special Session on "*Network Apps for Verticals*". This hybrid event was co-organised by ICT-41 projects including Smart5Grid, and took place on Wednesday, 8th of June. The session focused on discussing how Network App empowers the verticals on-boarding on 5G and reinforce the fact that 5G is a platform and not a pipe. Different actors from diverse vertical domains shared their design and their interaction with the 5G platform owner. Rita Santiago and Hélio Simeao, from Ubiwhere, physically attended the event and along with the 4 Smart5Grid Pilots, presented the Smart5Grid NetApp Concept and the overall ecosystem picture by introducing the Smart5Grid Platform. The Special Session was chaired by Bessem Sayadi (Nokia Bell-Labs France, 5G-PPP Software Network WG Chairman, FR) and by Christos Tranoris (University of Patras, GR).

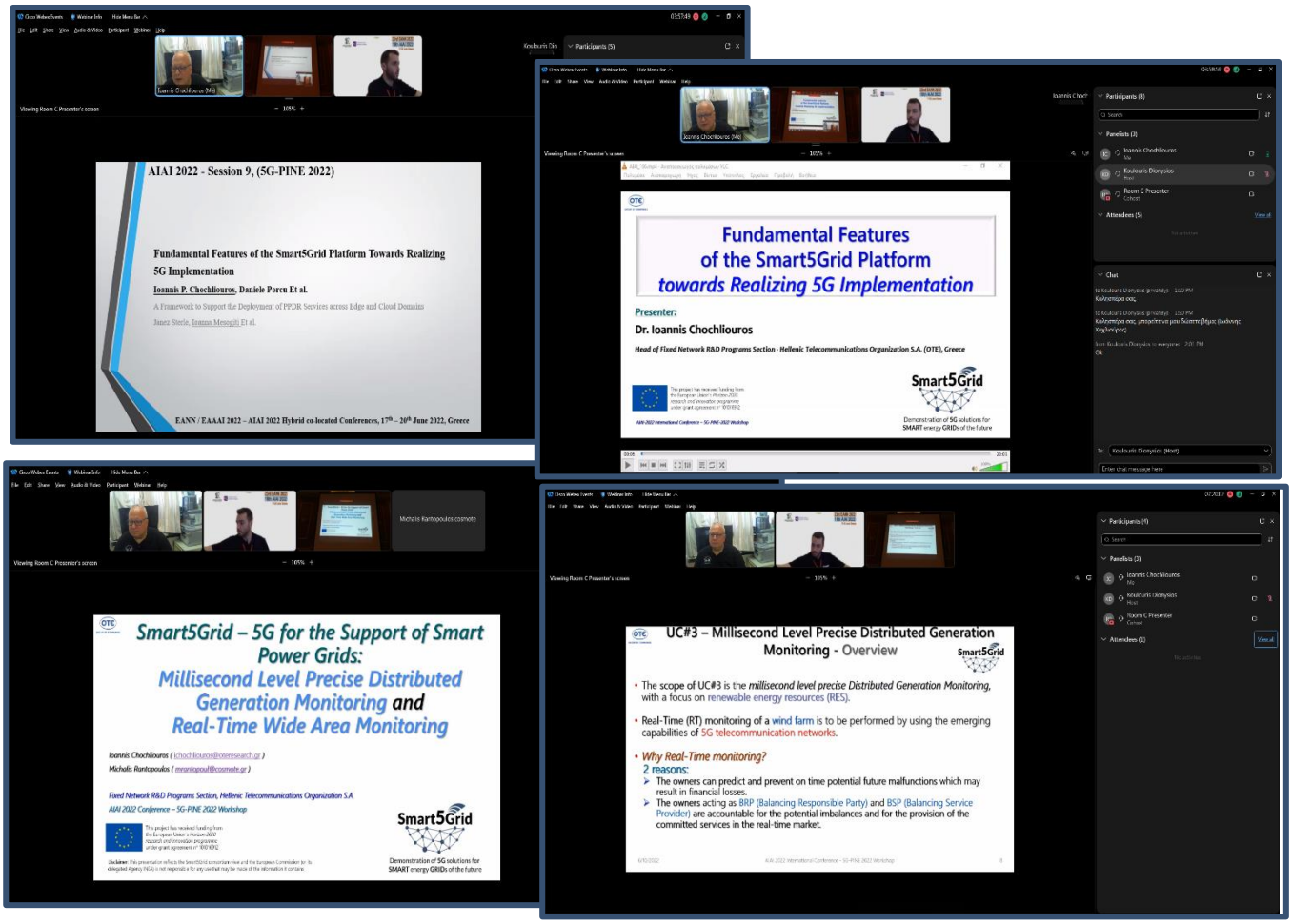
2.5.1.2.8. SMART5GRID WEBINAR

On the 21st of June 2022, Smart5Grid Project organized a webinar on *"5G Use cases for the Energy Vertical"*. The webinar started with the introduction of the Project Coordinator, Mr. Daniele Porcu, and the energy vertical vision. ENEL, UBITECH and IPTO partners delivered 4 Smart5Grid Use Cases' related presentations, focusing on the 4 project pilots, the Business KPIs and the Network Apps development. More details about the webinar the reader can find in SMART5GRID WEBINAR



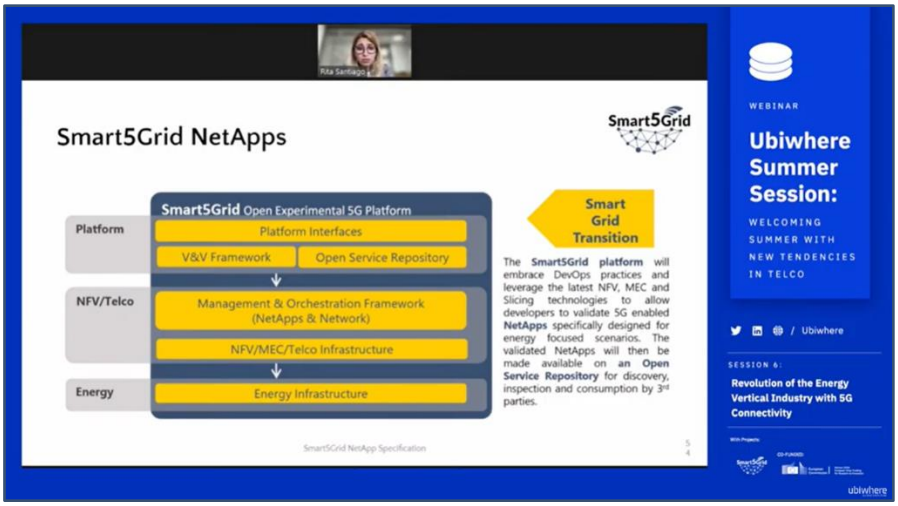
2.5.1.2.9. AIAI 2022 CONFERENCE – PAPER PRESENTATION

In the context of the 18th International Conference on Artificial Intelligence Applications and Innovation (https://ifipaiai.org/2022/) which was held in Crete, Greece, on the 17th-20th of June, in a hybrid mode, Smart5Grid project's partner, OTE, presented a synergetic Smart5Grid paper where several features of the project architecture were discussed and further assessed (particularly including concepts about smart grids, cloud-native applications and multi-access edge computing). This paper presentation has been given by Dr. Ioannis Chochliouros (OTE). In the same framework, Mr. Michalis Rantopoulos from OTE also presented a second synergetic paper discussing the context and the progress of two Sm*art5Grid uses cases r*elated to the Bulgarian pilot and the joint Greek-Bulgarian pilot. Both presentations were disseminated in the framework of the joint Workshop under the title "5*G – Putting Intelligence to the Network Edge*". It is important to mention that these two presentations have been part of the dedicated 7th 5G-PINE Workshop that has been organised and coordinated by OTE (Dr. Ioannis Chochliouros), with the support of representatives from other projects as well. The 7th 5G-PINE Workshop been established to disseminate knowledge obtained from ongoing EU projects as well as from any other action of EU-fu*nded r*esearch, in the wider thematic area of *"5G Innovative Activities – Putting Intelligence to the Network Edge"* and with the aim of focusing on Artificial Intelligence (AI) in modern 5G telecommunications infrastructures. Smart5Grid has been one of the "core" projects organising the 7th [5]G-PINE Workshop, in cooperation with the 5G-ERA project (coming also from ICT-41), the MARSAL project and the RECOMBINE MCSA project. More details can be found at: https://ifipaiai.org/2022/workshops/



2.5.1.2.10. UBIWHERE SUMMER SESSION

On the 28th of June, the Smart5Grid partner, Ubiwhere, organized the "*Ubiwhere Summer Session – Welcoming Summer with New Tendencies in TELCO*". The two panels showcased the main areas of intervention of Ubiwhere's R&I projects, focusing on the company's diversified offers and solutions. The sessions included a set of prominent personalities whose expertise and competence in the field have proven essential for the evolution of Telecommunications. Also, some solutions and projects were highlighted during this seminar, such as Smart5Grid, SNOB5G, FogProtect, Affordable5G and 5GaaS. In this context, the Smart5Grid overall project was presented, by UBI and Rita Santiago and project partners ENEL (represented by Daniele Porcu) and ENG (represented by Antonello Corsi), who contributed with a presentation under the title "*Energy Vertical Vision & from NRG-5 Trials to Smart5Grid*"" You may watch the video from the session here: https://www.youtube.com/watch?v=DSWY-L8g2RI



2.5.1.2.11. ICECET 2022 – PAPER PRESENTATION

On the 20th – 22nd July 2022 in Prague, Czech Republic, and in the context of the 2nd International Conference on Electrical, Computer and Energy Technologies (ICECET), IPTO partner presented the Conference paper entitled as *"Optimal Relocation of Virtualized PDC in Edge-Cloud Architectures under Dynamic Latency Conditions"* by Nikolaos Tzanis, Dimitrios Brodimas, Konstantinos Plakas, Michael Birbas and Alexios Birbas. The paper studies the increasing penetration of Phasor Measurement Units (PMUs) in the power grid, combined with the advancements in the communication technologies and the cloud-edge continuum which enable the deployment of sophisticated and demanding synchrophasor-based applications. The 2nd International Conference on Electrical, Computer and Energy Technologies (ICECET) is a multidisciplinary, peer-reviewed international conference that provides a forum for the exchange of latest technical information, the dissemination of the high-quality research results, the presentation of the new developments in the area, and the debate and shaping of future directions and priorities. ICECET aims to bring together leading academic scientists, researchers, and research scholars to exchange and share their experiences and research results on all aspects of Electrical, Computer and Energy Technologies. For more information see: www.icecet.com

2.5.1.2.12. PHOENIX FINAL WORKSHOP

On the 7th of July, Smart5Grid project participated in the PHOENIX Final Workshop which was held in Rome, Italy. Daniele Porcu, from ENEL and Antonello Corsi from ENGINEERING, presented the

advantages and the opportunities that 5G will bring to the Energy vertical and the Smart5Grid Network Apps. The PHOENIX Final Workshop welcomed 36 participants from 8 countries and 5 projects dealing with cybersecurity and critical infrastructures: PHOENIX, SMART5GRID (Portugal), IRIS, ELECTRON, CYBERSEAS.

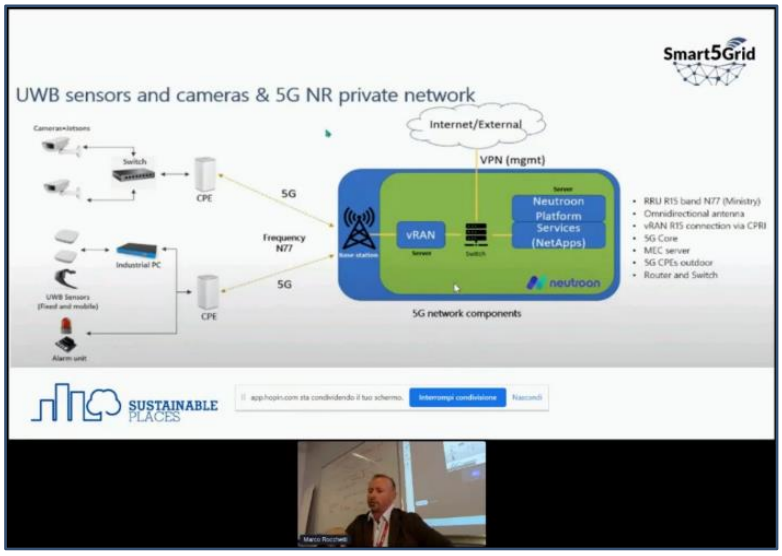
2.5.1.2.13. 2ND MEDITCOM CONFERENCE

In the context of the 2nd MeditCom Conference (https://meditcom2022.ieee-meditcom.org/) which was held in Athens, Greece, on the 5th-8th September 2022, Smart5Grid project participated, with physical attendance, in the joint Workshop titled "*Network Apps into Beyond 5G and 6G Network*" supported by Software Network Working Group. During this workshop, Antonello Corsi and Giampaolo Fiorentino from ENGINEERING, disseminated the Smart5Grid main achievements of the first 20 months of the project. In more detail, they illustrated the Network App definition and descriptor, the Smart5Grid platform and presented Use Case 3 ("*Millisecond Level Precise Distribution Generation Control*"). A list of possible extensions foreseen for the upcoming 6G networks was also provided.

2.5.1.2.14. SUSTAINABLE PLACES 2022

The 10th annual edition of Sustainable Places 2022 took place on the 6th-9th of October 2022, in Nice, France, in a hybrid mode. In this context a paper entitled as "*Smart5Grid Solutions for enhanced TSO grid observability and manageability in massive RES penetration environment*" was submitted and accepted by Smart5Grid partners and with the lead of ESO/EAD. Furthermore, Daniel Shangov and

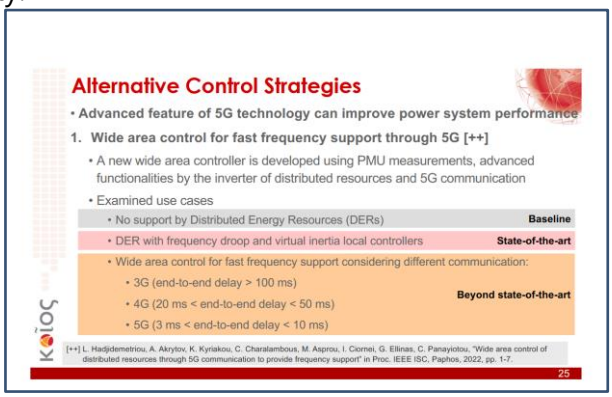
Krasimir Vlachkov, as representatives of Smart5Grid partner ESO/EAD, disseminated, with physical attendance, a presentation entitled as "*Smart5Grid Solutions for Enhanced TSO Grid Observability and Manageability in Massive RES Penetration Environment*" *in* the context of "G*rids and Demand Response*" Paper Session, which took place on the 8th of September. The presentation delineated key components of the Smart5Grid Open Experimentation Platform, including its Open Service Repository (OSR), Verification and Validation (V&V) framework, NetApp Controller (NAC), as well as their interactions. It provided a concise description of the four Use Cases (UCs) developed within the project and explored potential energy vertical implications of the Smart5Grid from TSO perspective by focusing on two UCs: UC3 ("*Millisecond Level Precise Distribution Generation Control*") and UC4 ("*Real-time Wide Area Monitoring pilot demonstrator of 5G virtual PDC capabilities for WAM of end-to-end electricity grids*"). In addition, both Smart5Grid partner representatives disseminated highlights of the Smart5Grid project during various topical discussions during the four-day sessions of Sustainable Places 2022. You can watch the full presentation here: https://www.sustainableplaces.eu/grids-and-demand-response/. You may read more here: https://www.sustainableplaces.eu/

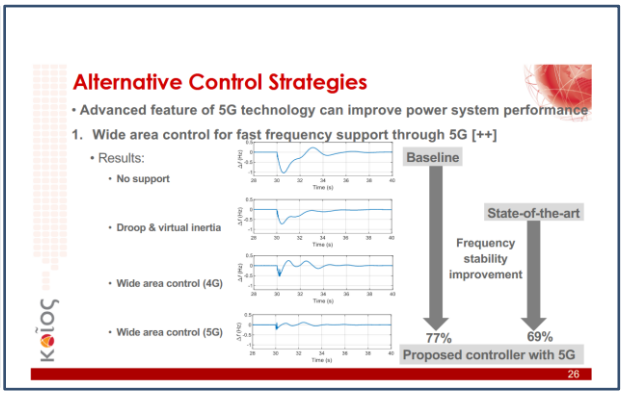


2.5.1.2.15. 8TH IEEE INTERNATIONAL SMART CITIES CONFERENCE -PAPER PRESENTATION

In the context of the 8th IEEE International Smart Cities Conference (https://attend.ieee.org/isc2-2022/), which took place in Paphos, Cyprus, on the 26th-29th of September, Smart5Grid Project successfully organized a Special Session on 5G for Smart Cities and Smart Grids. The presentations delivered by Smart5Grid's partners University of Cyprus, KioS Research Center and Sidroco, were related to results from pre-piloting activities of UC3 ("*Millisecond Level Precise Distribution Generation Control*") and UC4 ("R*eal-time Wide Area Monitoring*"), respectively, and a contribution focused on the Network App concept of the Smart5Grid project showcasing the Network App developed and the testing and validation procedure for the UC2 ("*Remote Inspection of Automatically Delimited Working Areas at Distribution Level*").

Moreover, Prof. Christos Panayiotou from UCY was invited to provide a keynote speech as part of the IEEE ISC2 conference (https://attend.ieee.org/isc2-2022/invited-speakers/). The topic of his speech was: "Making Smart Cities More Efficient, Safer and More Resilient". Part of this presentation he acknowledged the latest outcomes of the Smart5Grid project by highlighting the role of 5G technologies for providing resiliency and efficiency to the energy critical infrastructure of a smart city.





2.5.1.2.16. IEEE PES INNOVATIVE SMART GRID TECHNOLOGIES

On the 10th -12th of October, Smart5Grid project was represented by the UCY team of researchers, Dr. Lenos Hadjidemetriou, PhD student Christos Frangeskou, Dr. Markos Asprou and Prof. Christos Panayiotou. The team presented an assessment study for ground directional protection in inverter dominated distribution power networks, as part of the European flagship conference, IEEE PES Innovative Smart Grid Technologies, which took place in Novi Sad, Serbia. This year's conference theme was "*Together Towards Digitized, Decarbonised, and Distributed Smart Grids"* and it attracted more than 200 professionals in the energy vertical from all 5 continents around the globe.

2.5.1.2.17. WG TRIALS PLENARY MEETING

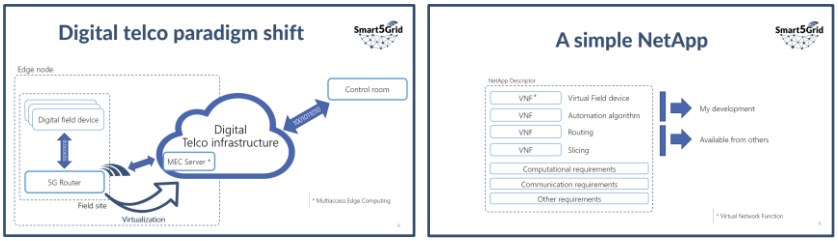
On the 24th of October and in the context of WG Trials Plenary Meeting, Dr. Irina Ciornei from UCY, delivered a presentation on Smart5Grid Open Experimentation Platform, NetApp concept and particularities in Smart5Grid, Network App Controller and communicated preliminary results from connectivity tests (Use Case 4). Ms. Sonia Castro and Ms. Paula Encinar-Sanz from ATOS, Mr. Michalis Rantopoulos from OTE, Mr. Dimitrios Brodimas from IPTO, Mr. Athanas Velkov from VivaCom, Ms. Ralitsa Rumanova from Entra Energy and Mr. Nicolla Cadenelli from NBC also contributed to this presentation.

2.5.1.2.18. 5G ITALY

In the context of the 5th edition of 5G Italy *"Towards the telecoms of the future"*, which was held in Rome, Italy, on the 29th November -1st December, Mr. Giampaolo Fiorentino from ENG disseminated Smart5Grid project with a presentation entitled as "*Smart5Grid as a revolution of the distribution network through the connectivity of 5G and Network Apps*". This presentation introduced the 5G network, and how the Network Application can create the synergy between energy and telco for the power grid domain. *The fifth edition of 5G Italy covered the research, development, and implementation activities currently under way in Italy and the rest of the World and featured the projects linked to the National Recovery and Resilience Plan –NRRP (Piano Nazionale di Ripresa e Resilienza, PNRR), allocating major investments for the digitalisation of the Country. In this transition process, 5G will act as one of the connecting points for electronic communications and will be a key factor to boost national economy, as well as drive economic growth*". For more information see https://www.5gitaly.eu/

2.5.1.2.19. ENLIT 2022

In the context of ENLIT, which was held in Frankfurt, Germany, on the 29th November -1st December, Mr. Daniele Porcu, the project coordinator delivered a presentation on Smart5Grid project entitled as "The Smart5Grid project: presentation at Enlit 2022". The presentation took place in the EU Projects Hub 2, during the session "*Europe's Digital Decade: Part One: Digitalisation*".



2.5.1.2.20. 24TH INFOCOM WORLD WORKSHOP

In conjunction with the 24th Infocom World, which took place on the 29th November, in Athens, Greece, the Workshop *"Research Projects for creating the Future and Innovative Telecoms Market"* was held. In this context, Smart5Grid partners, OTE (Dr. I. Chochliouros, Mr. M. Rantopoulos), EE (Ms. R. Rumenova) and IPTO (Mr. D. Brodimas) provided 5 presentations in the proceedings of the Special Session entitled *'5G in the Smart Grid – The Novel Approach of the Smart5Grid European Project.*

2.5.1.3. Exhibitions in industrial and scientific events

2.5.1.3.1. SMART CITIES EXPO WORLD CONGRESS

Smart5Grid Project was present in Smart City Expo World Congress '22 through Ubiwhere's booth. Visitors who attended the event and joined us were very interested in the project's objectives, the members who consist the Consortium and showed a particular interest in how 5G will be used in energy grids and the use of the Network Apps in this vertical. The event was attended by 20,400 physical and more than 21,000 online attendees from 134 countries and hosted 853 exhibitors.

2.5.1.3.2. ENLIT 2022

Smart5Grid project was present also in ENLIT, which took place in Frankfurt between 29/11 and 01/12. Smart5Grid project had a stand in the EU Project Zone (12.0.C10-20) and it was well visited by interested parties. The project was represented physically by our Project Coordinator, Mr. D. Porcu from ENEL, the Technical Coordinator, Mr. A. Corsi from ENG and one of our Bulgarian partners Mr. D. Shangov from ESO/EAD. In this context, on the 29th of November, Mr. Daniele Porcu, delivered a presentation during the Session: *Europe's Digital Decade: Part One: Digitalisation* providing all the relevant info about Smart5Grid Project. Additionally, Mr. Daniele Porcu, gave an interview about Smart5Grid project which will be podcasted in January 2023. The networking and dissemination opportunities offered in this event were leveraged properly as well, as the project was presented during all the three days of this event.

2.5.1.4. Organisation of events (workshops/seminars/training/poster sessions/webinars)

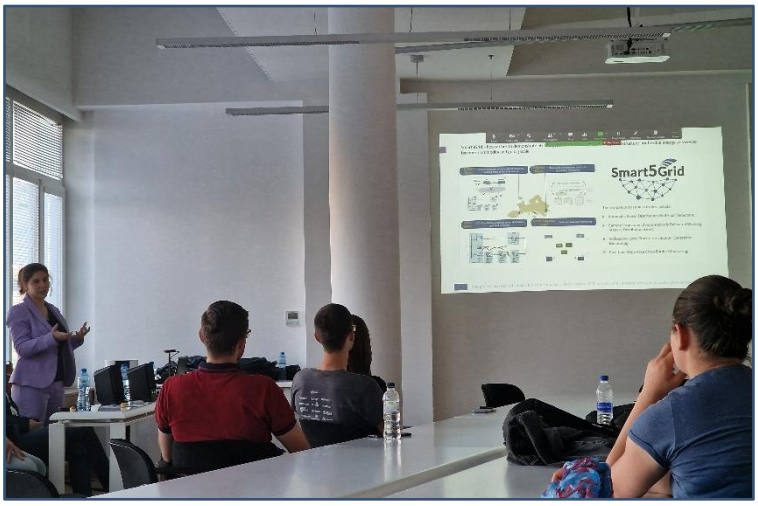
During the Y2, six (6) events and one (1) webinar were organised or co-organised by Smart5Grid partners in order to disseminate the project and reach targeted audience.

	EVENT	LEAD ORGANISER	DATE	TITLE
1	Electrical and Computer Engineering Students Conference (ECESCON)	IPTO	15-17th Apr 2022	Workshop on "Enabling Advancements in the Future Energy System"
2	EuCNC - 6G Summit	ICT-41 Projects	7-10 Jun 2022	Special Session on 'Network Apps for Verticals'
3	18th Artificial Intelligence Applications and Innovations (AIAI 2022)	OTE	17-21 June 2022	7th Workshop on "5G – Putting Intelligence to the Network Edge" (5G-PINE 2022)
4	Smart5Grid Webinar	Smart5Grid Consortium	21 Jun 2022	5G Use Cases for the Energy Vertical

5	IEEE International Mediterranean Conference on Communications and Networking	ICT-41 Projects	5-8 Sep 2022	Joint Workshop 'Network Apps into Beyond 5G and 6G Network'
6	8th IEEE International Smart Cities Conference	UCY -Kios Research Center	26-29 Sep 2022	Special Session on 5G for smart cities and smart grids
7	24th Infocom World	OTE	29thNov 2022	Special Session on 5G in the Smart Grid – The Novel Approach of the Smart5Grid European Project

2.5.1.4.1. NEW BULGARIAN UNIVERSITY EVENT

On the 12th of May 2022, Entra Energy (EE) and Vivacom organised an event in New Bulgarian University (NBU), presenting the energy transition and how 5G supports and enables it. The event was entitled as "*Smart5Grid - 5G Driver of the Future?*" and 6000 students were invited. The event took place in NBU but it was hybrid, so there were participants both online and physically.



2.5.1.4.2. ELECTRICAL AND COMPUTER ENGINEERING STUDENTS CONFERENCE (ECESCON) - WORKSHOP

On April 15th-17th 2022, IPTO's Department of Research Technology and Development participated as a major sponsor in the Electrical and Computer Engineering Students Conference (ECESCON), which was held in Greece, through a workshop and a booth. The workshop was *entitled "Enabling Advancements in the Future Energy System"*, and the aim was to inform the participants based on the topics of the "Grid Enhancing Flexibilities", the "Flexibility Markets" and the "5G Integration in the Future Power Systems". During this workshop other European research projects also presented their activites like Flexitranstore, Crossbow, Farcross, 5G-Victory, Coordinet and OneNet, increasing in this way the synergy among EC projects. ECESCON targets to build a competitive and trusted ecosystem for the Electrical and Computer Engineering Students to explore the state-of-the-art technologies that shape the future working environment in a variety of social, economic, and territorial contexts.
For more information you can visit the site https://www.ee.duth.gr/en/students/students-branches/ecescon/

2.5.1.4.3. EUCNC CO-ORGANISED SPECIAL SESSION

In the context of EuCNC 2022, which was held in Grenoble, France, on the 6th-10th of June, Smart5Grid Project along with other ICT-41 projects co-organised a hybrid Special Session on "*Network Apps for Verticals*". The Special Session was held on Wednesday 8th of June and the aim was to bring together all the NetApp stakeholders, discuss their experiences so far and pave the way for Network Apps into 6G to span all domains RAN/CORE/Transport/Devices/Applications. Thus the session targeted to:

- Highlight experiences and lessons learned with NetApp development and its Lifecycle management.
- Investigate how Standards include related information to realize the Network Apps vision.
- Understanding of all related stakeholders.
- Investigate cross-industry cooperation opportunities.
- Promote the innovative services and new business models introduced by the NetApp concept and their evolution towards 6G The session has been built upon the success of the series of past relevant EuCNC Special Sessions and Workshops and it aimed to provide useful inputs along the above-mentioned directions.

Different actors from diverse vertical domains shared their design and their interaction with the 5G platform owner.

This Workshop was co-organised from 9 ICT-41 Projects (I.e.: Smart5Grid, EVOLVED-5G, 5G-ERA, 5GASP, 5GMediaHUB, 5G-INDUCE, VITAL-5G and 5G-EPICENTRE)

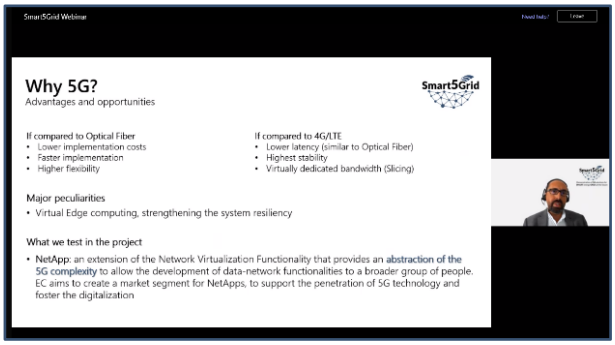
You can find more info in this link https://www.eucnc.eu/2022/www.eucnc.eu/programme/special-sessions/special-session-10/index.html

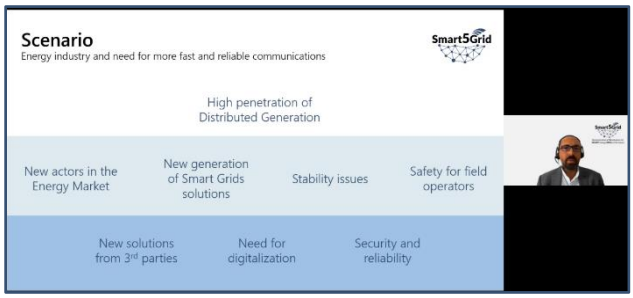
2.5.1.4.4. 7TH WORKSHOP ON "5G – PUTTING INTELLIGENCE TO THE NETWORK EDGE" (AIAI 2022)

In conjunction with 18th Artificial Intelligence Applications and Innovations (AIAI 2022) International Conference which was held in Hersonissos, Crete, Greece, on June 17-20, 2022, the 7th Workshop on "5G – Putting Intelligence to the Network Edge" (5G-PINE 2022) took place, under the organizational framework of the Smart5Grid project and by the supervision and the coordination of OTE (Hellenic Telecommunications Organization S.A.). This Workshop, following to the successful tradition of its predecessors, has been established to disseminate knowledge obtained from ongoing EU projects as well as from any other action of EU-funded research, in the wider thematic area of 5G and with the aim of focusing on Artificial Intelligence (AI) in modern 5G – and beyond – telecommunications infrastructures. The 5G-PINE 2022 Workshop emphasized upon presenting associated results, methodologies, trials, concepts and/or other findings originating from technical reports coming from related pilot actions and/or other relevant 5G-based applications, intending to enhance intelligence to the network edge. The 5G-PINE 2022 Workshop was a joint effort for the dissemination of research-based results as well as for the exchange of knowledge between several H2020 EU-funded projects. In more detail, 3 EU-funded H2020/5G-PPP projects (i.e.: Smart5Grid (Grant Agreement No.101016912), 5G-ERA (Grant Agreement No.101016681) and MARSAL (Grant Agreement No.101017171)) and one MCSA-RISE EU-funded project (i.e.: RECOMBINE (Grant Agreement No.872857)) joined their effort towards creating the core context so that to "attract" participation of other projects as well. Following to the long tradition of past 5G-PINE events, the 2022 Workshop has also been a success, as a total of thirteen (-13-) papers were presented and discussed interactively in three distinct sessions, promoting progress originating from seven (-7-) ongoing 5G-PPP projects (i.e.: Smart5Grid, 5G-ERA, MARSAL, 5G!Drones, LOCUS, 5G-COMPLETE & Int5Gent), two (-2-) H2020 projects emphasizing also on 5G aspects (i.e., RECOMBINE, DataPorts) and one national Spanish project (ARTIST). This was an excellent opportunity for establishing collaboration links and "paths" for exchanging knowledge between the participating projects (especially between Smart5Grid and 5G-ERA, as both belong in the same ICT-41 Call). Smart5Grid project's partner OTE, was responsible for the organization of the entire Workshop.

2.5.1.4.5. SMART5GRID WEBINAR

On the 21st of June 2022, Smart5Grid Consortium successfully organized a webinar on **"***5G Use cases for the Energy Vertical*". The webinar was attended by 44 people from different backgrounds mainly from Academia, energy, telecommunications, technological and security intelligence sectors.



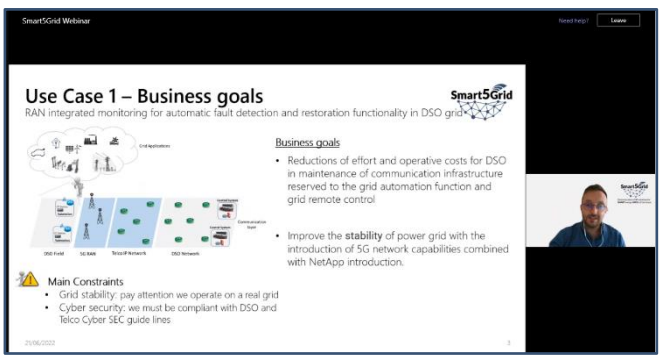


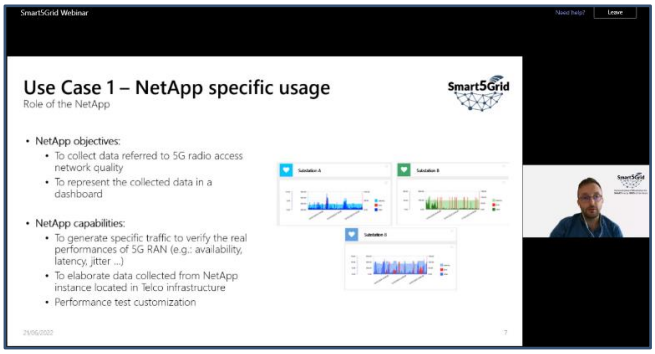
The aim of the Workshop was to discuss the application of 5G technology in Smart Grids via the following Use Cases:

1. Automatic Power Distribution Grid Fault Detection.
2. Remote Inspection of Automatically Delimited Working Areas at Distribution Level.
3. Millisecond Level Precise Distributed Generation Monitoring.
4. Real-time Wide Area Monitoring of power exchanges (cross border).

The webinar started with presentation of the project by the Project Coordinator, Mr. Daniele Porcu, and the energy vertical vision. Then, four partners presented the 4 pilots of the project as follows:

Session 1: Automatic power distribution grid fault detection - Fabrizio Battista (ENEL)





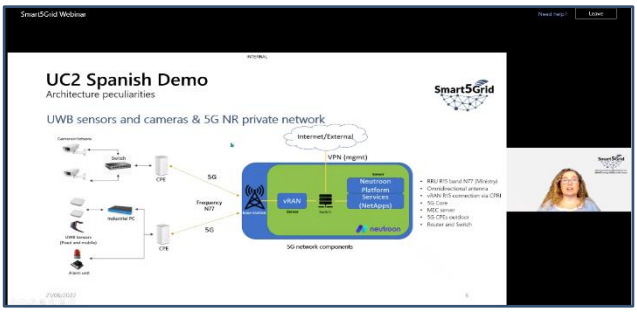
Session 2: Remote inspection of automatically delimited working areas at distribution level - Inmaculada Prieto (ENEL)

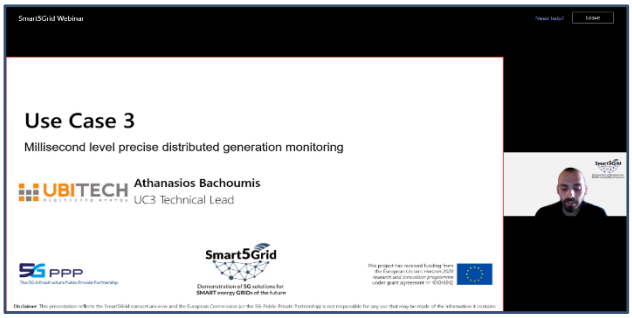
Session 3: Millisecond level precise distributed generation monitoring - Athanasios Bachoumis (UBITECH)

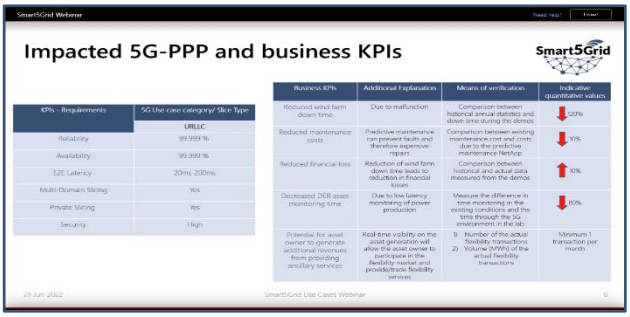
Session 4: Real-time wide area monitoring of power exchanges **-** Dimitrios Brodimas (IPTO)

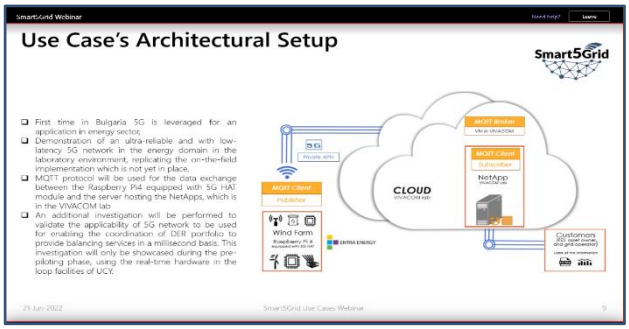
At the end of the presentations, the attendees had the opportunity to address questions to the presenters.

The webinar was efficiently communicated through our Social Media, Website, to our Community mailing list, to the Comms 5G-PPP mailing list and through the partners' networks.









2.5.1.4.6. 2ND IEEE INTERNATIONAL MEDITERRANEAN CONFERENCE ON COMMUNICATIONS AND NETWORKING – WORKSHOP

In the context of the IEEE 2nd Meditcom Conference which was held in Athens on the 5th-8th September 2022, the Smart5Grid project participated, with physical attendance, in the joint Workshop entitled "*Network Apps into Beyond 5G and 6G Network*". This workshop was co-organised by 9 ICT-41 Projects (i.e.: Smart5Grid, EVOLVED-5G, 5G-ERA, 5GASP, 5GMediaHUB, 5G-INDUCE, VITAL-5G and 5G-EPICENTRE) and the aim was to bring together all the NetApp stakeholders, discuss their experiences so far and "pave the way" for Network Apps into 6G to span all domains RAN/Core/Transport/Devices/Applications. The workshop was divided in two Sessions as follows:

Session I – NetApp Platforms into Beyond 5G and 6G Networks

1. *5G Application & Services experimentation and certification Platform* – 5GASP by Kostis Trantzas (University of Patras, Greece)
2. *Open cooperative 5G experimentation platforms for the industrial sector Network Apps* – 5G-INDUCE by Jakob Kämpfer (Oculavis.de)
3. *5G Intelligent Automotive Network Applications* – 5G-IANA by Konstantinos V. Katsaros (Institute of Communication and Computer Systems (ICCS), Greece)

4. *Experimentation and Validation Openness for Longterm evolution of VErtical inDustries in 5G era and beyond* – EVOLVED-5G by Dr. Harilaos Koumaras (NCSR "Demokritos", Greece)
5. *5G experimentation environment for 3rd party media services* – 5GMediaHUB by Kostas Ramantas (Iquadrat, Spain)

Session II – NetApp Platforms into Beyond 5G and 6G Networks

1. *Vertical Innovations in Transport and Logistics over 5G experimentation facilities* – VITAL-*5G* by Alexandru OPREA (Orange Romania), Andreea BONEA (Orange Romania)
2. *5G Enhanced Robot Autonomy* – 5G-ERA by George Agapiou (WINGS ICT Solutions, Greece)
3. *5G ExPerimentation Infrastructure hosting Cloud-nativE Network Apps for public proTection and disaster Relief* – 5G-EPICENTRE *by* Jean-Michel Duquerrois (Airbus)
4. *Demonstration of 5G solutions for SMART energy GRIDs of the future* – Smart5Grid by Antonello Corsi (Engineering, Italy), Giampaolo Fiorentino (Engineering, Italy)

Link: https://meditcom2022.ieee-meditcom.org/

2.5.1.4.7. 8TH IEEE INTERNATIONAL SMART CITIES CONFERENCE – SPECIAL SESSION

In the context of the 8th IEEE International Smart Cities Conference (https://attend.ieee.org/isc2-2022/), a hybrid event, which took place in Paphos, Cyprus, on the 26th-29th of September, Smart5Grid Project successfully organized a Special Session on 5G for Smart Cities and Smart Grids. This special session was entitled as "*5G technology and cloud native solutions for smart grids and smart cities applications*". In the Proceedings of the Conference and in the context of this Workshop, 3 papers were submitted and accepted by Smart5Grid partners, and 3 presentations were delivered by University of Cyprus, KioS Research Center and Sidroco.

This special session aimed to provide a focused environment for 5G-enabled solutions dedicated to applications for both smart cities and smart grids, introduce the 5G enabler, and inform conference attendees about the most recent advances in 5G-enabled smart cities and smart grids. Several discussions were held during the session about the values used for the latency range of several communication technologies such as 3G, 4G, and 5G that were compared for the pre-piloting tests of the UC3 and UC4 (whether they came from actual field tests or from the literature - the answer is that they came from both sources), how the wide area protection scheme was configured, and another question was related to the type of AI algorithm used for fast processing of images from cameras for the NetApp of UC2.

The IEEE International Smart Cities Conference welcomed stakeholders from communication, ICT, intelligent transportation and energy domain along municipalities across the globe (participants from more than 40 countries from all continents).

2.5.1.4.8. INFOCOM WORLD CONFERENEE 2022 - SPECIAL SESSION IN WORKSHOP

The latest 24th Infocom World Conference that has been held physically in Athens, Greece, on Novem*ber 29-30, 2022*, (*https://infocomworld.gr/*) has been considered as **"***the greatest ICT & Media Conference in South-Eastern Europe"* and it is widely regarded as "*the Major Annual Meeting of all the digital market stakeholders*" in order to implement digital transformation, conformant to current market needs and related challenges and especially contributing to the effort for creating a fully digital Greece.

The Infocom World Conference 2022, following a successful tradition of 24 subsequent years, has been about the revolutionary effects coming from the deployment of "Fiber and 5G Highways" in Greece.

As digital transformation evolves into a "key pillar" of growth for multiple aspects of our modern economy, deployment of appropriate network infrastructures capable of serving fast data transfer becomes a critical objective for further progress, especially due to the fact that such digital "highways" will also support the corresponding transformation of public and private sectors. This rapid digitization process is expected not only to strengthen the digital-based economy at all levels, but will also offer new "paths" for business and opportunities for growth. This, however, implicates for an effective and wide deployment of the necessary connectivity infrastructures (especially 5G) that are required for highly innovative services and/or corresponding applications.

In this context, market actors – and particularly the telecommunications operators – are making increased investments to develop 5G and fiber infrastructure, worldwide. Taking these trends into account we are, after all, at a time when large and important multinationals are choosing Greece for the development of their own hubs – whether it is data centers that serve the wider region or

technology and product development centers or hubs that strengthen the human resource skills. Thus, a reliable telecommunications infrastructure with state-of-the-art technology will not only strengthen the operation of such centers, but will also attract new investments, making Greece a "hub for hubs". Within the core objectives of the Infocom World Conference 2022 have been the way how Fiber and 5G are changing the market and offering new opportunities for the involved market players, with the aim of creating an innovation ecosystem for investments and growth.

The annual 2022 Conference has been organized in several parallel Workshops and Sessions, each one covering specific aspects and related challenges. Of particular importance has been the Full Day Workshop of November 29, 2002, organized by the Hellenic Telecommunications Organization S.A. (OTE), oriented towards "EU-funded Research Projects for creating the Future and Innovative Telecoms Market".

To this aim, the Hellenic Telecommunications Organization S.A. (OTE) has organized nine (-9-) distinct sessions, all oriented to actual 5G challenges and has invited several speakers coming from ongoing EU-funded projects, most of which from the 5G-PPP framework of reference.

The proposed sessions have been about:

1. Focusing on the fundamental context of the 5G infrastructure as an "enabler" for supporting development and further extension of modern smart grids, thus creating opportunities for investments and growth in the energy vertical market. Based on the framework of the actual Smart5Grid project, this session has discussed proposed use cases with direct market impact covering a diverse set of applications, several among the essential modules of the corresponding innovative architecture as well as some proposed Network Apps to be used by third parties. 5G networks constitute an important ingredient for the development of the smart grid technologies, allowing the grid to "adapt better" to the dynamics of renewable energy and distributed generation. Smart grid capabilities promise to control easier bi-directional power flows and to monitor, control and support distributed energy resources. A set of five (-5-) dedicated presentations have elucidated a great variety of aspects originating from the ongoing Smart5Grid context.
2. Emphasizing on the case of "smart ports of the future" in the era of "5G and beyond", taking into account all potential evolutionary processes and convergence aspects at various technical and business levels. Here the main focus has been about the framework proposed by the ongoing DataPorts project, supporting the transition of European seaports from "connected and digital" to "smart and cognitive". The proposed project platform aims at providing to seaports a secure and private aware-environment, where data coming from different sources can be shared by the stakeholders in a trusted and reliable way, in order to get real value from those data, providing a set of novel AI and cognitive tools to the wider port community. Four (-4-) presentations have covered various aspects of this very much promising effort.
3. Discussing and covering the innovative scope of the ongoing MARSAL project, especially focusing on the development of Machine Learning-based solutions towards Beyond 5G (B5G). Recent 5G deployments change the landscape of mobile networks in a profound way and at global level, with an evolved architecture supporting unprecedented capacity, spectral efficiency and increased flexibility. Actual challenges implicate for a future network (unified and hierarchical) infrastructure being able to: (i) support multiple distributed edge nodes and a huge number of access points, coordinated and orchestrated by entities in a low-cost and near-zero latency manner; (ii) provide an intelligent management of communication, computation and storage resources, which can be further enhanced by incorporating efficient ML algorithms, and; (iii) support multiple tenants via the application

of appropriate mechanisms to guarantee data and information security and integrity. Four (-4-) presentations have covered the above framework.

4. Discussing advanced 5G validation trials in market verticals. The ongoing 5G evolution is built on strong beliefs in benefits from new applications, with many specific use cases coming from diverse verticals. Support of the vertical industries also requires various architectural enhancements, to enable the enhanced performance of mobile networks as well as the required flexibility to adapt to diverse requirements imposed by the market actors. Three (-3-) 5G-PPP projects (i.e.: 5G-TOURS, 5G-HEART and 5G-VICTORI) have presented their proposed views and corresponding results.

5. Examining innovative challenges for 5G core technologies and Connected Automated Mobility (CAM). Although large-scale rollout of 5G networks has started becoming a reality, in parallel to the deployment of such 5G high-performing networks there is an unprecedented urge to support solutions tailored to specific types of networks, capable of offering ubiquitous coverage with high data rate availability, densification and high capillarity of access points to enhance 5G system capacity. The corresponding session has so discussed the context proposed by some related European projects (i.e., Affordable5G, 5G-ROUTES and NEMO), together with an innovative approach for Digital Twins in cities. Five (-5-) dedicated presentations have covered the above aspects.

6. Evaluating challenges towards promoting 5G innovations for verticals with third party services, via the design, establishment, deployment, operation, testing and validation of dedicated open platforms; these will be capable of providing access to networks resources used to develop suitable Network Apps, on top of 5G virtualised experimental environments to support requirements and developments from specific vertical sectors. This session specifically focused on (-3-) among the nine (-9-) fundamental European projects of the corresponding ICT-41 initiative (as there were dedicated and separate sessions for the cases of Smart5Grid and 5G-INDUCE), dealing with the energy, the Industry 4.0 and the Transport & Logistics verticals, correspondingly. This session has so discussed the context proposed by the 5GMediaHub project, the EVOLVED-5G project and the VITAL-5G project, in a total of four (-4-) dedicated presentations.

7. Assessing the innovative framework of the 5G-INDUCE project, relying on the deployment of an open ETSI NFV compatible 5G orchestration platform for the deployment of advanced 5G Network Apps. The platform's unique features provide the capability to the NetApp developers to define and modify the application requirements while the underlay intelligent OSS can expose the network capabilities to the end-users on the application level without revealing any infrastructure related information. The project focuses on the Industry 4.0 vertical sector, as one of the fastest growing and most impactful sectors in European economy. Four (-4-) presentations have covered the related scope.

8. Presenting a broader view and approach on concerns for long term evolution and for the inclusion of AI and ML techniques to support smart connectivity beyond 5G in the context of the ongoing AI@Edge, MonB5G, ENCRYPT and OCTAPUS projects. Intended challenge is to go well beyond the 5G capabilities as well as to prepare for the realisation of Smart Connectivity systems as-a-platform for a Next-Generation Internet, and for the support of a highly flexible connectivity infrastructure that can dynamically adapt to changing requirements of innovative applications whilst facilitating user data control and innovation friendly implementation of relevant legislation. A selection of four (-4-) presentations has covered the proposed framework.

9. Discussing various examples and/or related market applications, by identifying results within dedicated business or scientific scenarios. Among others, it comprised presentations coming from several ongoing research projects and related applied initiatives. These can serve as detailed examples of innovation in specific environments/ecosystems of our everyday life and experience. Three (-3-) presentations have been given covering the SLICES-SC project, several projects using earth observation and IoT for offering benefits to the citizens (i.e.: D2EPC, euPOLIS, HEART and HARMONIA projects) and a variety of R&I activities performed by the Municipality of the city of Egaleo in the Athens-Attica region.
The entire Workshop has hosted a total of thirty-six (-36-) distinct lectures, representing twenty-two (-22-) European projects.

The Workshop aimed to deal with several potential challenges rising from ongoing EU-funded research (i.e., either specific projects or wider frameworks) allowing to identify and assess corresponding network and services solutions, especially from the 5G operational framework. All these projects are able to further revolutionise and "boost" the telecommunications market to higher levels, by simultaneously promoting innovation and growth.
More informative elements with the corresponding uploaded presentations from all sessions can be found at: https://infocomworld.gr/24o-synedrio-infocom-world-2022-fiber-and-5g-highways-digitall-greece/epistimoniki-enotita/
Information can also be found at: https://infocomworld.gr/en/

Presentations of the Workshop have also been transmitted online in the web during the event and they can be found in a dedicated YouTube channel (i.e.: https://www.youtube.com/watch?v=7kmkJpQJqv8&t=618s)

In the first session that has been dedicated to the Smart5Grid context, five (-5-) presentations have been given during the event. Dr. Ioannis Chochliouros (OTE) has introduced the wider market framework for the energy vertical sector and focused upon various opportunities for the smart grid deployment in parallel with the expansion of 5G, following to the approach proposed by the Smart5Grid project. Then, Mr. Dimitrios Brodimas (IPTO) has presented a dedicated vertical use case about real-time wide area monitoring between Greece and Bulgaria, by emphasizing on opportunities and challenges for involved DSOs/TSOs. Mr. Michalis Rantopoulos (OTE) has further discussed the above use case, explaining the proposed network interconnection scheme as deployed by 5G operators in the two countries. A presentation prepared by Mrs. Ralitsa Rumenova (EE) has also been uploaded in the website, dealing with a second vertical use case about millisecond level precise distributed generation monitoring for optimized renewable energy resources (RES) operation and maintenance in Bulgaria. (Content of this presentation has been discussed online by Dr. Ioannis Chochliouros, OTE). In the continuity of the session, Dr. Ioannis Chochliouros has presented one more lecture about several essential components and core features of the Smart5Grid Platform, for implementing the 5G perspective.
The figure below, provides some screen-shots from these presentations and the related material.


Smart5Grid: Towards an Efficient Demonstration of 5G Solutions for the Smart Energy Grids of the Future
Dr. Ioannis Chochliouros, Telecommunications Engineer, M.Sc., Ph.D.
Fixed Network R&D Programs Section,
Research & Development Department, Fixed & Mobile
Hellenic Telecommunications Organization S.A.
Smart5Grid
Demonstration of 5G solutions for SMART energy GRIDs of the future
Dr. Ioannis Chochliouros – Hellenic Telecommunications Organization S.A. (OTE), Greece
Adtran
DIGITALL GREECE!
Real-time Wide Area Monitoring
Opportunities and Challenges for DSOs/TSOs
Vertical Use Case
Dimitrios Brodimas
UC Leader
ipto
5G ppp
Smart5Grid
COSMOTE
NOVA
vodafone
volton
Vertical Use Case:
Real-time Wide Area Monitoring between Greece and Bulgaria –
Developing a Modern Network Interconnection Scheme by the 5G Operators
Presenters:
Mr. Michalis Rantopoulos - Hellenic Telecommunications Organization S.A. (OTE)
Dr. Ioannis Chochliouros - Hellenic Telecommunications Organization S.A. (OTE)
alhua
ERICSSON
EY
RICOH
Millisecond level precise distributed generation monitoring for optimized renewable energy resources (RES) operation and maintenance
Vertical Use Case
VIVACOM
UNITECH
ENTRA ENERGY
Composition of the consortium
Smart5Grid Consortium
GRID
Lenovo
Essential Components and Core Features of the Smart5Grid Platform
for implementing the 5G perspective
Presenter:
Dr. Ioannis Chochliouros
Head of Fixed Network R&D Programs Section -
Hellenic Telecommunications Organization S.A. (OTE), Greece
NOKIA

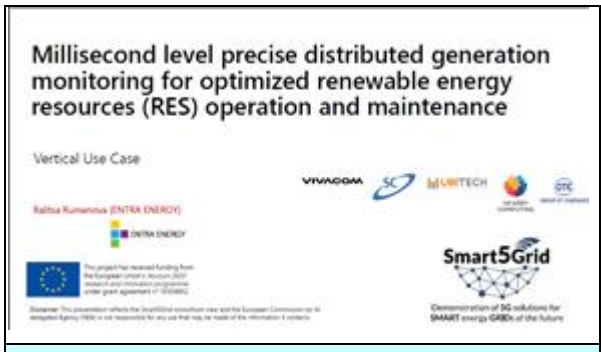
Smart5Grid presentations in Session 1 of OTE's Full Day Workshop (November 29, 2022) in the framework of Infocom World Conference 2022

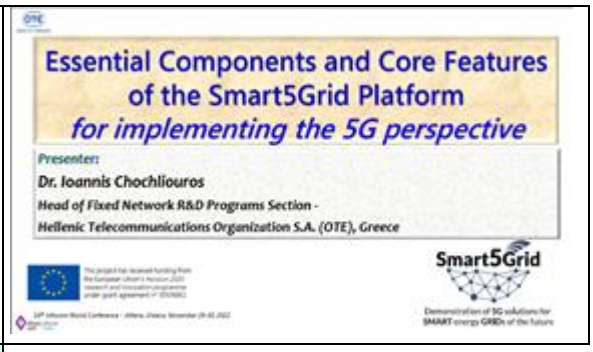
Regarding the wider ICT EU Call where Smart5Grid is included (i.e. the H2020-ICT-41-2020: 5G Innovations for Verticals with Third Party Services) apart from our project there was a session (Session 6) dedicated jointly to the 5GMediaHub project, the EVOLVED-5G project and the VITAL-5G project and another session (Session 7) fully dedicated to the 5G-INDUCE project.

Thus, five (-5-) among the ongoing nine (-9-) ICT-41 EU-funded projects have been presented and have been able to present informative material related to their objectives and frameworks, their proposed use cases, architectures and their ongoing implementation.

All projects in these three sessions had the possibility to "open" direct and interactive communication channels as well as to exchange results, knowledge and experiences, according to their progress.

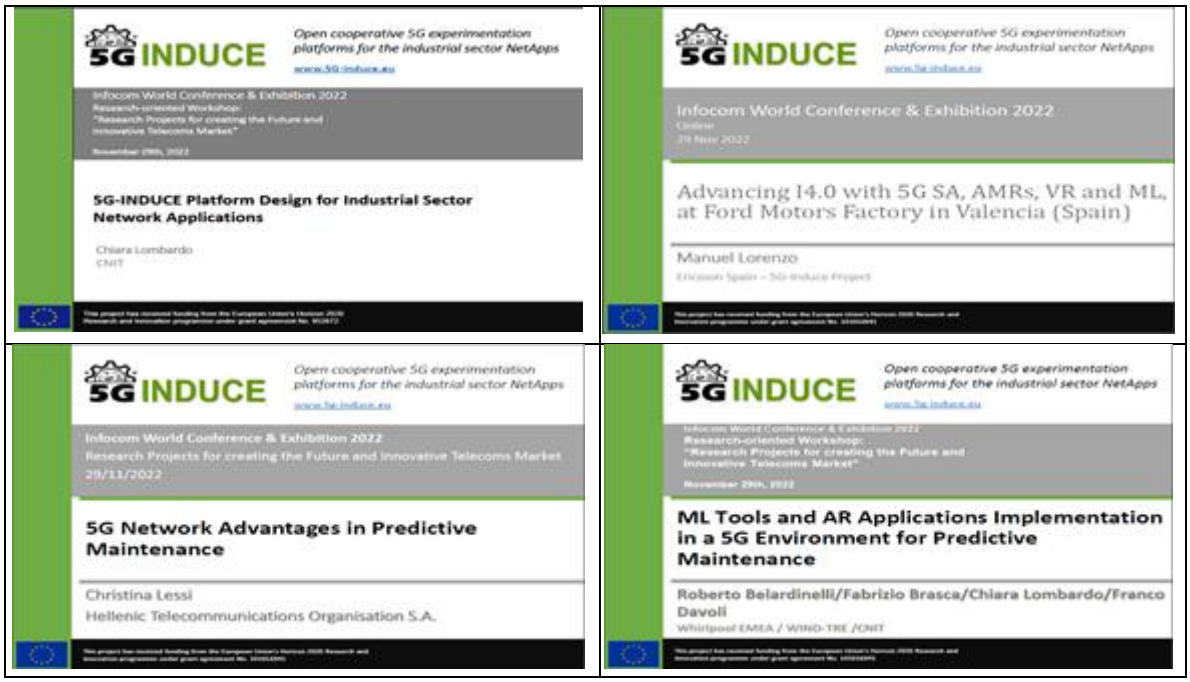
This, in particular, has been quite important for the cases of their proposed Network Apps and their dedicated verticals. The following figure provides an overview of all presentations given in Sessions 1, 6 and 7, coming from the topic of the H2020 ICT-41 Call, dealing with Network Apps. These have set a framework for interactivity and for exchanging of ideas and practices coming from the participating projects (i.e.: Smart5Grid, 5GMediaHub, EVOLVED-5G, VITAL-5G and 5G-INDUCE).





Session 6
(dedicated to the 5GMediaHub, EVOLVED-5G and VITAL-5G projects)

Session 7
(dedicated to the INDUCE-5G project)



Smart5Grid together with other H2020- ICT-41 EU-funded projects (Sessions 1, 6 and 7 of OTE's Full Day Workshop in the framework of Infocom World Conference 2022)

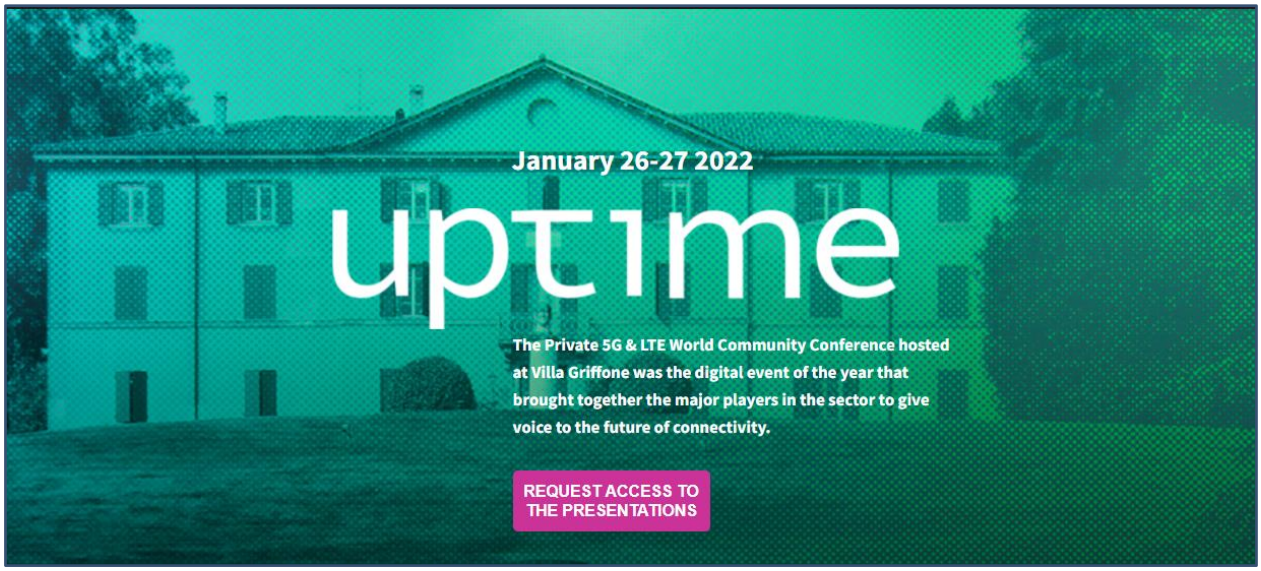
2.5.1.5. Other Events, Press Releases, Articles etc

2.5.1.5.1. UPTIME EVENT 2022

On January 26th-27th, UPTIME, the global event hosted in the evocative setting of Villa Griffone, home of Guglielmo Marconi and cradle of wireless communications, brought together an audience of around 1000 Private 5G and LTE professionals. The event consisted of two days of meetings and conferences, broadcast live on webstream, to deepen and discuss the scenarios and opportunities of the 5G universe, that is: the technology that revolutionizes the way we live, communicate and do business.

Participants had the opportunity to listen to the speeches of the 45 speakers and ask them questions to learn about the challenges, the main business cases and all news of the Private 5G world. A dedicated presentation focused on 5G-PPP projects, also including Smart5Grid.

UPTIME is an event organized by Athonet, a worldwide corporate with 15+ years of experience in delivering fully supported 4G, and now 5G, Core solutions for business-critical Enterprises and CSPs scaling up their networks. For all information on the event and to have access to videos and presentations: https://uptime.athonet.com/



2.5.1.5.2. MOBILE WORLD CONGRESS

On the 28th of February to 3rd of March, MWC took place in Barcelona, Spain. Smart5Grid partner, Athonet, was present showcasing demos various products and solutions at customers' booths and had dedicated meetings with customers and visitors. During these meetings, Athonet had the opportunity to disseminate Smart5Grid project. MWC' numbers for 2023 are great, indicating 10 700 physical attendees from industry sectors, from which 46% from TELCO industry.

2.6. Statistics, Evaluation and Impact Results of the Y1 Activities

2.6.1. Quantitative Results and Evaluation of Activities

In the previous Sections a summary of all the communication and dissemination activities was presented for the second year (reported period **M11-23**). In specific, in section 2.5, a thorough presentation of each activity was presented along with respective tables indicating additional information per activity (such as event name, activity title, etc.). Moreover in Table 3 can be found all the activities' goals set for year 2 as per the dissemination plan and the actual goals achieved. To facilitate the reader, the above-mentioned Table is also presented below (Table 6). Overall, the goals

have been met with exception of the Field Trials/Showcases as explained, as the project was not mature enough to showcase. In total, the Smart5Grid dissemination activities performed count a total of 56 activities.

PLANNED DISSEMINTATION ACTIVTIES	METRICS	PROJECT TARGET	TIMELINE	Y2	Activities Y2 Target (M13-M24)	Activities performed up to M23
Publications in journals, conferences and white papers.	Number of publications	**>20**	Publications: M06-M36 (and after the end of the project)	**40%**	**8**	**9**
Presentations in scientific events and workshops	Number of presentations	**>20**	Presentations: M01-M36	**35%**	**7**	**34**
Field Trials/Showcases	Number of trials/showcases	**>5**	Exhibitions/Workshops/Events: M13-M36	**30%**	**2**	**-**
Exhibitions in industrial and scientific events	Number of exhibitions/booths	**>5**	Demonstrations/Showcases: M13-36	**30%**	**2**	**2**
Organisation of events (workshops/seminars/training/poster sessions/webinars)	Number of events	**>10**	Events: M06-M36	**35%**	**4**	**8**
Other Events, Press Releases, Articles etc	Number of Events/articles	**As many**			**-**	**2**
TOTAL			M12-M23		**23**	**56**

Table 6: Smart5Grid metrics for the Dissemination Activities M12-M23

Similarly, below there is a table summarizing the communication results of Y2 (reported period M11-M23). Smart5Grid website and social media channels have performed well with a constant increase in the number of followers and visitors, respectively. All details about the impact of the communication activities during the year 2 (Period M11-M23) are summarized in Table 7. The reported periods vary according to when the results were possible to be extracted.

ACTIVITY	Y2 Achievements (M11-23 unless otherwise stated)	Achievements in Total (Y1+Y2)
Communication channels used	1 website, 4 Social Media Channels, 1 YouTube Channel	1 website, 4 Social Media Channels, 1 YouTube Channel
Total Number of News posted in Website (News section)	>46	>100
Total website visitors (M11-22)	3142	4200

Total website sessions (M11-22)	4708	6800
Total Number of Posts in Social Media channels (M11-23)	435	828
Total Number of Likes in Social Media channels (M11-23)	3080	5935
Total Number of Followers in Social Media channels (M11-23)	1061 vs 664 Y1	1061
YouTube channel	1 video	2 videos
YouTube Subscribers	18	30
YouTube Views	147	252
Newsletter issues published	3	7
Leaflets	1	2 (1 new + 1 updated)
Posters	1	1 +1 updated

Table 7: Smart5Grid Communication Activities in a nutshell (M11-M23)

2.6.2. Website Performance Statistics and Dashboards

Smart5Grid website statistical dashboards are created, processed evaluated and visualized monthly by INF with the use of Google Data Studio and Google Analytics. As already stated, the statistical dashboards correspond to a 3-month period and are distributed to the consortium members via email every trimester via the Smart5Grid WP7 mailing list. In addition, they are added to a respective folder in MS TEAMS for every partner to be able to access for historical reference. Google Data Studio is used in order to graphically represent statistical information regarding the traffic of the website, its visitors (in respect to the GDPR laws) and the sources from which the website is accessed.

The figures below represent the first year's dashboard covering the period from November 2021 to October 2022. Information that can be seen in Figure 24 and Figure 25 describe the audience's behavior in number of Users, session/per user, the average time on page, page views as well as the sources from which someone accessed the website. The website statistical dashboard may also be accessed online at:

https://datastudio.google.com/reporting/d16e0572-7ba2-4657-bf85-e8ec8f5cb575/page/pmtsB

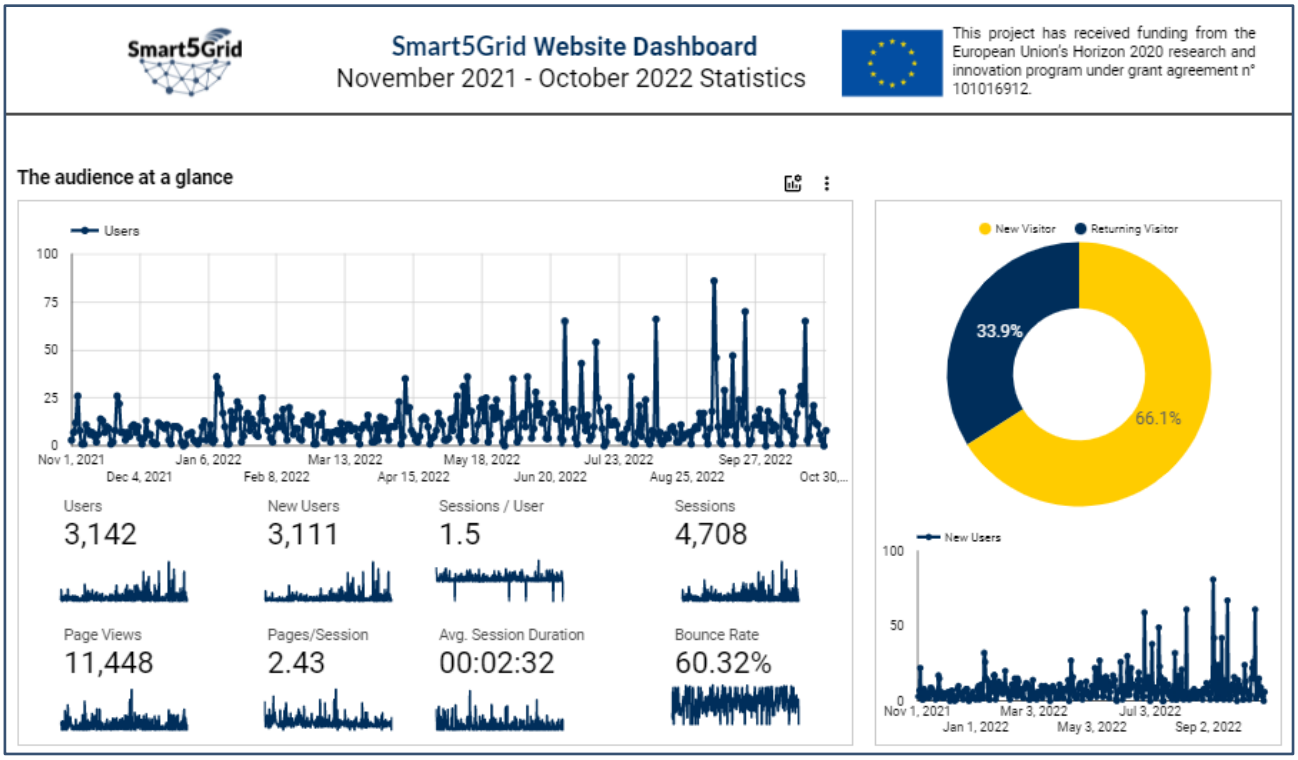


Figure 24: Smart5Grid Website Dashboard M11-M22

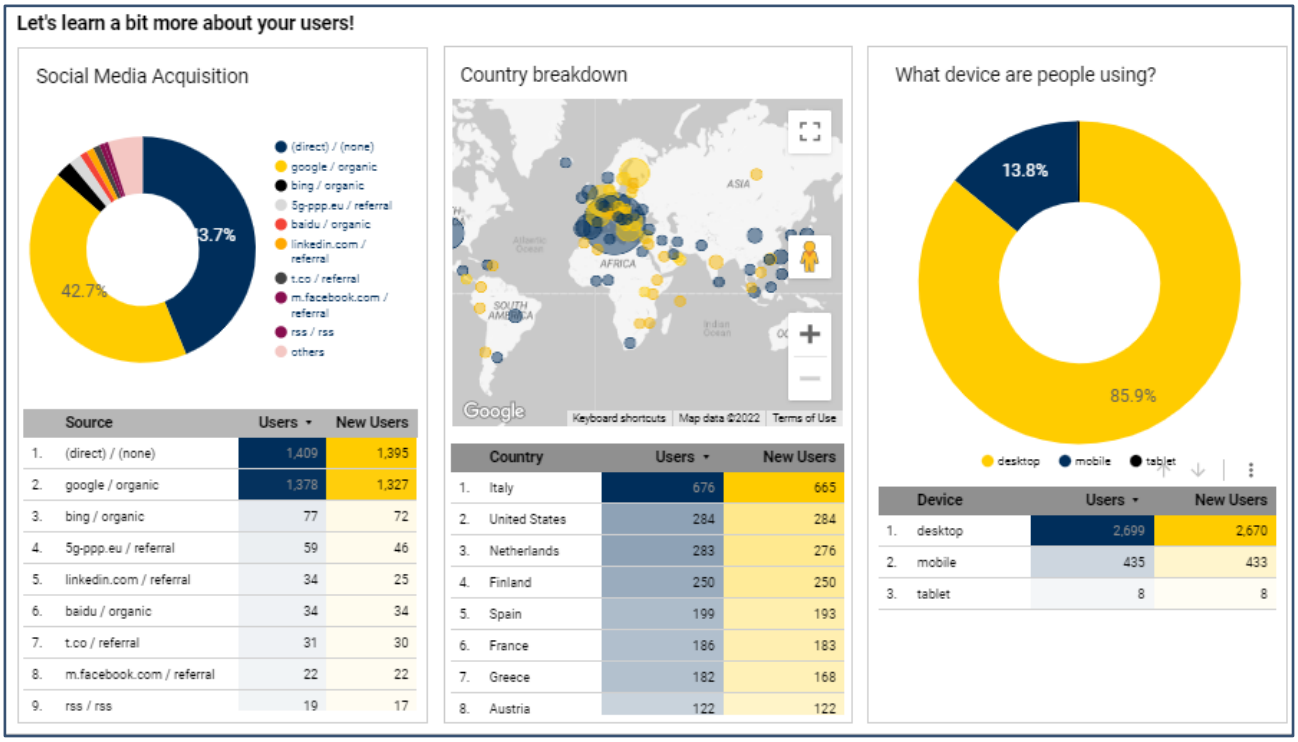


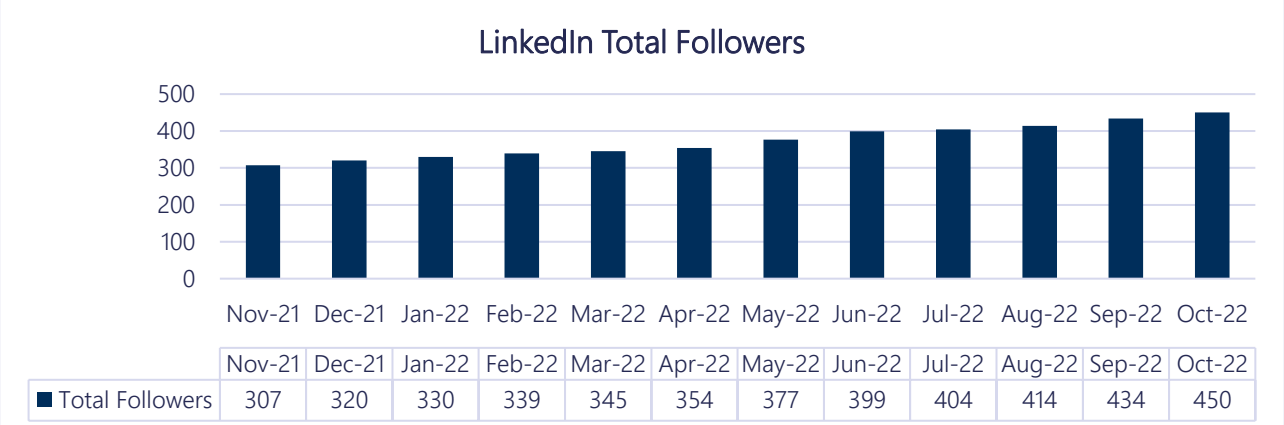
Figure 25: Smart5Grid Website Dashboard Analytics by Source, Country and Device

2.6.3. Social Media Performance Statistics and Dashboards

2.6.3.1. Smart5Grid LinkedIn Dashboards

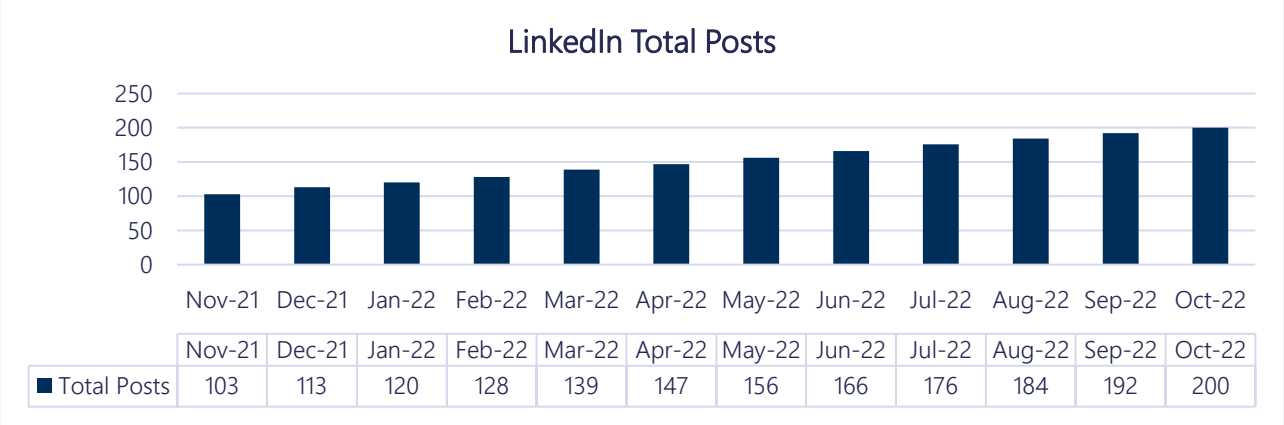
The statistical dashboards for the second year for LinkedIn were developed in order to evaluate the activities performed during the period from November 2021 to October 2022.

The figures below depict the total number of followers and the posts during this period. As expected, there is a constant increase in the number of followers, whereas the number of posts varies due to the dissemination of various events and project's activities.



	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22
Total Followers	307	320	330	339	345	354	377	399	404	414	434	450

Figure 26: Smart5Grid LinkedIn Followers' Evolution through M11-M22



	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22
Total Posts	103	113	120	128	139	147	156	166	176	184	192	200

Figure 27: Smart5Grid LinkedIn Posts per month M11-M22

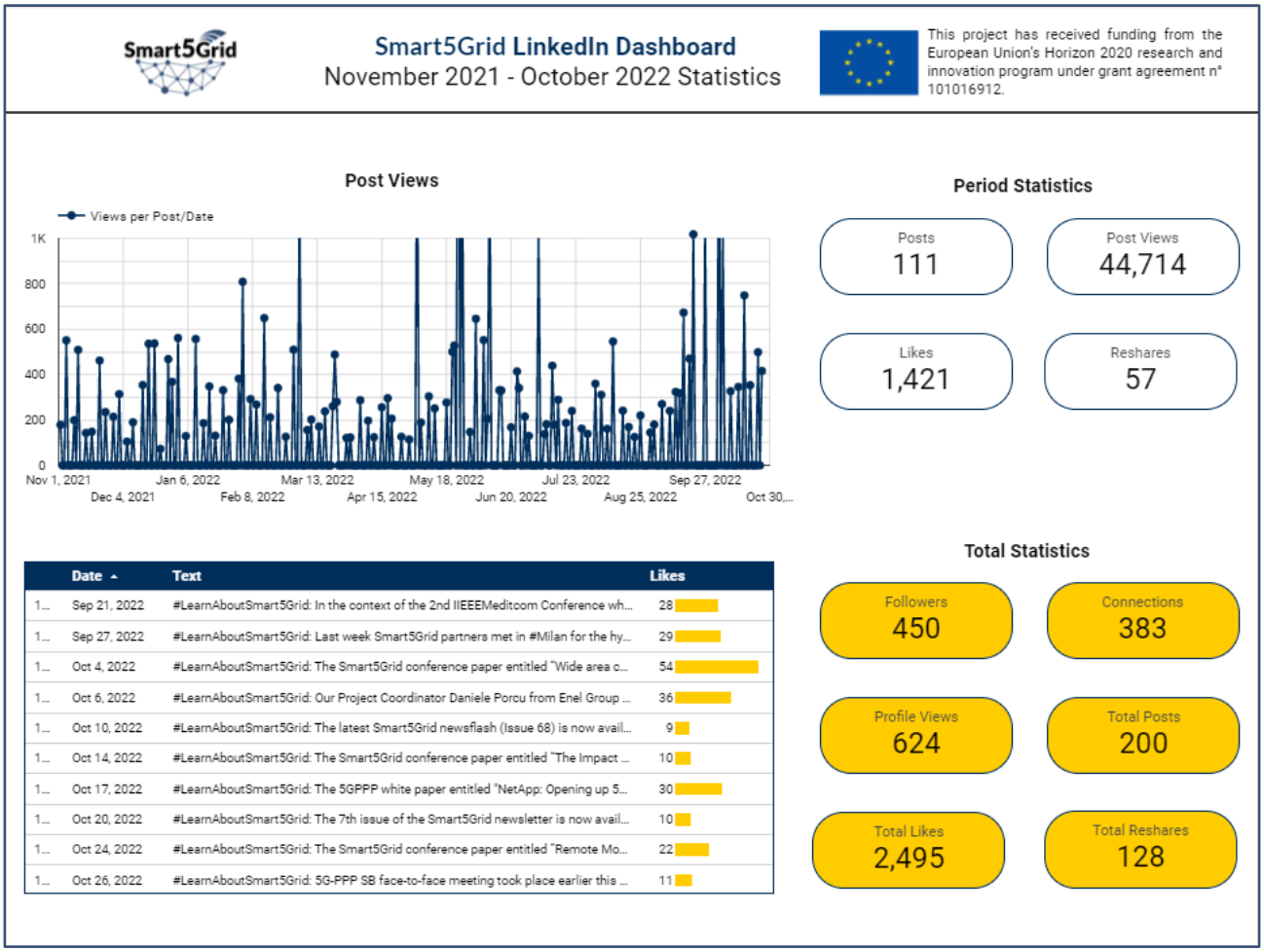
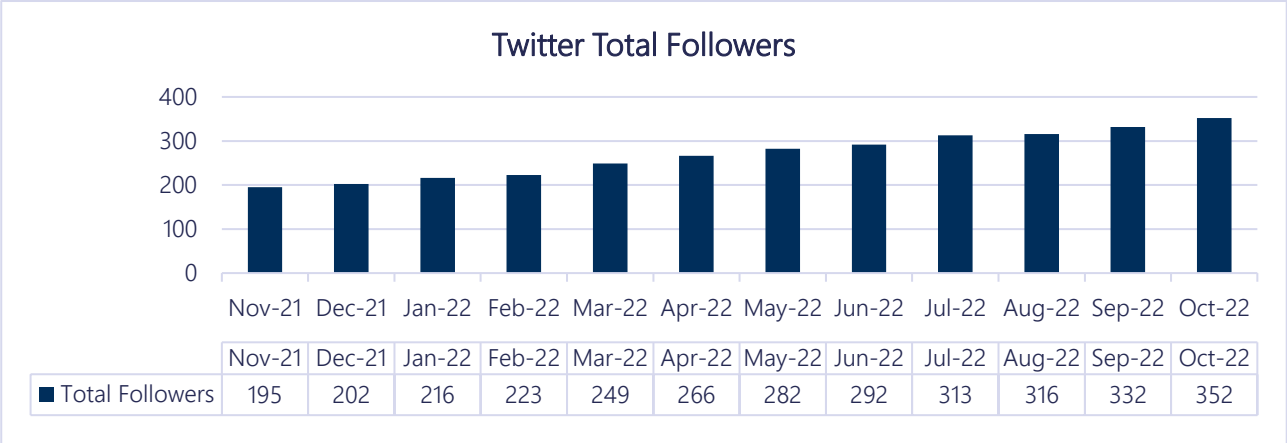


Figure 28: Smart5Grid LinkedIn Dashboard

LinkedIn is the most popular platform and has been used for communicating 111 posts and achieving 57 reshares with a total of more than 44,714 views and 1,421 likes, providing up-to-date information of the Smart5Grid project's activities to a network of 450 followers. For viewing online the LinkedIn dashboard one may use the following link: https://datastudio.google.com/reporting/39ddc951-058c-477c-b10b-72bea19ddd20/page/1SSqB

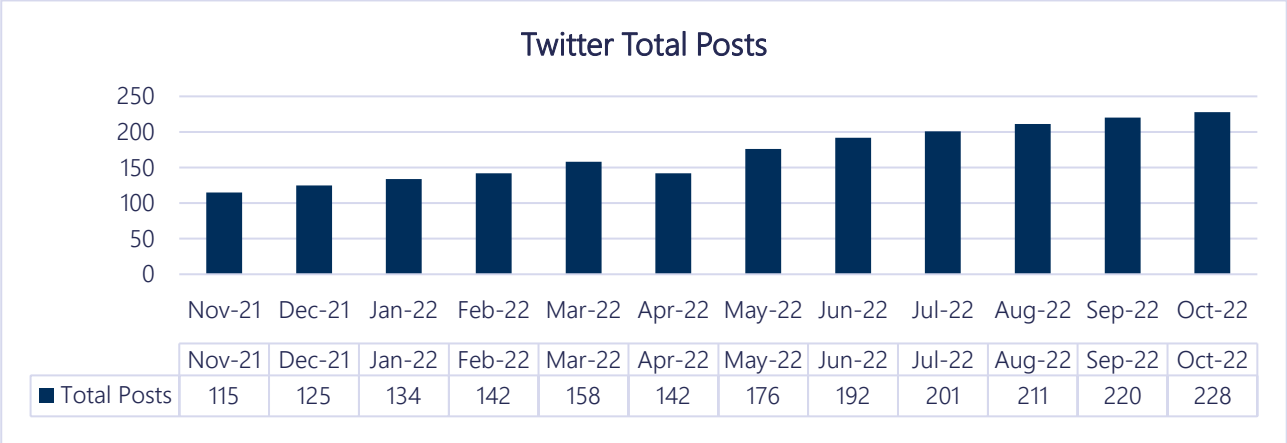
2.6.3.2. Smart5Grid Twitter Dashboards

The next most popular medium is Twitter with 352 followers. The table below provides information regarding the evolution of followers and the number of posts per month for the 12-month period from November 2021 to October 2022.



	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22
Total Followers	195	202	216	223	249	266	282	292	313	316	332	352

Figure 29: Smart5Grid Twitter Followers' Evolution through M11-M22



	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22
Total Posts	115	125	134	142	158	142	176	192	201	211	220	228

Figure 30: Smart5Grid Twitter Posts per month M11-M22

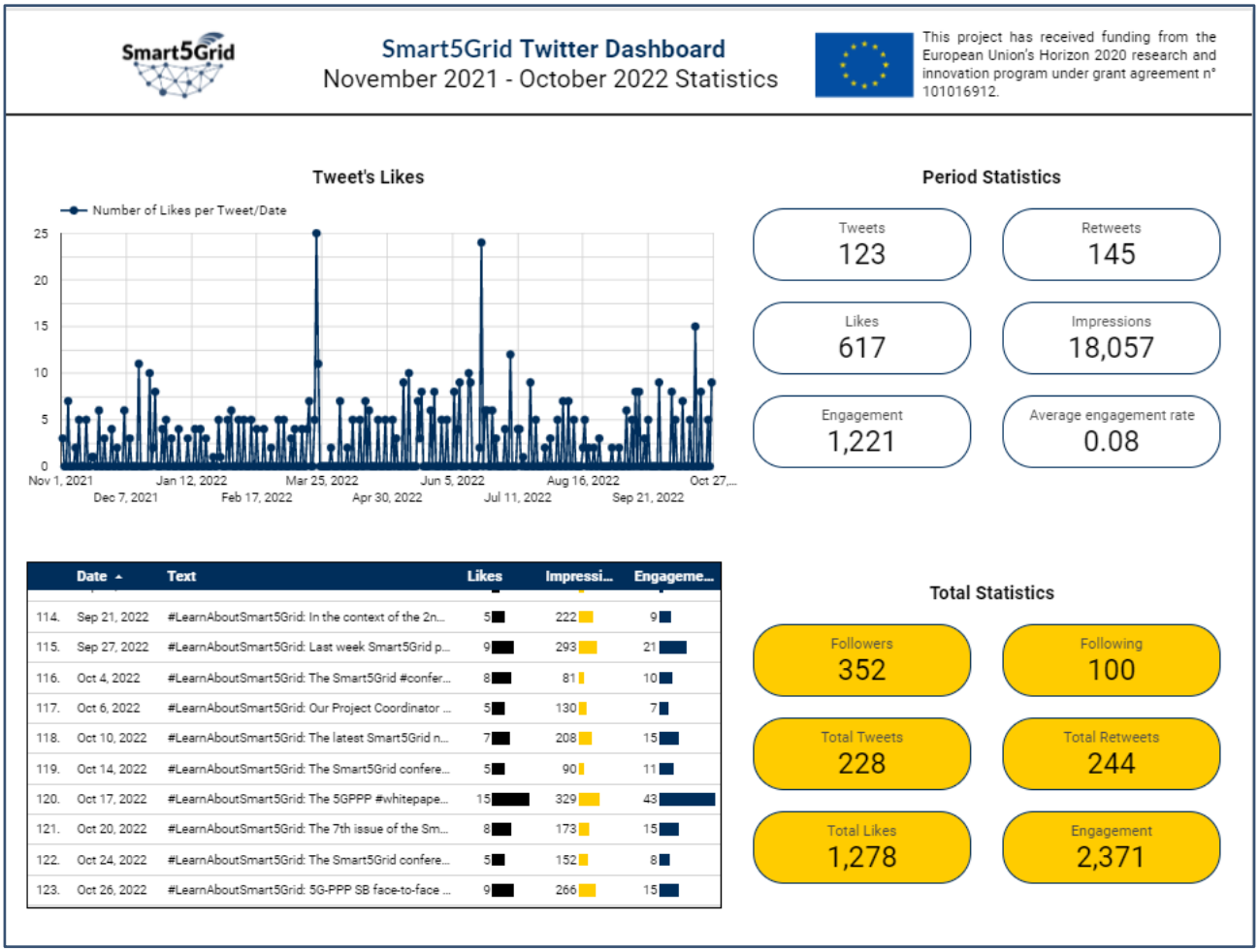
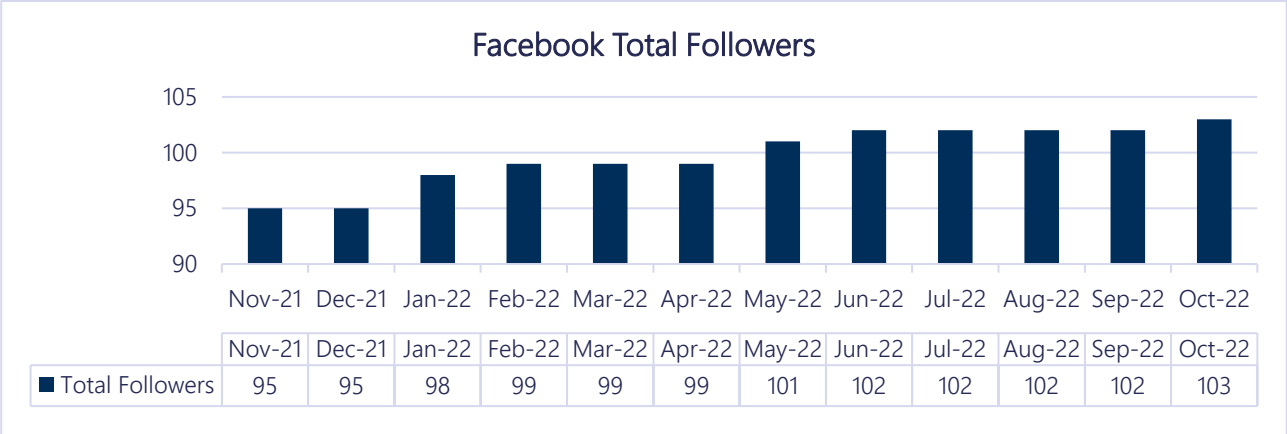


Figure 31: Smart5Grid Twitter Dashboard

Twitter channel has been used for communicating 123 tweets and achieving 145 retweets with more than 18,000 impressions, with 661 likes and 1,221 engagements. Similarly, the engagement rate of 8% (vs 6% the previous period) confirms the high involvement of the 352 followers to the medium's activities. For viewing online the Twitter dashboard one may use the following link: https://datastudio.google.com/reporting/d474d132-8fd9-4016-a994-613bc7de9c97

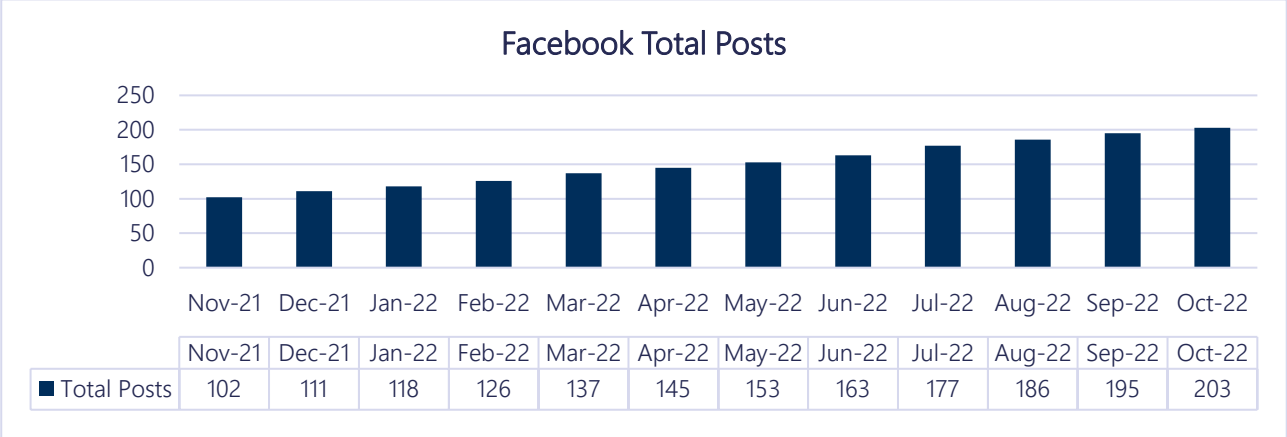
2.6.3.3. Smart5Grid Facebook Dashboards

Facebook Statistical dashboards for cover similarly the 12-month period from November 2021 to October 2022. The figures below show the evolution of the number of followers and the number of posts throughout the period under examination.



	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22
Total Followers	95	95	98	99	99	99	101	102	102	102	102	103

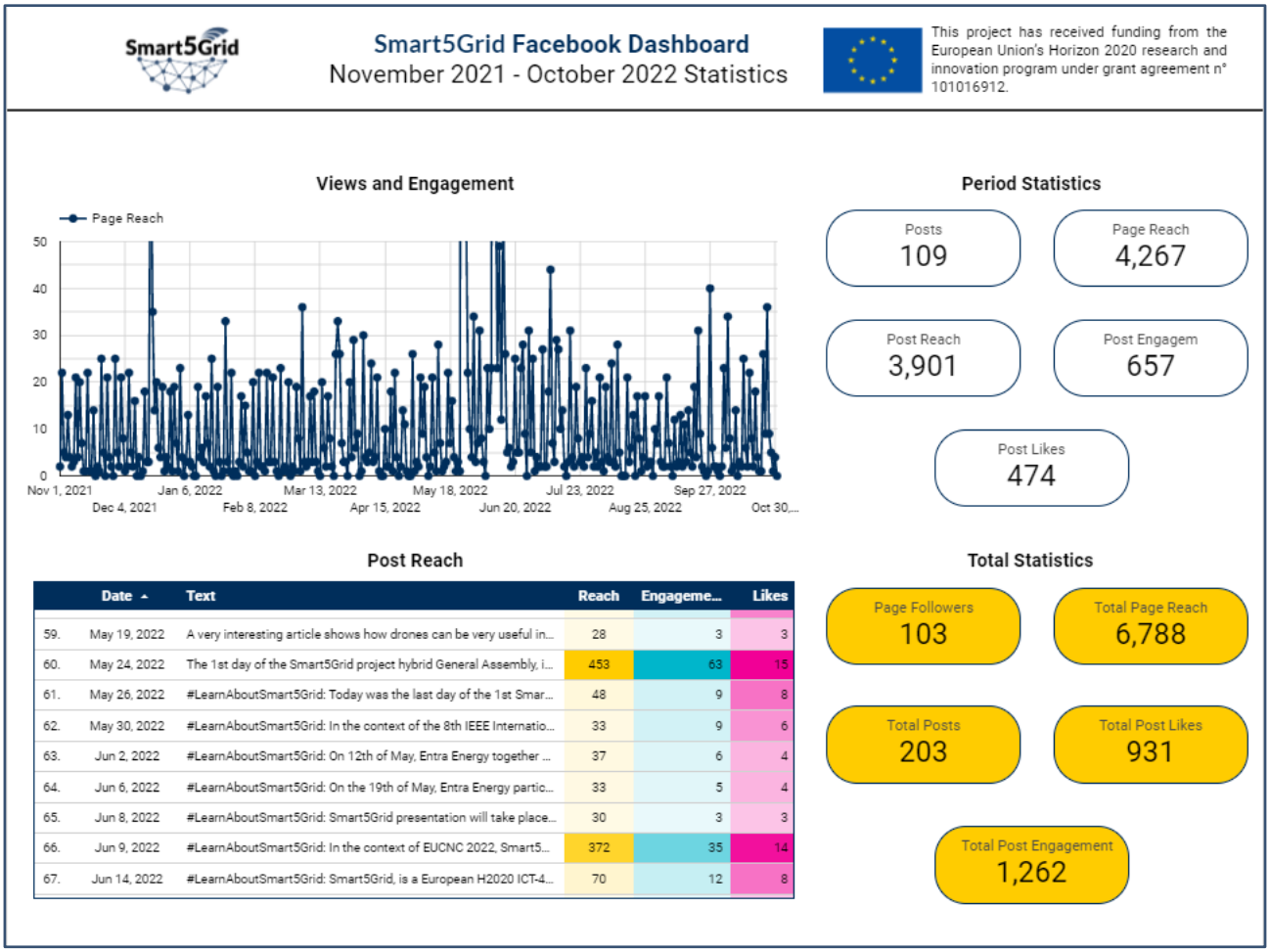
Figure 32: Smart5Grid Facebook Followers' Evolution through M11-M22



	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22
Total Posts	102	111	118	126	137	145	153	163	177	186	195	203

Figure 33: Smart5Grid Facebook Posts per month M11-M22

As expected and due to the research/technical character of the Smart5Grid project, Facebook and Instagram attract less followers. In any case, they are still communication platforms of high significance to reach the wider audience and we will continue to communicate in an adequate manner.



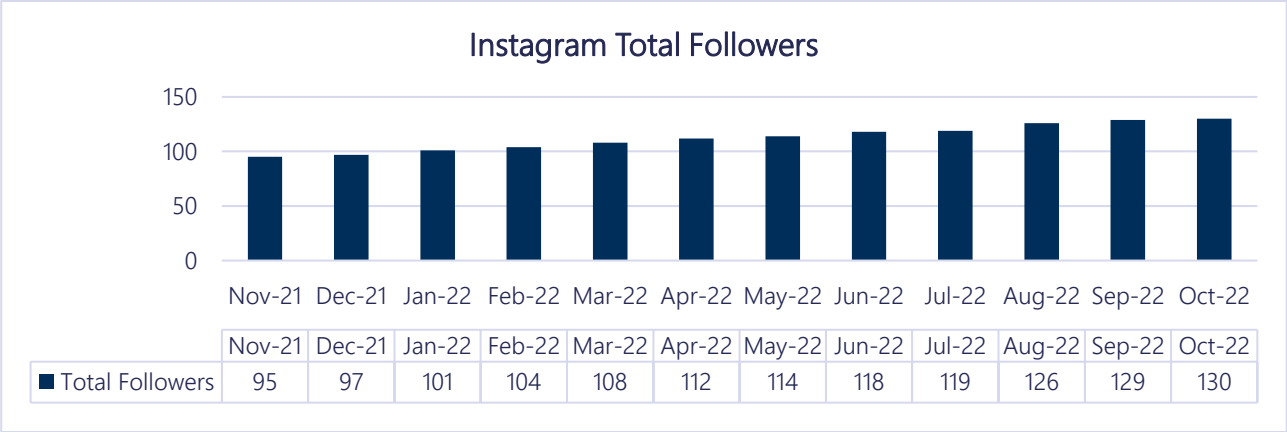
	Date	Text	Reach	Engageme...	Likes
59.	May 19, 2022	A very interesting article shows how drones can be very useful in...	28	3	3
60.	May 24, 2022	The 1st day of the Smart5Grid project hybrid General Assembly, i...	453	63	15
61.	May 26, 2022	#LearnAboutSmart5Grid: Today was the last day of the 1st Smar...	48	9	8
62.	May 30, 2022	#LearnAboutSmart5Grid: In the context of the 8th IEEE Internatio...	33	9	6
63.	Jun 2, 2022	#LearnAboutSmart5Grid: On 12th of May, Entra Energy together ...	37	6	4
64.	Jun 6, 2022	#LearnAboutSmart5Grid: On the 19th of May, Entra Energy partic...	33	5	4
65.	Jun 8, 2022	#LearnAboutSmart5Grid: Smart5Grid presentation will take place...	30	3	3
66.	Jun 9, 2022	#LearnAboutSmart5Grid: In the context of EUCNC 2022, Smart5...	372	35	14
67.	Jun 14, 2022	#LearnAboutSmart5Grid: Smart5Grid, is a European H2020 ICT-4...	70	12	8

Figure 34: Smart5Grid Facebook Dashboard

Facebook channel has been used for communicating 109 posts to 103 followers, but with the use of Tags, Image posts etc the project achieved to reach more than 3,901 accounts and get 657 actions of engagement (post interactions). For viewing online the Facebook dashboard one may use the following link: https://datastudio.google.com/reporting/06c116b4-00db-420a-b267-80000765287c/page/j5mpB

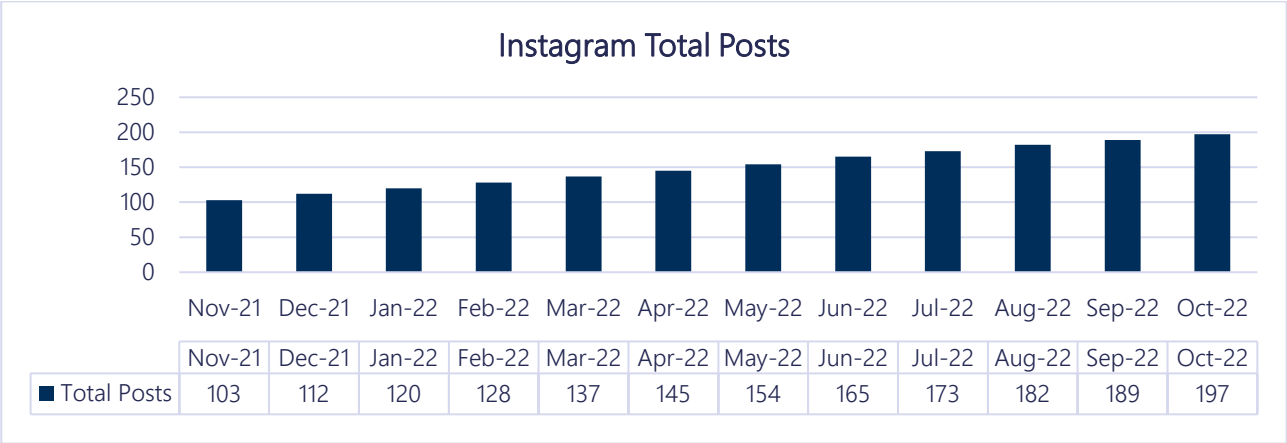
2.6.3.4. Smart5Grid Instagram Dashboards

The Instagram statistical dashboards for the covered period from November 2021 to October 2022 are shown below. This channel differs from the rest of the channels due to its nature focusing on pictures. The number of followers is equivalent to that of Facebook and, in both cases, there is an incremental tendency. The figures below show the evolution of followers and the posts per month. As also mentioned above, the posts vary due to the activities performed by the project's partners.



	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22
Total Followers	95	97	101	104	108	112	114	118	119	126	129	130

Figure 35: Smart5Grid Instagram Followers' Evolution through M11-M22



	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22
Total Posts	103	112	120	128	137	145	154	165	173	182	189	197

Figure 36: Smart5Grid Instagram Posts per month M11-M22

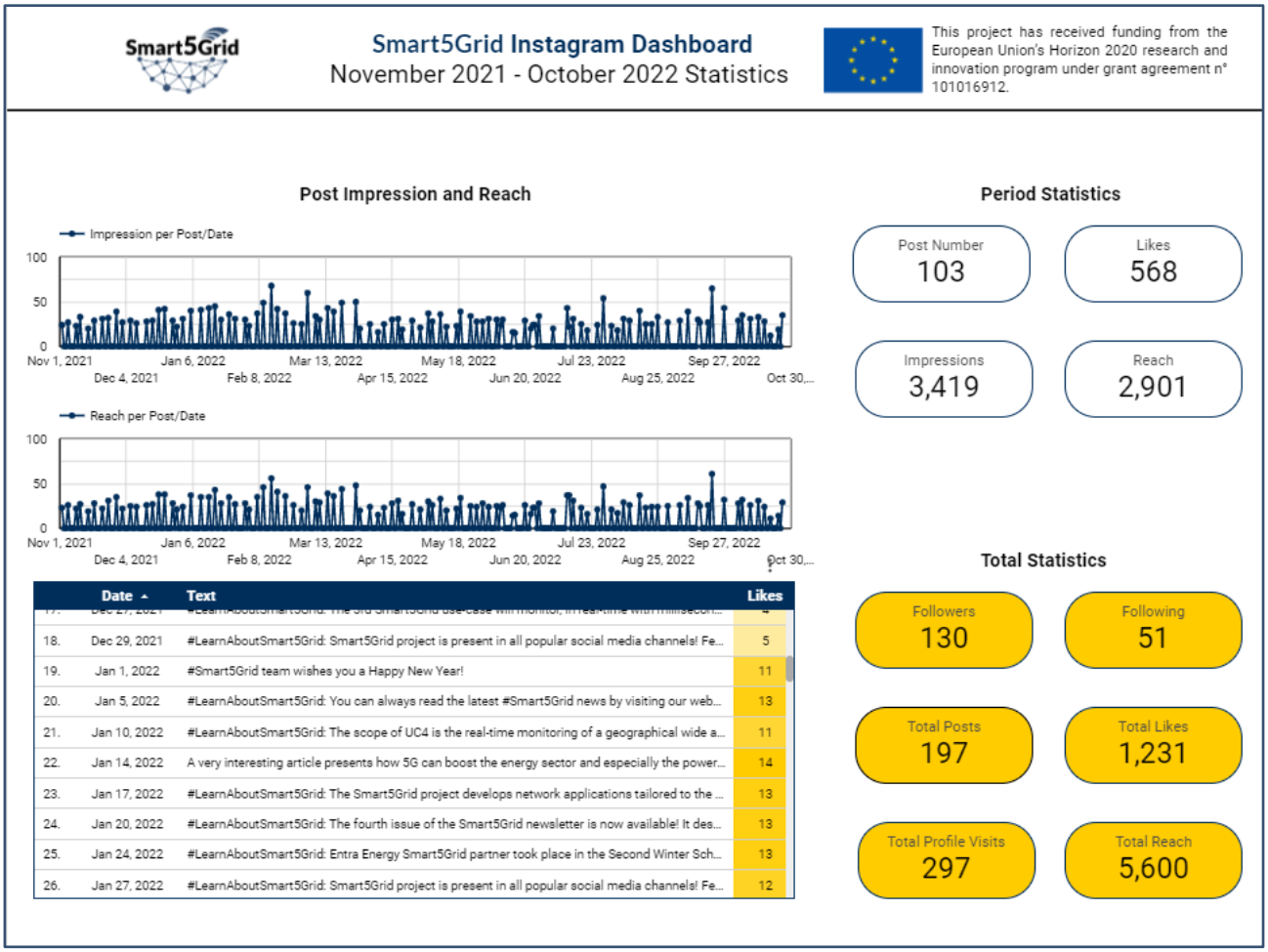


Figure 37: Smart5Grid Instagram Dashboard M11-M22

In total, Instagram has been used for communicating 103 posts to 130 followers and achieving 568 likes, more than 3,400 impressions and reaching 5,600 accounts. Also, there are 297 profile visits. For viewing online the Instagram dashboard one may use the following link: https://datastudio.google.com/reporting/e7db6638-3919-4c67-bc22-42582cf60815/page/rKQqB.

2.6.4. Dissemination and Communication Goals for the rest of the project

Following the completion, of the 23 months of the project and based on the results achieved during the Y2 (M12-23), there are no important deviations as per initial communication and dissemination plan and set KPIs (presented in D7.2). The only deviation concerns the Field Trials and Showcases KPIs which will be added to Y3 goals. Following the method of the previous deliverables (i.e. D7.2 and D7.3) we summarize the quantitative goals, based on a split ratio percentage of **20/30/50 approximately** that is used for setting the minimum planned goals per year and activity (based on the total quantitative figures and the timeline already set in Table 2 for the entire project lifetime). Following the above split ratio,

Table 8 summarizes the goals for Smart5Grid dissemination activities for Y3 towards the completion of the project.

PLANNED DISSEMINTATION ACTIVTIES	METRICS	PROJECT TARGET	TIMELINE	Y3
Publications in journals, conferences and white papers	Number of publications	**>20**	Publications: M06-M36 (and after the end of the project)	**10**
Presentations in scientific events and workshops	Number of presentations	**>20**	Presentations: M01-M36	**9**
Field Trials/Showcases	Number of trials/showcases	**>5**	Exhibitions/Workshops/Events: M13-M36	**4+2**
Exhibitions in industrial and scientific events	Number of exhibitions/booths	**>5**	Demonstrations/Showcases : M13-36	**4**
Organisation of events (workshops/seminars/training/poster sessions/webinars)	Number of events	**>10**	Events: M06-M36	**5**
Other Events, Articles/Brochures etc	Number of events/ publications		M03-M36	**-**

Table 8: Smart5Grid metrics for the Dissemination Activities of Y3

Publications, organized events like workshops, webinars, showcases, etc., aimed at SME's and 5G business, academic, and scientific target audiences, will be intensified in Y3 as the project's results and accomplishments will be available for formal documentation and dissemination to the stakeholders. The Smart5Grid Consortium intends to host webinars, participate actively in EuCNC, and participate in other significant events to highlight outcomes in the upcoming year.

2.7. Impact creation for SMEs Engagement

In D7.3 we presented the SMEs engagement plan as they are considered as key stakeholders and key beneficiaries of the project's results, within the scope of the communication plan and strategy for impact creation. This section focuses on the actions already taken in attracting interested SMEs in the scope of communication and impact. Please note that **the actions presented below are focused only on WP7 related communication/impact activities in order to attract SMEs and raise their interest (engage them)** for potential involvement within Smart5Grid project (i.e. external SMEs acting as third parties for external experimentation).

For further and more detailed plan regarding the SMEs engagement as third party experimenters, the reader should read the D2.3 *"Alignment with Previous 5G PPP Phases and Roadmap for third party involvement"*.

- **Join our Community Form – Online form:** As already stated in this deliverable an online form was created on the website through which, interested SMEs and other stakeholders can provide their contact details and to express their interest in Smart5Grid project news and experimentation platform.
    - This form was communicated through:
        - our Social Media channels,
        - our website
        - SME WG
        - 5GPPP Comms mailing list.
        - Smart5Grid Newsletter
        - Additionally, it was included in the video in the Smart5Grid project stand in ENLIT event.
        - It is recommended to all Smart5Grid partners to include and promote them in their presentations.
- **Webinar:** The webinar, organised by Smart5Grid Consortium, *"5G Use cases for the Energy Vertical"*, aimed SMEs, among other stakeholders, targeting to the dissemination of the core essence of the project to our audience.
- **Leaflet Creation:** as already mentioned in this deliverable a new 'Join our Community' leaflet was created in order to be used in events and attract the attention of SMEs and different stakeholders to our Community. This leaflet was communicated to SME WG and our Social Media.
- **Survey:** This survey gathered feedback on the relative importance of various factors for third parties which will be invited to use the experimentation platform (framework) and will allow them to develop and test 5G Network Apps.
    - This survey was communicated through
        - SME WG
        - EVOLVED-5G project
        - 5G-PPP Comms mailing list
        - Our Join our Community database

3. 5G-PPP Program Liaison and Activities

In this section, we describe the activity of the project in the 5G-PPP Programme, to which we are actively contributing in our commitment to maximize its impact.

We start by providing an update about our participation in the 5G-PPP Steering and Technical Boards and in those WGs that we previously identified as "relevant" for the Smart5Grid project. We then describe the progress made in terms of collaboration with those on-going phase 3 projects with which we identified some kind of synergy and where collaboration was foreseen as possible.

3.1. Participation in 5G PPP Steering / Technical board and WGs

3.1.1. Steering board

A total of 6 SB meetings have been held during the current year. In January, Smart5Grid had a short presentation to illustrate to all SB members the Consortium's efforts for SME engagement, inviting all project to participate to a survey.

In September, after the pandemic interruption, a physical meeting has been organized in Athens, giving the opportunity to discuss on cross WG topics. As 5G-PPP is going to finish and 6G-IA is already starting, a way to perform the handover of all the achievements should be identified. Within this changing perspective, Smart5Grid raised the question about the need for coordination among all WGs to decide on the future of NetApps, being the main subject of all ICT-41 projects. The SB appointed the TB to lead this coordination among the different WG involved.

3.1.2. Technical board

The work done inside the 5G-PPP Technical board has been extensive and crucial to the development and implementation of all the technologies related to 5G and the connected future extension on 6G as well as for the NetApp definition across all the different domains and solutions present in the board. Regarding the main contributions, ENG on behalf of Smart5Grid project, provided content in the 5G-PPP Technical board in the following documents:

- Contribution shared document representing the 5G-PPP ICT-41 Projects Key Achievements v3.2.
- Contribution to the cartography in 5G-PPP Projects KPIs Phase III.

These contributions increased the collaboration among the different projects presented in 5G-PPP ecosystem helping on framing commonalities and underlining differences so to have a coherent overview of the 5G network and software platforms.

Smart5Grid participated in the different activities both remotely but also in person: it also was present in the F2F Meeting of Technical board in Athens (October 2022).

Additionally, Smart5Grid participated in related activities in the board for increase the cooperation strictly correlated to the different ICT-41 projects so to create a common ground to represent the NetApp both from the technical point of view and from the business side. The main outcomes of this activity have to be summarized as a list of activities to be performed in the next months.

- Investigation and detail about the creation of the Network Software Operator stakeholder to be collocated between System Operator and NetApp developers so to speed up the adoption of the Network Apps in the 5G ecosystem.
- Coordination of ad hoc pre-standardization activities to be directly covered in the Pre-Standardization WG.
- Creation and maintenance of a shared spreadsheet on the 5G-PPP portal to present all the ICT-41 projects outcomes (developed codes, Network Apps, and information about Network Apps such as NetApp descriptors and similar).

3.1.3. 5GPPP WGs

Table 9 shows the Smart5Grid project participation in 5G-PPP projects/ 6G-IA WGs. Some updates have been made since the submission of deliverable D7.3, which are highlighted in bold in the table. In concrete:

- ATOS and ENG, initially representing the project in the Architecture WG and the Software Networks WG respectively, swapped their roles. As ATOS was *T2.2 ("Overall Architecture Design of Open Experimental 5G Platform and Network Apps Specifications")* leader during the first nine months of the project, when the architecture of the Smart5Grid platform was being designed, that designation made sense at that time. In the last months, however, the focus of the Software Networks WG has revolved around a common definition of the NetApp concept among ICT-41 projects. As ATOS was also responsible for leading the definition and technical specification of the Smart5Grid NetApp, it was decided by the consortium that ATOS was involved in the that WG activities as well.

- The Smart5Grid project started to follow a newly created 6G-IA WG, the Open Smart Networks and Services WG. The partner representing Smart5Grid in this WG is UBI.

AREA	WORKING GROUP	Smart5Grid REPRESENTATIVES
5G PPP	Steering Board	ENEL Daniele Porcu (daniele.porcu@enel.com) Project Coordinator
	Technology Board	ENG Giampaolo Fiorentino (giampaolo.fiorentino@eng.it) Technical Manager
	COMMS	8BELLS George Kontopoulos (george.kontopoulos@8bellsresearch.com) Communications Manager Deputy: Dimitrios Nodaros (dimitris.nodaros@8bellsresearch.com)
	5G / Beyond 5G Architecture	**ENG** **Antonello Corsi (**Antonello.Corsi@eng.it**)** **Deputy: Giampaolo Fiorentino (**giampaolo.fiorentino@eng.it**)**
	Software Networks (SDN/NFV)	**ATOS / ENG** **Paula Encinar (paula.encinar@atos.net)** **Deputy: Antonello Corsi (**Antonello.Corsi@eng.it**)**
	Test, Measurement and KPIs Validation (TMV)	WI3 Gianluca Rizzi (gianluca.rizzi@windtre.it) Deputy: Fabrizio Brasca (FabrizioGabrio.Brasca@windtre.it)

6G IA	**Open Smart Networks and Services**	**UBI** **Rita Santiago (rsantiago@ubiwhere.com)** **Deputy: Hélio Simeão (hsimeao@ubiwhere.com)**
	Trials	UCY Irina Ciornei (ciornei.irina@ucy.ac.cy) Deputy: Lenos Hadjidemetriou (hadjidemetriou.lenos@ucy.ac.cy)
	Vision and Societal Challenges	8BELLS George Kontopoulos (george.kontopoulos@8bellsresearch.com) Deputy: Dimitrios Nodaros (dimitris.nodaros@8bellsresearch.com)
	Security	UBE Anastasis Tzoumpas (atzoumpas@ubitech.eu) Deputy: Thanasis Bachoumis (abachoumis@ubitech.eu)
	Pre-Standardization	OTE Ioannis Chochliouros (ichochliouros@oteresearch.gr) Deputy: Michalis Rantopoulos (mrantopoul@cosmote.gr)
NetworldEurope	SME	INF / 8BELLS Nikolaos Vrionis (nvrionis@infolysis.gr) Deputies: Vaios Koumaras (vkoumaras@infolysis.gr) George Kontopoulos (george.kontopoulos@8bellsresearch.com) Dimitrios Nodaros (dimitris.nodaros@8bellsresearch.com)

Table 9: Smart5Grid project participation in 5G PPP / 6G IA WGs

In the section below, we describe the main activities of each of the WGs in which Smart5Grid project is actively participating as well as the main new contributions made by the project since D7.3 submission. Before that, we summarized all the previous contributions as reported in D7.3.

3.1.3.1. Summary of contributions to WGs made until December 2021

AREA	WORKING GROUP	Main contributions until December 2021
5G PPP	5G / Beyond 5G Architecture	• Participation in bi-weekly calls and meetings • Presentation about Smart5Grid project • Contribution to the 5G-PPP Architecture White Paper version 4.0 with Smart5Grid view on Network Apps as Vertical Applications. Issued in October 2021
	Software Networks (SDN/NFV)	• Participation in regular calls and meetings • Presentation about Smart5Grid project • Presentation on Smart5Grid Network Apps concept • Contribution to the "From VNF to API: Opening up 5G and beyond networks to verticals" White Paper version 4.0 with Smart5Grid view on Network Apps as Vertical Applications
	Test, Measurement and KPIs Validation (TMV)	• Participation in regular calls and meetings • Presentation about Smart5Grid project
	Trials	• Participation in regular calls and meetings • Presentation about Smart5grid project

6G IA		• Presentation of Smart5Grid project and its specific use-cases fully dedicated to the energy vertical (smart grids) at the bilateral webinar TSDSI-5G IA
	Vision and Societal Challenges	• Participation in regular calls and the production of a white paper focusing on 5G ecosystem business modeling
	Security	• Participation in regular calls
	Pre-Standardization	• Participation in regular calls and meetings • Presentation about Smart5Grid project
NetworldEurope	SME	• Participation in regular calls and meetings • Contributions related to the update of "Find Your SME" webpage • Update of vertical sectors of interest (Energy) • Contribution to SMEs brochure new release • Participation to position letter and discussions about the role of SMEs in HE and SNS calls

Table 10: Summary of contributions to 5G PPP / 6G IA WGs up to December 2022

3.1.3.2. New contributions (Year 2022)

3.1.3.2.1. COMMUNICATIONS GROUP

WG MAIN ACTIVITIES (IN THE LAST YEAR)

The Communications Group serves as a communications and dissemination related information exchange for all 5G-PPP projects. Participants on the WG's mailing list receive updates regarding all current 5G-PPP projects, as well as dissemination opportunities that might be of interest.

The WG also facilitates interactions about common presentation materials, brochures, flyers, webs, tweets, etc., as well as preparations for joint events to work efficiently between the persons responsible in the projects.

Representatives from the Smart5Grid project participate in the WG meetings, activities and mailing list to facilitate the communication and dissemination of the project.

3.1.3.2.2. ARCHITECTURE WG

WG MAIN ACTIVITIES (IN THE LAST YEAR)

The activity of the Architecture WG during last year revolved around the publication of a new newspaper, **"**6G Architecture Landscape – European perspective"[3], released in December 2022. The goal of this White Paper is to summarize the findings from the European research landscape on the first version of the 6G architecture. This includes the various technical enablers as well as the first End-to-End system and functional view of the 6G architecture structure. The document reflects the joint opinion of the latest generation of projects as listed for parts 4, 5 and 6 of phase 3 of the 5G PPP programme.

SMART5GRID CONTRIBUTIONS (IN THE LAST YEAR / FORESEEN)

ATOS and then ENG participated in the WG regular calls, scheduled every two weeks.

[3] https://5g-ppp.eu/6g-architecture-landscape-new-white-paper-for-public-consultation/

3.1.3.2.3. SOFTWARE NETWORKS WG

WG MAIN ACTIVITIES (IN THE LAST YEAR)

One of the main topics discussed in the context of the SN WG during the last year was, in synergy with the Architecture WG, to converge to a unified definition of NetApp also to open the possibility to provide standardization contributions. In this sense, the WG released in September 2022 the white paper "NetApp: Opening up 5G and beyond networks". The paper targeted to demystify the concept of the NetApps. Different implementations have been conducted by the different ICT-41 projects considering different API types and different level of trust between the verticals and the CSP. In this paper, the different approaches considered by the projects are summarized and categorized. Most of ICT-41 projects conveyed their views. In addition, the paper collected the view of some projects from ICT-52 & ICT-42.

SMART5GRID CONTRIBUTIONS (IN THE LAST YEAR / FORESEEN)

As routinary activities in the Software Network WG, both ENG and ATOS participated in regular calls and meetings and, when needed, introduced the main aspects of Smart5Grid, especially as regards the NetApp concept.

As mention in the previous section, Smart5Grid contributed to the the white paper "NetApp: Opening up 5G and beyond networks" released in September 2022.

Other activities engaged during 2022 were the following:

- In the context of the 2nd IEEE MeditCom Conference which was held in Athens on the 5th-8th September 2022, Smart5Grid project participated to the SN WG organized session titled 'NetApps into Beyond 5G and 6G Network'. During this workshop, ENG, had the opportunity to present the Smart5Grid main achievements of the first 20 Months of the project.
- ENG also coordinated the effort that brought to the peer review submission in the IoT-Magazine (edited by IEEE COMSOC) of a paper titled: "5G Energy NetApp" dedicated to all the projects in the ICT-41 and organized in the SN WG.

3.1.3.2.4. TEST, MEASUREMENT AND KPIS VALIDATION WG

WG MAIN ACTIVITIES (IN THE LAST YEAR)

Among the activities performed by this WG, we can highlight:

- KPIs Measurement Tools - From KPI definition to KPI validation" whitepaper.
- Workshop on 6G KPIs.
- Analysis of new or improvement of current tools for measuring 6G KPIs: Whitepaper Beyond 5G/6G KPIs and Target Values.

SMART5GRID CONTRIBUTIONS (IN THE LAST YEAR / FORESEEN)

WI3, on behalf of the Smart5Grid, is involved in the finalization of the 5G Tools whitepaper that will describe an overview of the tools used to measure 5G KPIs in 5G-PPP projects.

A testing scenario template (TST) has been created. This template contains the necessary information to measure KPIs (e.g., network configuration, UE capabilities, service characteristics, the environmental details in which the tests are executed, the metrics and KPIs to be collected and validated). Different KPIs (e.g., latency, availability, packet loss, etc.) and probes have been identified.

Tools identified to launch measures can be open source (e.g., ping), tools developed withing EU projects (e.g., 5GProbe) and proprietary tools (e.g., CyPerf).

Data collection platforms are necessary to collect and monitor the metrics, while visualization tools are required to visualize and analyze data.

It is important define a KPIs model applicable in Smart5Grid and in similar projects. It is important define a KPIs model applicable in Smart5Grid and in similar projects.

3.1.3.2.5. OPEN SMART NETWORKS AND SERVICES

WG MAIN ACTIVITIES (IN THE LAST YEAR)

The Open Smart Network and Services (SNS) WG was established in 2022. This WG promotes and supports the evaluation, adoption, deployment, and evolution of open solutions for 5G and beyond 5G/6G networks. One of the first tasks of the WG is to promote and support the evaluation, adoption, deployment, and evolution of open, disaggregated, intelligent and fully interoperable Radio Access Networks (RANs) as a "key technology" for future mobile networks (5G and beyond). For this, the WG is aiming to bridge the open initiatives in the industrial domain with the ongoing or planned R&D and standardization work (3GPP, O-RAN Alliance…), bringing together subject matter experts from the academy (university, research institutes, etc.) and industry (operators, vendors, SMEs, verticals, etc.), aiming to accelerate the development of a EU-wide open ecosystem of technologies that will include hardware equipment and software-defined, virtualized, and automated solutions. The group has the following objectives:

- Influence the definition of the technical work programme to evolve the maturity of open solutions.
- Support the continued development and dissemination of Open R&D projects with the aim of creating a dynamic and vibrant ecosystem of technologies, hence strengthening the European industry.
- Support the evaluation and the adoption of disaggregated solutions in legacy and future networks to enable a true multi-vendor environment.
- Engage with industry to understand and develop solutions for innovative use cases.
- Create bridges between the standardization (e.g., 3GPP, O-RAN Alliance), product test & validation activities (e.g., TIP) and the research projects.
- Promote a common understanding of standards and architectures and maturity status.
- Promote actions for the formation of a dynamic European Open ecosystem.
- Engage with European Security Framework to assure the Open based networks comply with the security standards defined by EU.

SMART5GRID CONTRIBUTIONS (IN THE LAST YEAR / FORESEEN)

Since this is a new WG, the work is still being established and organized. Therefore, through our participation in meetings our main goal so far was to further understanding what the goals and purposes of this WG are. In addition, we have presented the project and its existing outcomes.

3.1.3.2.6. TRIALS WG

WG MAIN ACTIVITIES (IN THE LAST YEAR)

The Trials WG of the 5G-PPP was established back in 2016 by the 5G Infrastructure Association after the publishing of the 5G Manifesto[4] of industry in Europe and in the context of the 5G Action Plan[5] of the European Commission. The WG aims to develop a 5G, 5G Advanced and 6G European Trial Roadmap and leverage on the knowledge gained for upcoming trial roadmaps for beyond 5G/6G systems in the context of the Smart Networks and Services partnership in Horizon Europe, to facilitate the involvement of verticals in the trials' roadmap, to discuss and define business principles underpinning the economic viability of trials or to increase the visibility of the trials and pilots carried out by 5G-PPP and SNS projects, with emphasis on 5G-PPP/Phase 3 and SNS/Phase 1 projects, among others.

The activities of the group are currently organized in four Streams, which may change yearly or the most often after 6 months, depending on the activities that are foreseen for the respective period. Those four streams are: (1) 5G Private Trials Observatory, led by Didier Bourse (Nokia) and Carole Manero (iDATE); (2) 5G and towards 6G Verticals, led by Valerio Frascolla (Intel); (3) 5G Trials Cities, led by Jyrki Huusko (VTT), and (4) 5G International Cooperation led by Baruch Altman (LiveU-TV).

The Trials WG organized regular plenary meetings (online only) on a quarterly basis. On those meetings, transversal activities from all four streams were discussed with reports from on-going projects and from the champions of the WG Strems. Relevant outcomes of those activities are:

- PPP Trials & Pilots Brochure n°4. Overall coordination in collaboration with 5G PPP TB, organization/ participation in evaluation panel (to be released by end of 2022).
- PPP Trials & Pilots Brochure n°5. Overall coordination in collaboration with 5G PPP TB, organization/ participation in evaluation panel (Dec. 2022 – the definition phase).
- White Paper 'Evolution of use cases and verticals towards 6G' due by the end of 2022.

It is to be noticed that those brochures include only use-cases from completed projects while on-going projects are yet not eligible to contribute.

SMART5GRID CONTRIBUTIONS (IN THE LAST YEAR / FORESEEN)

The Smat5Grid partner participating in the WG Trials is University of Cyprus (UCY). UCY actively participated in the quarterly transversal activity meetings, and it also delivered a presentation with the updates on the progress of the Smart5Grid activities in year 2. This presentation was a collaborative effort from several partners in the project, such as UCY, IPTO, OTE, NBC, EE, and ATOS. The presentation included a summary of the proposed Smart5Grid platform architecture, the Smart5Grid NetApp concept, its alignment, and complementary approach compared with the draft 3GPPP vision, as well as updates on preliminary 5G network testing results from the Smart5Grid pilots. Furthermore, Smart5Grid proposed contributions for one of the sections of the White Paper 'Evolution of use cases and verticals towards 6G' related to a possible use-case from the smart grids vertical for which 5G advanced and 6G KPIs might be needed. Specifically, the proposed contribution

[4] https://www.euractiv.com/wp-content/uploads/sites/2/2016/07/5G_Manifesto.pdf

[5] https://digital-strategy.ec.europa.eu/en/policies/5g-action-plan

refers to enhancement of UC4, wide area monitoring and control of smart grids with high integration of distributed highly variable renewable power generation (IPTO, OTE, UCY)

3.1.3.2.7. VISION AND SOCIETAL CHALLENGES WG

WG MAIN ACTIVITIES (IN THE LAST YEAR)

The Vision and Societal Challenges WG actually consists of five subgroups:

- The Smart Networks and Services Vision SG – SNSV SG is the technology group, most closely related to the discussion and selection of required technical topics, technologies, architecture, etc.
- The Business Validation, Models, and Ecosystem SG – BVME SG is trying to create and validate economic models and related ecosystems for 5G, 5G advanced, and, soon, 6G.
- The Portfolio Structuring and Analysis SG – PS&A SG essentially has the job to structure the portfolio of the research and to analyze to which extent the planned research results were achieved. However, PS&A is not doing it alone, but in consensus with other bodies, e.g., with the 6GIA Board and, through a liaison, with NetworldEurope European Technology Platform (ETP). For now, PS&A will mainly analyze the 5GPPP deliveries vs. the initial 5GPPP planning.
- The Societal Needs and Value Creation SG – SNVC SG is the group trying to identify societal value of the upcoming 6G, independently of its realization later.
- The Member State Initiatives in 5G/6G SG – MSI SG is focusing on identifying and reporting on 5G/6G related initiatives in the different member countries.

SMART5GRID CONTRIBUTIONS (IN THE LAST YEAR / FORESEEN)

8BELLS, on behalf of the Smart5Grid project, participates in the Business Validation, Models, and Ecosystem SG activities, evaluating opportunities for contribution while also screening the WG suggested business modeling approach for use in the project's business planning activity.

The SG meets biweekly. The meetings of the reporting period mainly focused on the production of a white paper in 5G Ecosystem business modelling. More specifically, the white paper suggests ways to approach business modelling in the context of 5G and beyond ecosystems, since a business ecosystem has a higher volume of interdependent actor roles, actors, and new types of business relationships. Identifying and designing sustainable business models in such a busy and complex environment is a challenge, subsequently the white paper suggests a stepped approach on how to carry out business modelling, catering to the perspectives of all stakeholders. In Smart5Grid business modeling, we adopt the ecosystem view of the value chain, and we expect to contribute the project approach in the white paper.

3.1.3.2.8. SECURITY WG

WG MAIN ACTIVITIES (IN THE LAST YEAR)

This WG was officially launched on 5/4/2016 and results from an initiative created by a Phase 1 Security Project (5G-ENSURE). Since its creation this Working Group has been the place where the 5G Security topics and vision were discussed and also progressed. By the end of Year 2017 and per decision of the 5G Industry Association Board this WG was moved to 6G-IA (at the time 5G IA). As such this WG is not only open to Projects from any of the phases of 5G-PPP but also to 6G-IA members interested in joining. The purpose of the group is to foster development of the 5G Security Community made of 5G security experts and practitioners who pro-actively discuss and share information to collectively progress and align on the field. This while organizing specific

communications/events (e.g. white papers, workshops), interacting with other WGs whenever Security input is needed and developing liaisons with other interested/interesting Security communities.
During the last year, the Security WG mainly focused on the contribution to the Strategic Research and Innovation Agenda on 6G as well as to the development of 4 short white papers (SWPs). The 4 papers are the following:

- SWP1 "Access Control Mechanisms to Verticals"
- SWP2 "SDN/NFV virtualization, 5G Slicing and Security Considerations"
- SWP3 "5G Attack Referential"
- SWP4 "Vertical security needs"

SMART5GRID CONTRIBUTIONS (IN THE LAST YEAR / FORESEEN)

Smart5Grid has participated in the WG online meetings and provided feedback during the discussions. A Smart5Grid presentation has been scheduled in order to inform the partners about the project objectives and results. In addition, Smart5Grid plans to contribute to SWP4 "Vertical security needs" by proposing an Energy Vertical dimension on the current analysis. The main challenges that are being addressed in SWP4 are the following:

- Creating on demand security models.
- Creating assurance schemes to reduce the overall complexity of 5G ecosystem and integrating liability or risk management while being compatible with the EU Cybersecurity Act.
- Ensuring Security Service Levels with sufficient granularity sufficient to capture the heterogeneous needs of the verticals. We have mainly based this granularity on three levels of criticality.
- Investigating liability-aware security management.

Last but not least, Smart5Grid will follow-up that developments related to the other 3 SWPs, which are not at the same maturity level as SWP4 but are expected to be further elaborated during the first quarter of 2023.

3.1.3.2.9. SME WG

WG MAIN ACTIVITIES (IN THE LAST YEAR)

Below are summarized the core SME WG activites for the period 1/2022-11/2022:

- SME WG virtual meeting (23rd May 2022). Welcoming new members and setting up the strategy for the next months, SNS and 6G-IA programs details and the role of SMEs in them.
- New version of SMEs brochure and update of the Find your SME webpage by October 14
- The latest SME WG General Assembly meeting took place online on 27 September 2022. Attended by INF on behalf of Smart5Grid. Topics discussed: SNS phase 1 call feedback and Q&A, the WiTaR INITIATIVE (Women in Telecommunications and Research) The new update of the SME web page or brochure.

SMART5GRID CONTRIBUTIONS (IN THE LAST YEAR / FORESEEN)

During the reporting period, Smart5Grid members of SME WG, and INF in particular as the main representative, have made the following contributions. Please note that most SME WG activities are members oriented (for promoting SME members) and not mainly project oriented, as it happens in other 5G-PPP WGs. Recursive annual activities are performed during each year for the provision of updated versions of core SME WG communication material such as website, brochure and

upcoming EC calls details (in favour of SMEs). Through these contributions and material aspects of the projects are communicated too.
Vertical sectors of interest were updated during 2022 and the Energy sector was maintained, as the main sector of activity for specific SMEs and running projects, both at the FInd your SME webpage and in the SME brochure (2022 version, still under final editing)

INF contributions related to the update of "Find Your SME" webpage (2022 edition) https://www.networldeurope.eu/find-the-sme-you-need-new-page/

Contributions made to SMEs brochure (new release 2022) where the profile of several SMEs has been updated and new SME members added representing new projects

Contributions to the SME WG consultation rounds towards 6G-IA/SNS for the role and participation of SMEs in the upcoming SNS cluster calls (phase 1 and upcoming phase 2 for 2023)

Sharing to the SME WG mailing list and rest SME member several Smart5Grid events and activities such as: Join Smart5Grid Community registration form, Smart5Grid Survey on 5G NetApp experimentation facility, CfP for the Smart5Grid "5G Use Cases for the Energy Vertical" webinar.

3.1.3.2.10. PRE-STANDARDIZATION WG

WG MAIN ACTIVITIES (IN THE LAST YEAR)

The role of standardization in creating marketable products and solutions throughout R&I projects is of particular importance[6]. Similarly to research data management, included in the H2020 programme guidelines, effective valorization through standards requires strategic thinking on standardization, including sufficient resources to "address" the specific needs during the lifetime of R&I projects. There need to be close "ties" between projects and the appropriate technical committees that develop standards. Awareness of the benefits of standardization is an equally important prerequisite for the successful involvement of research generators in standardization activities. It proves to be important to plan standardization activities and to identify the standardization needs during the course of a project effort[7].
Operating in this framework[8], the 5G-PPP has a very pro-active relationship with standards development and provides many mechanisms to help vertical stakeholders participate in various ways, in the corresponding process. The 5G-PPP will deliver solutions, architectures, technologies, and standards for ubiquitous Next Generation (NG) communication infrastructure over the coming decades. The Pre-Standardization Working Group has been established as one among the essential 5G-PPP WGs, for the support of standardization-related activities, within the broader scope of the 5G-oriented EU-funded research across the three funding phases and it is extending its activities also in the 6G Smart Networks and Services Industry Association[9] (6G-IA) context.
Following to its explicit foundation rules, the main activities of the Pre-Standardization WG have been about:

- Identifying standardization and regulatory bodies to align with, such as for example ETSI[10], 3GPP[11], IEEE[12] and other relevant standards bodies & ITU-R[13] (including WPs) and WRC[14] (including, for example, ECC PT1[15]).
- Tracking inputs to standards organizations coming from the progress of the ongoing 5G-PPP projects and also by using inputs coming from those projects[16].
- Encouraging and enabling projects to showcase results during the monthly calls as part of the drive to collect success stories and support impact reporting.

- Developing a roadmap of relevant standardization and regulatory topics for 5G[17] and also; evaluating existing roadmaps at international level and proposing its own roadmap for 5G being aligned at international level[18],[19].
- Influencing pre-standardisation on 5G and related R&D and potentially propose where topics should be standardised.
- Influencing timing on R&D work programs (e.g. EC WPs).
- Strengthening the collaboration with ETSI, its Roadmap Technical Report and mapping of EU research in terms of relevant ETSI activities to encourage interactions and inputs.
- Continuing close collaboration with 3GPP on the 5G User Event series: two-part edge computing webinars (industry vertical perspectives and ETSI MEC[20]; 3GPP SA2[21] and SA6[22]); Vertical Industry Requirements for RAN Release 18; AI in 5G and upcoming 6G networks.
- Liaising with ETSI, 3GPP specialists to keep the WG members up to speed on standardization work, also including StandICT.eu[23] on the EU ICT standards landscape.
- Finalizing the B5G/6G Standards Roadmap with a view to supporting inputs during the SNS lifecycle and liaison on the forthcoming SNS JU.
- Identifying gaps to be targeted in future EU-funding programmes.
- Fostering the development of globally harmonised standards.
- Tracking progress towards EU priority topics as defined by the EC[24].
- Collaborating with other 5G-PPP WGs and Task Forces as required.

This WG is also working on a Standardization Roadmap supporting B5G/6G under the SNS programme[25]. The core aim of this interactive effort is to recognize the potential to impact standardization from the expected *timeline*, *phases*, and *key areas of work* for B5G (Beyond 5G) and 6G research towards 2030, within the scope of innovative solutions promoted by the various SNS initiatives. In particular, the SNS JU intends to foster Europe's technology sovereignty in 6G by implementing the related research and innovation (R&I) programme leading to the conception and standardisation around 2025. This WG encourages preparation for early market adoption of 6G technologies by the end of the decade. Mobilising a broad set of stakeholders is "key" to address strategic areas of the networks and services value chain[26]. The idea is to collect feedback and help consolidating a B5G and 6G research with standardization potential roadmap; such a roadmap is expected to support activities related to the wider EU research ecosystem with the final aim of maximising impact on standardisation and promoting beneficial solutions, applicable to the market sectors (especially in verticals).

The Pre-Standardization WG has also contributed to the completion of the EC Report on a "Scoping Study for Supporting the development of a Code of Practice for Researchers on Standardisation"[27], about defining a strategy on collecting education needs and actions to help researchers in the context of B5G and 6G.

The 5G-PPP Initiative has provided several scientific solutions that have been contributed to standardization activities and the global academic and research community through publications. More importantly, solutions that emerged through 5G-PPP projects have been integrated into final products. In addition, the 5GPP projects have been driving test and validation activities in Europe, collecting significant experience for all stakeholders, and raising public awareness on the capabilities of 5G networks.

The 5G-PPP is working on several fronts to support the 5G standardisation process whereas the 5G IA's Pre-Standardization WG supports projects in defining and driving their inputs in relation to standardization activities. This WG reports on impact on standardization across the various phases of the 5G-PPP Initiative[28], on an annual basis.
The importance of EU funded projects to build a world-wide consensus in a pre-standardization level, the visionary specification of futuristic use cases and the raising of public awareness about the capabilities of 5G networks is undeniable. The 5G Infrastructure PPP Initiative and 5G IA achieved significant progress and impact during the current year.
5G-PPP is an active contributor to 5G standardization globally. Twenty-two projects (all Phase 3, except the SLICENET project) have contributed to two rounds of inputs in Q4-2020 and Q2-2021. In this activity over 230 contributions to Standards Developing Organisations have been tracked. Overall, the 5G-IA Pre-Standardization WG has tracked 237 inputs based on specific and tangible inputs (e.g. technical reports, study/work item, PoC, new commercial requirements) as opposed to broader inputs collected in previous years. Most inputs have been submitted to 3GPP (96), IETF[29] (50) and ETSI (38), with a growing number of inputs to IEEE, and inputs to sector associations working groups for like 5GAA[30] and 5G-ACIA[31].

The strengthened collaboration with ETSI enables the Pre-Standardization WG to give its members practical guidance on transferring their results through standardization. The collaboration is also an opportunity to highlight relevant ETSI activities members can join and potentially lead, such as forming an Industry Specification Group (ISG) for B5G/6G. One example is Reconfigurable Intelligent Surfaces (RIS ISG) as a cross-industry initiative. Regarding the ETSI Technology Radar, members have selected their priority enablers for analysis. Among other relevant resources, the Radar will continue to play a key role as a reference document for B5G/6G technology trends and related standardization.

The 5G User Event series has enabled the WG and Market Representation Partners[32] (MRPs) to impart new knowledge on ETSI MEC, 3GPP SA2 and SA6, industry vertical perspective, acting as a forum for educating multi-stakeholders on edge computing. Insights into related standardization work also highlighted an important gap in the EC ICT Standardization Rolling Plan 2021 on edge computing. The workshop on RAN Release 18[33] brought together not only the subset of MRPs, namely 5GAA, 5G-ACIA, 5G-MAG[34], PSCE[35], but also EUTC[36] (energy), IALA[37] (maritime), TCCA[38] (critical communications), UIC[39] (rail), ESOA[40] (non-terrestrial networks), as well as Novamint[41] (French SME), which has supported several verticals in 3GPP, and 5G-SOLUTIONS[42]. Close interactions took place with a WG member RAN specialist who gave a detailed report on the 3GPP RAN Release workshop two weeks later, including coverage of topics of interest to verticals. The webinar on AI in 5G and upcoming 6G networks was a first investigation into the evolving role of artificial intelligence with insights from Digital Catapult[43], NetworldEurope[44], Nokia (3GPP) and Siemens (industry vision and connections to the AI, Data and Robotics Partnership[45]). This also picked up on an invited talk on AI standardization from a standards specialist (NEC Labs Europe and expert in StandICT.eu) in reference to the proposed EC legislation by polling registrants on their familiarity with said legislation, machine and deep learning.

To "drive" inputs as close to the market as possible, input tracking has focused on tangible inputs to working and study groups, including study and work items, gap analyses, PoCs, technical reports and technical specifications rather than on meetings and presentations, which were counted at the beginning of Phase 1. Inputs that are being normalized are also tracked. This approach helps the EC understand where EU leadership in standardization is coming from while bearing in mind the focus

and project lifecycles, especially for the Phase 3 projects with their diverse timelines. The figure below shows the overall inputs collected[46].

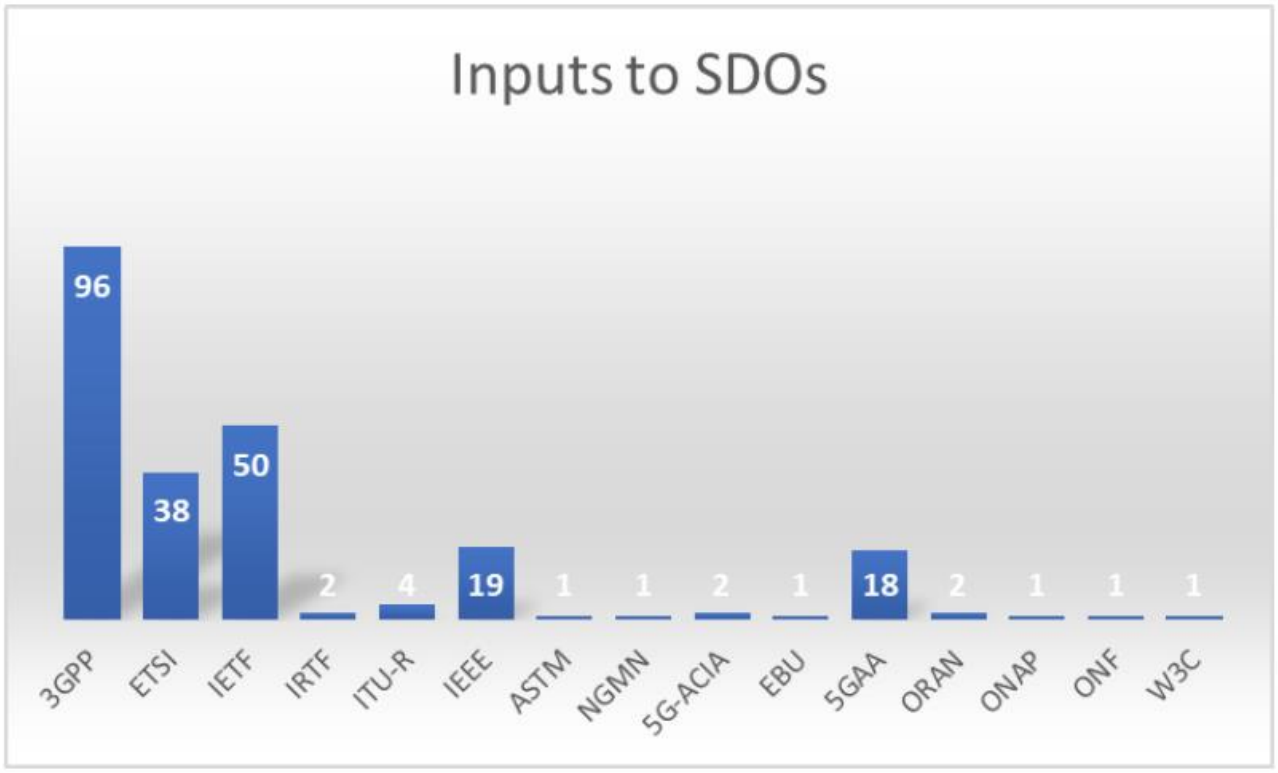


Figure 38: Inputs to SDOs (according to the 5G-PPP Progress Monitoring Report 2021)

The WG and the MRP activities are highly complementary in showcasing EU excellence in 5G standardization in a global context. Overall, the 5G-IA Pre-Standardization WG has tracked the following inputs to standardization organizations. Most inputs have been submitted to 3GPP (96 inputs), IETF (50 inputs) and ETSI (38 inputs), with increasing inputs to IEEE (19 inputs) and inputs to sector associations like 5GAA (18 inputs).

As of 2022, contributions have been provided to 3GPP SA2 and to 3GPP SA6, to 3GPP RAN[47] and in particular to 3GPP RAN3[48], to 3GPP CT1[49], to ETSI RIS[50] and to ETSI ENI[51], to O-RAN[52], to ITU, to ISO[53] and to NGMN[54] (see Figure xx, below).

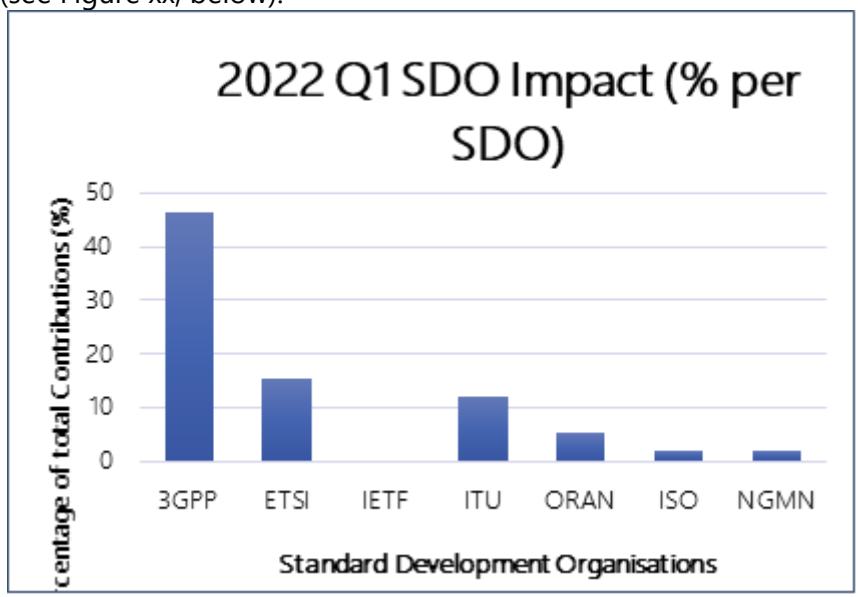


Figure 39: Inputs to SDOs by 2022 Q1

3GPP, ETSI and ITU have been the "privileged" targets. 3GPP is the main global standards organisation for mobile communications, focusing on the design of the 5G system and supporting a variety of industry verticals. Note that 50% of the work carried out focuses on 5G functionalities applicable across diverse verticals. The 3GPP work programme covers a multitude of enablers as part of a toolbox of functionalities that verticals can use to create their own services[55]. Contributions in various 3GPP TSGs (as of Q1 of 2022) are as illustrated in the following figure.

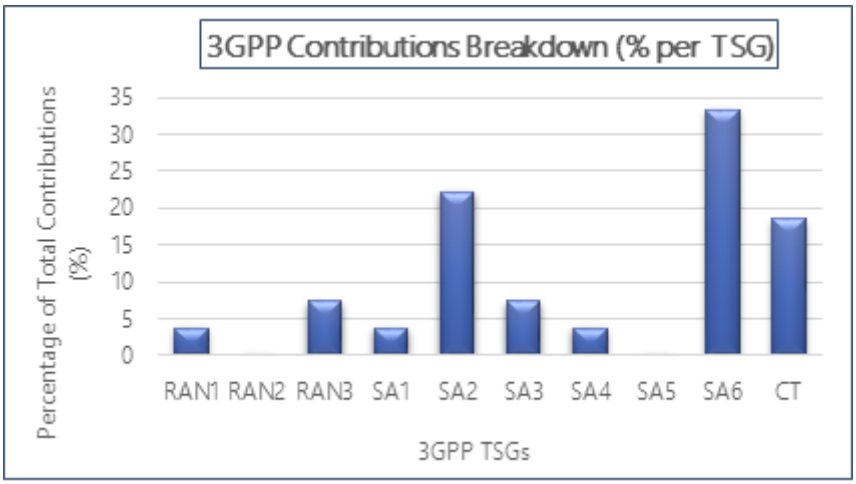


Figure 40: 3GPP Contributions Breakdown (% per TSG) by 2022 Q1

In the scope of their mutual collaboration, the 6G-IA Pre-Standardization WG and ETSI have joined forces at EuCNC 2022 for a special session entitled "Research Results Impacting B5G and 6G through Standardization" on Thursday, 9 June 2022[56]. The session aimed at guiding researchers on why, how and when to best approach standardization to take their research results towards industry adoption and onto global developments.

Contributions in various ETSI ISGs (as of Q1 of 2022) are as illustrated in the next figure.

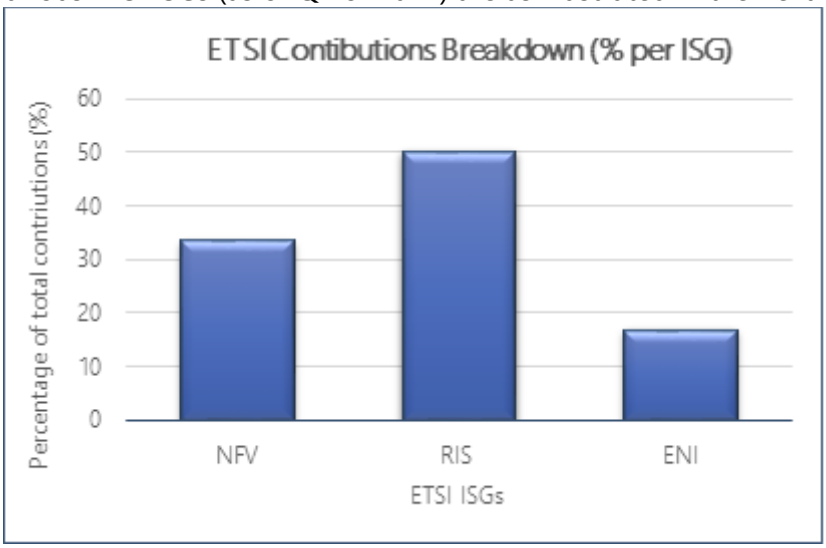


Figure 41: ETSI Contributions Breakdown (% per ISG) by 2022 Q1

The Pre-Standardization WG has also performed weekly calls to define a strategy and a plan for 2022, in view of the upcoming 3GPP Rel-19[57] (5G Advanced). There were also contributions to the 3GPP Rel-17[58] (RAN; SA) and Rel-18[59] (RAN).

SMART5GRID CONTRIBUTIONS (SO FAR / FORESEEN)

OTE, as representative of the Smart5Grid project, has attended most of the scheduled activities of the Pre-Standardization WG, organised on a monthly basis. In this scope, OTE had the opportunity to monitor the wider scope of this WG, to actively participate to the related discussions as well as to inform the other participants about the intended aims/objectives of the Smart5Grid project. OTE has also contributed to the ETSI Technology Radar[60] enabling technologies and use cases organised by the Pre-Standardization WG and has provided corresponding feedback.

Following to the completion of the 2nd Review Meeting of the Smart5Grid project, OTE has prepared a Smart5Grid presentation covering all recent progress of the project, especially emphasizing on the use cases and the corresponding Network Apps. Based on the expected progress of the Smart5Grid trials covering all use cases, it shall be expected that more "concrete" project results are to be presented in the Pre-Standardization WG during the third year of the project effort.

3.2. Collaboration with other 5GPPP projects

Table 11 reports those 5G PPP Phase 3 projects with which Smart5Grid identified some synergies and where we foresee that some potential collaboration may be possible. That table has been updated with respect to the table included in D7.3 after a deeper analysis during the last year.

PROJECT	PHASE	PARTNERS INVOLVED	Partners foreseen some collaboration
5G-INDUCE	5G PPP Phase 3, Part 6: 5G innovations for verticals with third party services & Smart Connectivity beyond 5G. H2020-ICT-41-2020: 5G innovations for verticals with third party services	WI3 8BELLS OTE UBE	WI3
EVOLVED-5G		ATOS INFOLYSIS 8BELLS	ATOS INFOLYSIS 8BELLS
VITAL5G		OTE	OTE
DAEMON	5G PPP Phase 3, Part 6: 5G innovations for verticals with third party services & Smart Connectivity beyond 5G. H2020-ICT-52-2020: 5G-PPP Smart Connectivity beyond 5G	OTE	OTE
MARSAL		OTE	OTE
5G ROUTES	5G PPP Phase 3, Part 5: 5G Core Technologies innovation and 5G for Connected and Automated Mobility (CAM) ICT-53-2020 call: 5G-PPP 5G for Connected and Automated Mobility	ATOS	ATOS
LOCUS	5G PPP Phase 3, Part 4: 5G Long Term Evolution 5G-PPP ICT-20-2019	OTE	OTE
MonB5G		OTE	OTE
5GTOURS	5G PPP Phase 3, Part 3: Advanced 5G validation trials across multiple vertical industries	ATOS OTE	ATOS OTE

5GHEART	5G-PPP ICT-19-2019	OTE	OTE
5GENESIS	5G PPP Phase 3, Part 1: Infrastructure Projects 5G-PPP ICT-17-2018	ATOS INFOLYSIS ATH	ATOS INFOLYSIS

Table 11: Smart5Grid collaboration with other 5G PPP projects

In the following sections, we summarize the synergies found and report on the progress of such collaboration project by project.

3.2.1. 5G-INDUCE

The prime goal of the 5G-INDUCE project is to develop an end-to-end service orchestration platform over enabling 5G experimentation infrastructures (with specific target in the Industry 4.0 vertical sector) able to provide the essential mechanisms for the on-boarding of advanced 5G Network Apps and the efficient management of the infrastructure resources, independently of the underlay network orchestration layer. The aim is to provide the enabling interfacing layer between the vertical sector end-users and the infrastructure owner to select, deploy and also extend their 5G applications with the appropriate networking features that comply with the application requirements, in terms of physical network constraints (such as bandwidth and latency), as well as functional constraints (such as locality, resiliency, security). Moreover, the 5G-INDUCE platform enables Network App developers to have a common interface for the porting of Network Apps, either as complete services (in the form of linked application components) or individual extension components to existing services.

The project builds upon the MATILDA[6] orchestration platform[7],[8] that has been further evolved to cope with dynamics and life cycle management. The platform's unique features provide the capability to the NetApp developers to define and modify the application requirements, while the underlay intelligent Operation Support System (OSS) can expose the network capabilities to the end-users on the application level without revealing any infrastructure related information. This process enables an application-oriented network management and optimization approach that is in line with the operator's role as manager of its own facilities, while it offers the development framework environment to any developer and service provider through which tailor-made applications can be designed and deployed, for the benefit of vertical industries and without any indirect dependency through a cloud provider. A DevOps testbed has been implemented that allows for testing of Network Apps before deployment at the experimentation facilities. The mobile network infrastructure at the three experimental facilities has been set up in its major part and test can start in the remaining period of the project.

WI3 participates to both projects and collaborative works will take place. Some sort of synergies could be the joint dissemination activities either in the internal WI3's corporate framework or in

[6] MATILDA (" A Holistic, Innovative Framework for the Design, Development and Orchestration of 5G-ready Applications and Network Services over Sliced Programmable Infrastructure") project, Grant Agreement No.761898, https://www.matilda-5g.eu/

[7] MATILDA project: Deliverable D3.1, "Intelligenece Orchestration Meechanims – First Release", August 2018.

[8] MATILDA project: Deliverable D3.2, "Intelligenece Orchestration Meechanims", May 2019. Available at: https://www.matilda-5g.eu/index.php/outcomes

international events. Interactivity and exchange of knowledge gained, within a wider 5G framework can also be promoted.

OTE is also a partner in the 5G-INDUCE effort and has strongly been involved in the description and evaluation of the proposed use cases, focusing on respective market applicability for exploitable benefits provided via the 5G implementation.

3.2.1.1. Current status

5G-INDUCE targets the development of an open, ETSI NFV compatible, 5G orchestration platform for the deployment of advanced 5G Network Apps. The In order to achieve the targeted development goals and also demonstrate successfully the functionality of the 5G-INDUCE platform solution through a number of use cases and over real industrial experimentation facilities, several actions took place during the first reporting period (RP1) of the project effort.

The main achievements of the project effort following to the "conclusion" of RP1 are as following:

(i) Implementation of a Network Application Orchestration (NAO) platform based on the MATILDA project platform with microservice enhancements[9].
(ii) Implementation of an OSS based on the MATILDA project platform[10] making it more modular and providing a convergence layer for different virtualisation techniques and varieties of programmability, including microservice support, NFVCL (NFV Convergence Layer), Metal Convergence Layer (MetalCL) developments but also slice intent support.
(iii) Extension of the platform for life cycle management with DevOps to support dynamic onboarding and for geo-scaling to support mobility of stateless components between edge clouds[11].
(iv) Monitoring and API enhancements.
(v) Set-up of 5G SA & NSA networks at three experimentation facilities.
(vi) Definition of 8 use cases[12] and derivation of related 5G KPIs.
(vii) Development of Network Apps for respective use cases.

The project focuses on the Industry 4.0 vertical sector[13], as one of the fastest growing and most impactful sectors in European economy with high potentials for application software development SMEs and with the capability to tackle all diverse cases of service requirements[14]. The project platform is integrated over three (3) 5G Experimentation Facilities in Spain, Greece, and Italy, while including links towards actual industrial sectors, for the showcasing of Network Apps in a real 5G environment. This further enhances bot benefits and validity of the project as works are correlated to real market

[9] 5G-INDUCE project: Deliverable 2.1: "5G platform design and requirements in support of Industrial sector Network Apps", April 2022. Available at: https://www.5g-induce.eu/index.php/outcomes/
[10] Ibid.
[11] Ibid.
[12] 5G-INDUCE project: Deliverable 2.2: "Targeted use cases and Network App related requirements", April 2022. Available at: https://www.5g-induce.eu/index.php/outcomes/
[13] Ibid.
[14] 5G-INDUCE project: Deliverable 2.3: "5G technology and strategic investment sectors in Industry 4.0", July 2022. Available at: https://www.5g-induce.eu/index.php/outcomes/

implementation via the dedicated test-beds and refer to real scenarios so fuse with immediate potential impact to the market.

OTE shares the view that success of 5G technologies depends closely on their ability to "attract" vertical stakeholders, seeking the move of their services from cloud to the edge, to meet unique KPIs. In this scope, the 5G-INDUCE project is based on the belief that such attractiveness requires vertical stakeholders and NetApp developers to be able to smoothly deploy and manage applications in distributed 5G network environments, in a secure fashion and with strict KPI requirements. The successful implementation of this vision constitutes the main objective of 5G-INDUCE and this creates opportunities for all involved actors in order to promote their presence in new market sectors. Via the intended use of 5G and the proposed Network Apps deployment, OTE will have the opportunity to extend its market portfolio in the Industry 4.0 vertical sector. OTE will further assess the proposed use cases as for their intended applicability in the 5G market and will try to find "similarities" with other research and business activities, especially those originating from projects coming from the same ICT-41 Call. Integration of the 5G-INDUCE platform over the experimentation facilities based on the deployed 5G infrastructures provides incentives for further collaborative work between 5G-INDUCE and Smart5Grid in particular. OTE aims to "assess" progress in both frameworks under a "joint" scope, among others.

In addition, both projects have deployed interactive collaboration in common dissemination activities such as the Infocom World 2022 Conference and Exhibition where, under OTE's coordination, Smart5Grid and 5G-INDUCE have each one organised dedicated thematic sessions and have presented their proposed architectures and their corresponding Network Apps.

3.2.2. EVOLVED-5G

3.2.2.1. Analysis of synergies and Potential collaboration identified in D7.3

As Smart5Grid, EVOLVED-5G is an *H2020-ICT-41-2020 "5G innovations for verticals with third party services"* project. Although in different fields (Energy, in the case of Smart5Grid; Industry 4.0, in the case of EVOLVED-5G), both projects share similar goals, such us:

1. Development of Network Apps.
2. Delivery of a 5G experimentation platform for the validation and verification of Network Apps.
3. Community building and engagement for SMEs and third-party experimentation.

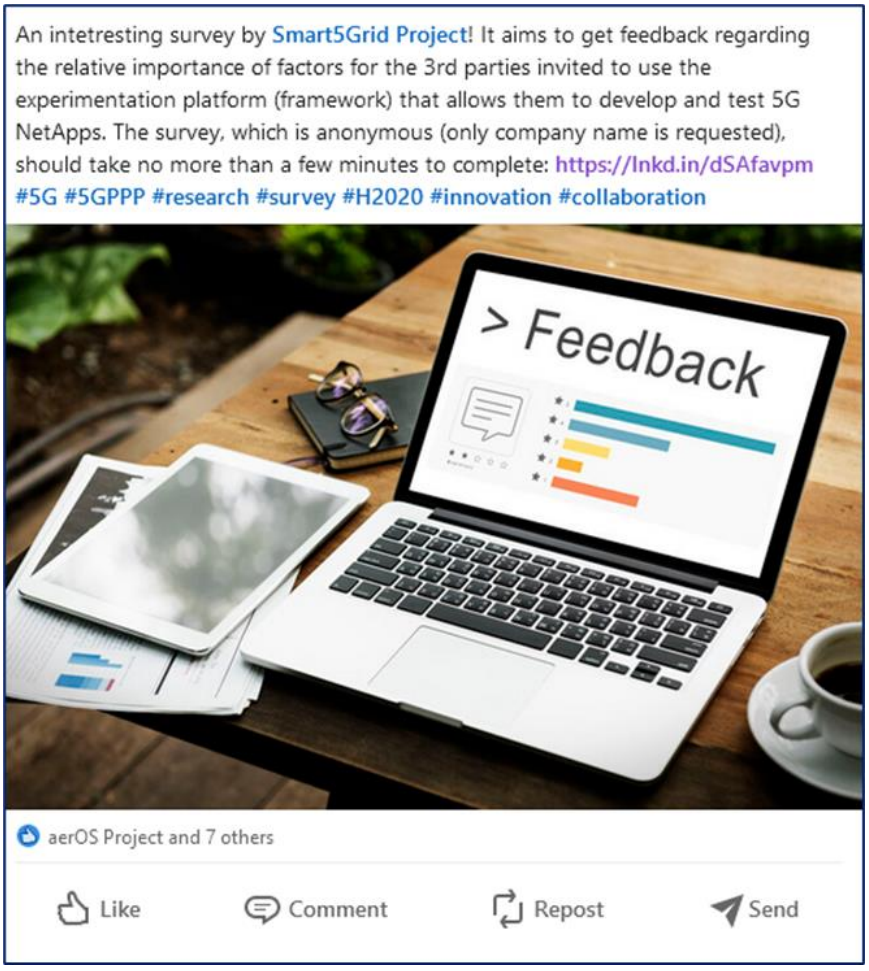
Therefore, collaboration in both technical and dissemination / engagement aspects might be feasible.

3.2.2.2. Current status

Thanks to the participation of common partners in both projects (ATOS, INFOLYSIS, 8BELLS), the progress of the project is being constantly monitored in order to identify synergies and potential collaboration. Technical aspects such us the definition and specification of the EVOLVED-5G Network Apps, the architecture defined, its verification and validation framework, etc. have been thoroughly analyzed. Technical conversations are currently taking part in the context of the ICT-41 Call projects Task Force. More information about this Task Force will be provider later in this document.

Collaboration on actions related to community building, training, and involvement of SMEs and third parties has progressed a little bit further. INF, as communication leader in both projects, tries to ensure that he common organization of such actions take place. In March 2022, Smart5Grid project was invited to participate as speaker in a Training Workshop organized by EVOLVED-5G in collaboration with the Computer Science department of Athens Metropolitan College. The workshop was entitled "5G Networks Programmability" and Smart5Grid project and its approach towards Network Apps was presented. EVOLVED-5G project was also invited to 8Bells "1st Open Annual Workshop on Future ICT" organized on 25th of May 2022. Furthermore, project coordinators and technical managers have met in 5G-PPP SB and TB face to face meetings in Athens, in October 2022. Also, in late November's online 5G-PPP Steering Board the involved partners of the meetings will have the chance to examine the common participation of all ICT-41 projects in the upcoming EuCNC & 6G Summit in June 2023.

The collaboration is multi-level as these projects are collaborating for promoting each other's activities through social media channels. For instance, EVOLVED-5G project has communicated our survey for the 3rd parties invited to use the Smart5Grid experimentation platform in EVOLVED-5G Twitter and LinkedIn channels.



On the other hand, we, as a project, promoted through our Twitter and LinkedIn channels, the EVOLVED-5G Accelerator Program Info Day. At this, point is needless to highlight the mentions and

the tags being used in social media in order to improve the visibility, interaction and boost the impact of both projects.

Last but not least, these two projects, have participated in IEEE MeditCom that took place on September 5th – 8th. This was a physical event where a hybrid joint Workshop titled 'Network Apps into Beyond 5G and 6G Network'. took place. During this workshop, Antonello Corsi and Giampaolo Fiorentino from ENG, had the opportunity to present the Smart5Grid main achievements of the first 20 months of the project. In more detail, they illustrated the Network Application definition, descriptor, the Smart5Grid platform and presented Use Case 3. This workshop was co-organised from 9 ICT-41 Projects. Apart from Smart5Grid and EVOLVED-5G, 5GERA, 5GASP, 5GMEDIAHUB, 5GINDUCE , VITAL5G and 5GEPICENTRE participated. The aim was to bring together all the Network Applications stakeholders, discuss their experiences so far and pave the way for Network Applications into 6G to span all domains RAN/CORE/Transport/Devices/Applications. The official invitation to our project was made by EVOLVED-5G's technical manager Dr. Harilaos Koumaras.

3.2.3. VITAL5G

3.2.3.1. Analysis of synergies and Potential collaboration identified in D7.3

One of the main challenges in the 5G context is the shortening the idea-to-market process through the creation of a European testbed for Small- and Medium-sized Enterprises (SMEs) that is fully automated and self-serviced, for rapid development and testing of new and innovative Network Applications.

VITAL-5G project's[15] main aim is about designing and implementing a flexible platform that can host 5G-enabled Network Apps[16] which will optimize the performance of the Transport & Logistics (T&L) vertical ecosystem[17]. In order to demonstrate how such Network Apps could help different T&L vertical sectors, VITAL-5G provides with an available repository of Network Apps that will be

[15] VITAL-5G ("Vertical Innovations in Transport And Logistics over 5G experimentation facilities") project, Grant Agreement No.101016567, https://www.vital5g.eu/

[16] The selected Network Apps to be developed within VITAL-5G are a representative set of Network Apps that address specific industry challenges existing in the T&L sector. Related use cases are about: (i) automated vessel transport; (ii) 5G connectivity and data-enabled assisted navigation using IoT sensing and video cameras; (iii) automation and remote operation of freight logistics; (iv) remote technical monitoring and predictive maintenance.

[17] The strategic objective of VITAL-5G is to create an open, virtualized and flexible experimentation facility comprised of an intelligent virtual platform, three distributed European 5G-testbeds (Antwerp, Athens and Galati (Danube)) and associated vertical infrastructure, to enable the testing and validation of Network Applications for Transport and Logistics (T&L) services in real-life conditions utilizing 5G connectivity. To that end, VITAL-5G engages significant logistics stakeholders (Sea/River port authorities, road logistics operators, warehouse/hub logistic operators), Mobile Network Operators (MNOs), as well as innovative SME experimenters, thus prioritizing a multi-modal focus and addressing challenges of the entire 5G-enabled T&L ecosystem.

deployed and tested in three different use cases[18]. In such an open format collaboration, multiple Network Apps[19] will be developed, reused, enhanced and validated owed to the complementary facilities offered by VITAL-5G infrastructure. The goal of these Network Apps is to address the T&L sector challenges, by offering extra functionalities, as described in the corresponding use case analysis. Additionally, the implemented Network Apps will inspire and help 3rd party experimenters (i.e., NetApp developers and vertical experimenters) to design and test their own Network Apps or vertical services, either by demonstrating certain functionalities or directly making them publicly available for their use and experimentation. It is considered that each VITAL-5G facility has its own technology implementation (RAN, Core, Virtualization, Security) in terms of 5G infrastructure and network implementation, monitoring tools and related service KPIs. Network Apps also extend the current standards to enable the definition of their requirements in terms of 5G slices and 5G Core services

The VITAL-5G project is addressing specific R&D innovations and enhancements to Intent-Based APIs for Network Apps, that is: translation of high-level Transport and Logistics (T&L) - oriented intents into 5G network components/VNF and NetApp deployments and configurations. It also provides the functionality extensions to the intent-based APIs in order to accommodate more complex multi-vertical environment of the corresponding trials. The combination of innovative 5G testbeds with vertical specialised facilities and infrastructure through an open service validation platform can so create an exceptional opportunity for third parties (such as SMEs) to reuse the VITAL-5G Network Apps as well as to validate their T&L-related solutions and services, by utilising real-life resources and facilities otherwise unavailable to them, with a view to driving new SME revenues.

Thus, by a pure conceptual definition, both VITAL-5G and Smart5Grid frameworks have many similarities, at least related to the way how Network Apps are to be defined, designed, developed and tested/validated by using similar 5G-based infrastructures. Although the domain of vertical applications differs, the proposed network architectures are structured under analogous and proportional – if not identical – principles, while involvement of third parties – as legal entities – follows the same "rules for engagement". Apart from the above, enabling novel business models development for open, integrated and cooperative services across multiple domains is a common priority for both projects.

One of the main challenges in the 5G context is the shortening the idea-to-market process through the creation of a European testbed for Small and Medium-size Enterprises (SMEs) that is fully automated and self-serviced, for rapid development and testing of new and innovative Network Applications. The pan-European Transport & Logistics eco-system is considered one of the main adopters of 5G, and as such, the successful transfer of 5G-empowered services from trials/pilot stages

[18] VITAL-5G project: Deliverable D1.1, "Report on use case requirements", June 2021. Available at: https://www.vital5g.eu/wp-content/uploads/2021/07/VITAL5G-D1.1_Report-on-Use-case-requirements_v1_Final.pdf.

[19] VITAL-5G's concept of Network Apps is defined as virtual applications that are built and distributed through self-contained packages comprising their virtual images and metadata, descriptors and scripts that simplify their composition in service chains formed by virtualized and physical functions.

to production depends highly on the availability of flexible and intuitive tools and APIs for design, management and orchestration of their services

OTE participates to both projects and, consequently, several collaborative activities are expected to happen, especially relevant to: (i) the essential 5G architecture and the proposed platform[20] to serve the dedicated use cases; (ii) the definition of the corresponding Network Apps[21] together with their testing and validation methodology[22],[23] and; (iii) proposed KPIs for assessing intended progress. Among others, exchange of ideas about proposed methodologies and related practices will support a more enhanced evaluation of the corresponding testing and validation tools, for the pure benefit of any 3rd party experimenter, thus offering a trusted and secure service execution environment under realistic terms and conditions and by following applicable market practices. This will allow any 3rd party to further improve and fine-tune their proposed Network Apps, as well as to support and promote design/formation of new ones. As a consequence, it will be expected to strengthen SME's presence in the evolving 5G-driven ecosystem.

The NetApp concept is one of the "key pillars" of VITAL-5G since we envision Network Apps as the building blocks of the T&L service chains on top of 5G-enabled infrastructures. In addition, the added value of 5G connectivity is of critical importance for both projects, especially for their market adoption to serve the vertical sector by offering innovation and perspectives for growth. Based on this, collective outcomes can be evaluated under a "joint" 5G-based vision, covering both technical and business aspects. Finally, Smart5Grid and VITAL-5G can both support joint dissemination activities for the promotion of 5G in verticals, especially around Network Apps.

3.2.3.2. Current status

The project is progressing well towards achieving its objectives. VITAL-5G's main achievements (after the completion of the first reporting period) are mainly listed as follows: (i) Overall definition of the project architecture[24], main building modules and interfaces between them; also integration with the three testing sites (although one of the sites is still not yet fully integrated); (ii) Definition of the NetApp package, NetApp blueprint, Experimenter Blueprint and Experiment Descriptor, based on the

[20] VITAL-5G's platform is a complete system that comprises hardware, software and 5G connectivity components and it is implemented in three different 5G-PPP testbeds already established from the H2020-ICT-17-2018 5G-EVE project (Athens and Galati) and the H2020-ICT-53 5G-Blueprint project (Antwerp), properly extended and updated.

[21] VITAL-5G project: Deliverable D2.1, "Initial Network Apps blueprints and Open Repository design", December 2021. Available at: https://www.vital5g.eu/wp-content/uploads/2022/01/ VITAL5G_D2.1_Initial_Network_Apps_blueprints_and_Open_Repository_design_Final.pdf

[22] VITAL-5G project: Deliverable D1.4, "Testing and Validation Methodology", December 2021. Available at: https://www.vital5g.eu/wp-content/uploads/2022/01/VITAL5G-D1.4-Testing-and-validation-methodology_Final.pdf

[23] VITAL-5G project: Deliverable D2.2, "VITAL-5G experimentation platform – Early (testing) drop", March 2021. Available at: https://www.vital5g.eu/wp-content/uploads/2022/04/VITAL5G-D2.2_VITAL-5G_experimentation_platform_Early_testing_drop_v1.0.pdf

[24] VITAL-5G project: Deliverable D3.1, "Report on VITAL-5G infrastructure upgrades & extensions", March 2022. Available at: https://www.vital5g.eu/wp-content/uploads/2022/04/VITAL-5G_D3.1-Report-on-VITAL-5G-infrastructure-upgrades-extensions_v1.0.pdf

outcomes of the prior 5G EVE project[25]; (iii) Definition of the testing and validation methodology[26],[27], and definition of the test case template for the technological validation; (iv) "Early-drop" of the VITAL-5G platform with minimum functionalities working: web GUI, Experiment LCM, Service LCM, Network Apps, Services & Experiments catalogue and Blueprints validation tool; (v) First working version with limited functionalities of selected Network Apps; (vi) Definition of common set of KPIs to be collected in all experiments; (vii) First analysis of possible business models[28],[29] for the project Network Apps and for the VITAL-5G platform itself.

The definition of the system architecture[30] within the broader 5G conceptual framework is a critical "staring point" as it helps towards explicitly delineating the scope of the project in 5G. Indeed, 5G is the "key enabler" for new business and for digital transformation initiatives to integrate vertical industries into the network slice concept. It focuses on maximizing the sharing of network resources and creating dedicated logical networks with personalized customer specific functions. The 5G architecture, as defined by 5G-PPP efforts and involvement [31] , supports vertical industries and the service performance in the 5G-PPP ecosystem over different experimental 5G facilities.

Another important aspect of the project current effort is related to the definition and implementation of Network Apps that can be used by other members of the consortium as well as by potential third parties. In addition, the 5G architecture requirements have been explained in a concrete way per use case and service, in parallel with security requirements that have been made concrete. The definition of the testing and validation methodology, although not yet put to the test, constitutes an important achievement of the full set of work. Corresponding KPIs have been defined and will be used through the testing and validation activities. Delivering an open, virtualized 5G-enabled testing and validation experimentation facility, will provide the means for relevant T&L stakeholders to deploy and benchmark the performance of their innovative Network Applications on top of a 5G network.

Some initial series of business models for the proposed Network Apps will allow for better assessment of the business benefits offered by the project. This shall "enable" the innovation for

[25] 5G EVE ("5G European Validation platform for Extensive trials") project, Grant Agreement No.815074, https://www.5g-eve.eu/

[26] VITAL-5G project: Deliverable D4.1, "Trial planning and experimentation methodology", June 2022.

[27] The scenario of validation is performed in the real-life testbeds' resources environment and the targeted facilities are making available the proper tools and 5G technologies to achieve the demanding experiments requirements. The 5G testbeds will assure the platform for the technology deployment of the advanced networks and techniques for E2E services deployment and SLA assurance, 5G communication services implementation (eMBB (enhanced Mobile Broadband), URLLC (Ultra-Reliable and Low Latency Communications), mMTC (massive Machine Type Communications)), E2E network slicing implementation, dynamic and flexible services support, as a high degree of automation and coordination within and cross network domains is required.

[28] VITAL-5G project: Deliverable D5.1, "VITAL-5G Market analysis report", September 2021.

[29] VITAL-5G project: Deliverable D5.2, "Business Plan", June 2022.

[30] VITAL-5G project: Deliverable D1.2, "System Specifications and Architecture", December 2021. Available at: https://www.vital5g.eu/wp-content/uploads/2022/01/VITAL5G-D1.2-5G-system-specifications-and-architecture_Final.pdf .

[31] 5G-PPP Architecture Working Group, [Online]: https://5g-ppp.eu/5g-ppp-5g-architecture-wg-white-paper-rev-3-0-for-public-consultation/

open, integrated and cooperative services across multiple domains, addressing specific T&L use cases and will justify the investment from key stakeholders. Progress will foster the development and advancement of a T&L centred ecosystem, which will "drive" the European integration of 5G services into the T&L vertical, by bringing together key vertical stakeholders (port authorities, road operators, MNOs, etc.) with SMEs developing cutting-edge technology and applications and other market players (such as network operators).

OTE actively participates to the VITAL-5G activities, in particular by joining one of the three testing sites. OTE expects to assess the effectiveness of the proposed architecture and will investigate 5G-based similarities to the ongoing Smart5Grid effort. The way how Network Apps have been defined in VITAL-5G to serve specific needs and/or requirements and with the aim of supporting specific functionalities in dedicated use cases, will be helpful for assessing the same process in the original Smart5Grid context. The proposed testing methodology together with the defined set of KPIs will allow for potential comparison with relevant actively deployed in Smart5Grid, towards a more "unified" 5G-based approach, of course to the extent possible and mainly considering the technical background. Furthermore, the initial work proposing a context for business validation will provide feedback and offer opportunities for potential market applicability.

OTE expects to assess progress and proposed solutions under a more generalised framework, comprising of contributions coming from both concepts, with the aim of extending its 5G connectivity and applying it to serve various verticals' needs in parallel with actions for deploying exploitable suitable Network Apps. Meanwhile, through this process, joint dissemination activities are taking place in various frameworks (i.e., within the company and the OTE Group of Companies as well as in collaborations with other partners).

In addition, both projects have deployed interactive collaboration in common dissemination activities such as the Infocom World 2022 Conference and Exhibition. In this major business-oriented event, under OTE's coordination, both Smart5Grid and 5G-INDUCE have presented their scopes and especially their proposed Network Apps, under a "joint" framework.

3.2.4. DAEMON

3.2.4.1. Analysis of synergies and Potential collaboration identified in D7.3

Throughout and beyond their fifth generation, mobile networks undergo an architectural revolution, aimed at supporting the extreme requirements set by future services that will assume performance indicators like virtually infinite capacity or perceived zero latency. The mobile network architecture is being redesigned for end-to-end softwarization and cloudification, while the atomization of the classical access-core dichotomy is paving the road for network micro-domains. This transition creates a challenging framework which is to be further extended by the DAEMON[32] context.

The success of Beyond 5G (B5G) systems will largely depend on the quality of the Network Intelligence (NI) that will fully automate network management. Fundamental to the optimal operation of the softwarized, cloudified and atomized network infrastructure will be the Network

[32] DAEMON ("Network intelligence for aDAptive and sElf-learning Mobile Networks") project, Grant Agreement No.101017109, https://h2020daemon.eu/

Intelligence responsible for managing the composite mosaic of network functions and associated resources in presence of a surging mass of services, tenants and slices. Present trends in NI for next-generation network orchestration that are promoted by major standardization bodies pivot on the notion of closed-loop Artificial Intelligence[33] (AI). According to this paradigm, the NI instances deployed at centralized orchestrators and controllers work in closed control loops: abiding by the learning principles of modern AI, they record the context of management decisions, collect observations about the quality of such decisions via continuing monitoring, and then use the feedback to improve future choices. A closed-loop model lets NI apprehend what is important for an operator in a certain situation and learn over time to automate optimal decision making towards expected targets. The current, prevailing vision for closed-loop NI contemplates instances located at centralized orchestrators or controllers in the control plane that interact with VNFs deployed in the data plane. This model requires that network state information be gathered from the different VNFs and transported to a central entity, where they are processed by the pertinent AI algorithms; decisions must then travel back across the network before they can be enacted.

Such AI models are commonly regarded as the cornerstone for NI design; indeed, AI models have proven extremely successful at solving hard problems that require inferring complex relationships from entangled and massive (e.g., traffic) data. However, AI is not the best solution for every NI task; and, when it is, the dominating trend of plugging "vanilla" AI into network controllers and orchestrators is not a sensible choice.

Departing from the current hype around AI, DAEMON will set forth a pragmatic approach to NI design. The project aims to carry out a systematic analysis of which NI tasks are appropriately solved with AI models, providing a solid set of guidelines for the use of machine learning in network functions. For those problems where AI is a suitable tool, DAEMON will design tailored AI models that respond to the specific needs of network functions, taking advantage of the most recent advances in machine learning. Building on these models, DAEMON will design an end-to-end (E2E) NI-native architecture for B5G that fully coordinates NI-assisted functionalities.

Advances to NI devised by DAEMON will be applied in practical network settings to: (i) deliver extremely high performance while making an efficient use of the underlying radio and computational resources; (ii) reduce the energy footprint of mobile networks; and (iii) provide extremely high reliability beyond that of 5G systems. To achieve this, DAEMON will design practical algorithms for eight concrete NI-assisted functionalities, carefully selected to achieve the objectives above. The performance of the DAEMON algorithms will be evaluated in real-world conditions via four experimental sites, and at scale with data-driven approaches based on two nationwide traffic measurement datasets, against nine ambitious yet feasible KPI targets.

The detailed focus towards NI as promote by the DAEMON scope can be beneficial to multiple networks of the future, serving a great variety of applications in diverse sectors, also including those of the Smart5Grid original effort. Any potential progress due to NI advances including aspects as those mentioned just above, could also be assessed for the Smart5Grid purposes. It is expected that possible updates/enhancements to the network infrastructure, as instructed by DAEMON, could also

[33] DAEMON project: Deliverable D2.1, "Initial report on requirements analysis and state-of-the-art frameworks and toolsets", June 2021. Available at: https://h2020daemon.eu/deliverables/

be implemented in Smart5Grid networks. This concept may be beneficial for future network implementations.

OTE is involved in both Smart5Grid and DAEMON projects and so it is expected that any sort of potential collaborative work can be realised in common, in the framework of the corresponding evolution of effort. For the time being, there is plan for collaborative activities in joint events as well as for exchanging knowledge and experiences for matters affecting the underlying 5G-based network infrastructure. Both projects are also expected to contribute to joint events, especially to those that are market oriented.

3.2.4.2. Current status

DAEMON is establishing methodologies to adapt legacy AI models based on recent deep learning approaches to the specificities of real-world NI problems. Indeed, networking operation, optimization, and management is a complex and particular framework with many singularities that distinguish it from other fields. This is important when it comes to incorporating new approaches into the network, since top-level solutions with unmatched performance in other less constrained fields may fail to provide the envisioned operability in networking. Among the core objectives of the DAEMON effort is about delivering high network performance while making an efficient use of the underlying (radio and computational) resources and also about providing extremely high reliability based upon the underlying infrastructure of 5G systems and beyond. These are strongly relevant to the specific context promoted by the Smart5Grid effort, where exploitation of deployed 5G infrastructure is among major concerns. Ensuring network reliability is critical for offering services to the market.

DAEMON has already proposed in initial vision[34] for a network intelligence framework with a more systematic and deeper integration of NI, thereby providing means to overcome the limits of current control plane-centric closed-loop approaches. Related work provides an essential set of information able to "enable and drive" coordination and cross-compatibility across NI deployed in different network domains that are operating at different timescales, potentially covering aspects coming from Smart5Grid as well. In addition, current DAEMON's effort[35] may help for "enabling" NI deeper into the network infrastructure as well as for adjusting AI techniques to the specific needs of the network environment and operations, with the aim of developing novel AI hybrid approaches. Once deployed and properly tested, these could potentially be used to extend, enhance and modernize current OTE's 5G network.

The DAEMON NI-assisted architectural framework will enable the penetration of intelligence into both the user and control planes, thereby creating a multi-time scale hierarchical NI architecture consisting of distributed NI instances for network management[36], which altogether collaborate to improve their individual learning and decision-making processes and so promoting transition towards B5G. The above context, via NI's proper inclusion, may help network infrastructures

[34] Ibid.

[35] DAEMON project: Deliverable D2.2, "Initial DAEMON Network Intelligence framework and toolsets", July 2022. Available at: https://h2020daemon.eu/deliverables/

[36] DAEMON project: Deliverable D4.1, "Initial design of intelligence orchestration and management mechanisms", November 2021. Available at: https://h2020daemon.eu/deliverables/

becoming more efficient, effective and autonomous. This will also allow for developing novel AI techniques that can dynamically adapt to available network resources, by trading-off accuracy with, e.g., inference latency or computational complexity. Such revolutionizing features will support 5G-/B5G-based service offering especially for energy verticals, which is Smart5Grid's case. Related B5G functionalities[37] discussed by the DAEMON framework that could also be relevant to Smart5Grid can be: (i) energy-aware Virtual Network Function (VNF) orchestration; (ii) capacity forecasting; (iii) automated anomaly detection, and; (iv) self-learning management and orchestration.

DAEMON's developed algorithms[38] that aim to improve the network under very specific KPIs such as the reliability of the system, its pure performance and, most importantly, its sustainability, reducing the energy consumption of the system are also important for consideration in any future effort for deploying B5G/6G infrastructure. Related B5G functionalities discussed by the DAEMON framework that could also be relevant to Smart5Grid can be: (i) energy-aware Virtual Network Function (VNF) orchestration; (ii) capacity forecasting; (iii) automated anomaly detection, and; (iv) self-learning management and orchestration.

3.2.5. MARSAL

3.2.5.1. Analysis of synergies and Potential collaboration identified in D7.3

5G mobile networks will be soon available to handle all types of applications and to provide service to massive numbers of users. In this complex and dynamic network ecosystem, an end-to-end performance analysis and optimization will be among the key features, in order to effectively manage the diverse requirements imposed by multiple vertical industries over the same shared infrastructure.

MARSAL[39] targets the development and evaluation of a complete framework for the management and orchestration of network resources in 5G and beyond, by utilizing a converged optical-wireless network infrastructure in the access and fronthaul/midhaul segments. At the network design domain, MARSAL targets the development of novel cell-free (CF) based solutions that allow a significant scaling up of the wireless Access Points (APs) in a cost-effective manner by exploiting the application of the distributed cell-free concept and of the serial fronthaul approach, while contributing innovative functionalities to the O-RAN project[40]. In parallel, in the fronthaul/midhaul segments, MARSAL aims to radically increase the flexibility of optical access architectures for Beyond-5G Cell Site connectivity via different levels of fixed-mobile convergence. At the network and service management domain, the design philosophy of MARSAL is to provide a comprehensive framework for the management of the entire set of communication and computational network resources by exploiting novel ML-based algorithms of both edge and midhaul DCs, by incorporating the Virtual Elastic DataCenters/Infrastructures paradigm. Finally, at the network security domain, MARSAL aims to introduce mechanisms that provide privacy and security to application workload and data, targeting to allow applications and users to maintain control over their data when relying on the

[37] Ibid.

[38] DAEMON project: Deliverable D3.1, "Initial design of real-time control and VNF intelligence mechanisms", November 2021. Available at: https://h2020daemon.eu/deliverables/

[39] MARSAL ("Machine Learning-based, Networking and Computing Infrastructure Resource Management of 5G and Beyond Intelligent Networks") project, Grant Agreement No.101017171, https://www.marsalproject.eu/

[40] For further details also see: https://www.o-ran.org/

deployed shared infrastructures, while AI and Blockchain technologies will be developed in order to guarantee a secured multi-tenant slicing environment.

Until today, MARSAL has achieved significant progress in the following sections:

- Preliminary version of the high-level MARSAL architecture[41], including the main building blocks and communication channels.
- Initial set of specifications[42],[43] for virtual elastic infrastructure to be used in the different PoCs.
- Adoption of ML in different architectural components, specifically in one of the objectives guaranteeing privacy and security[44] in multi-tenancy environments.
- Cell-free networking[45] for distributed traffic management.
- Development of an mmWave solution for virtualized Radio Access Network (vRAN) elements, based on the O-RAN Alliance architecture concept.[46]
- Elastic Edge Computing, targeting optimization of the Mobile Edge Computing (MEC) nodes and the network slicing management systems via adoption of analytic and decision-making engines[47].

OTE is involved in Smart5Grid and MARSAL projects and, consequently, potential synergies can be realised in the course of both projects, especially focusing upon the novel network-related aspects that are strongly promoted by MARSAL's effort.

3.2.5.2. Current status

MARSAL is targeting the development of a new framework for the management and orchestration of converged 5G and beyond 5G networks. In particular, the study of converged optical/wireless networks is considered for access and frontal segments, but also the mobile access networks are targeted by the new architecture (free cells deployment).

MARSAL also offers a joint multi-objective optimization framework for the efficient, self-driven orchestration and management of communication, storage, and computational resources in an integrated way. Beyond 5G networks will be characterized by Self-Driven infrastructures, with

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41 MARSAL project: Deliverable D2.2, "MARSAL's network architecture specifications", January 2022. Available at: https://www.marsalproject.eu/wp-content/uploads/2022/09/D2_2_V1.0.pdf

42 MARSAL project: Deliverable D2.1, "Description and definition of targeted PoCs", September 2021. Available at: https://www.marsalproject.eu/wp-content/uploads/2021/09/D2.1-Marsal-final.pdf

43 MARSAL project: Deliverable D2.3, "1st release of the requirements and specifications of MARSAL's manageent and security components", December 2021. Available at: https://www.marsalproject.eu/wp-content/uploads/2022/09/D2_3_V1.0.pdf

44 Ibid.

45 MARSAL project: Deliverable D3.1, "Initial report on distributed processing cell-free RAN and Hybrid MIMO fronthaul network design", June 2022. Available at: https://www.marsalproject.eu/wp-content/uploads/2022/09/MARSAL_D3_1_v1-final.pdf

46 MARSAL project: Deliverable D3.2, "Initial report on O-RAN based NG-RAN for cell-free networking", July 2022. Available at: https://www.marsalproject.eu/wp-content/uploads/2022/09/MARSAL_D3_2_final.pdf

47 MARSAL project: Deliverable D4.2, "Initial report on elastic MEC platform design and data-driven orchestration and automation", June 2022. Available at: https://www.marsalproject.eu/wp-content/uploads/2022/09/MARSAL_-D4_2_V1.0-final.pdf

pervasive ML and closed-loop autonomy at all layers[48]. This autonomy-related feature could potentially be useful also in the future SmartGrid's network.

Among others, MARSAL introduces mechanisms that guarantee privacy and security in multi-tenancy environments, targeting both end-users and tenants[49]. In this way, application providers and end-users can maintain control over their data when relying on shared infrastructures, without sacrificing on functionality. MARSAL's security mechanisms and policies aims at providing trustworthiness and resiliency against security failures or breaches, thus guaranteeing data and computation integrity, and generating privacy preserving data representations. This can also be beneficial for the specific context of Smart5Grid and MARSAL's experience may be useful for corresponding actions.

During 2022, both projects have also deployed interactive collaboration in common dissemination activities such as: (i) the 5G-PINE 2022 Workshop, organised by OTE, in the context of the AIAI-2022 International Conference, where Smart5Grid and MARSAL were among the "core" organisers, and; (ii) the Infocom World 2022 Conference and Exhibition where, under OTE's coordination, Smart5Grid and MARSAL have each one organised dedicated thematic sessions and have presented their proposed progress, at various levels.

3.2.6. LOCUS

3.2.6.1. Analysis of synergies and Potential collaboration identified in D7.3

LOCUS[50] aims at harnessing the ongoing 5G opportunity to natively incorporate, in the 5G network infrastructure, hooks, technologies and application programming interfaces devised to enable, and significantly foster, location/context-based services together with powerful business analytics. Based on novel paradigms such as Multi-Access Edge Computing (MEC) and network softwarization technologies, LOCUS proposes a holistic approach to research key architecture[51] and technology building blocks, as well as to provide versatile, flexible, secure, privacy-preserving and efficient operations of heterogeneous technologies and services[52]. This can be achieved through accurate and ubiquitous localization and insightful context feature extraction using analytics technologies.

Localization, together with analytics and their combined provision as-a-service, greatly increase the overall value of the 5G ecosystem, allowing network operators to better manage their networks and to dramatically expand the range of offered applications and services. The project has been completed by October 2022. LOCUS' main target has been about providing results applicable to real-world scenarios of relevance to both academia and industry, including: Smart Network Management

[48] Ibid.

[49] MARSAL project: Deliverable D5.2, "Initial report on data privacy protocols in multi-tenant infrastructures", June 2022. Available at: https://www.marsalproject.eu/wp-content/uploads/2022/09/MARSAL_D5.2.pdf

[50] LOCUS ("LOCalization and analytics on-demand embedded in the 5G ecosystem, for Ubiquitous vertical ApplicationS"), Grant Agreement No.871249, https://www.locus-project.eu/

[51] LOCUS project: Deliverable D2.5, "System architecture – final version", November 2021. Available at: https://www.locus-project.eu/wp-content/uploads/2021/12/D2.5_nbm_17-11-21.pdf

[52] LOCUS project: Deliverable D4.4, "Implementation of the virtualization platform for network control and management: final version", April 2022. Available at: https://www.locus-project.eu/wp-content/uploads/2022/06/D4.4_nbm_29-4-22.pdf

based on Location Information of 5G equipment; Network-assisted Self-driving Objects, and; People Mobility & Flow Monitoring, including emergency services.

The accurate 5G localization and the intended integration with non-3GPP technologies set specific ambitions for LOCUS that can potentially be relevant to Smart5Grid use cases, especially within indoors applications. In this scope and for some of the Smart5Grid scenarios that are relevant to the remote inspection of energy installations, LOCUS may be useful for the remote inspection of automatically delimited working areas at distribution level (use case 2), if such areas involve indoors premises.

Another common element between the two projects (LOCUS and Smart5Grid) is the fact that are both consider a 5G core service-based architecture[53] which follows both 3GPP specifications (e.g. according to ETSI GS MEC 003 V1.1.1 approach[54]), so there are many conceptual similarities as of the intended use of the related networks functions. LOCUS proposes a hybrid virtualization platform that integrates different technologies and solutions to distribute the LOCUS virtual functions across edge and core computing locations within the 5G end-to-end infrastructures. Based on this, LOCUS developed a preliminary software prototype, which combines an initial version of the LOCUS MANO with a small-scale virtualization platform[55].

OTE participates to both LOCUS and Smart5Grid projects. In this scope, collaborative works can take place for the support of dissemination activities as both projects are based upon 5G innovative features. Although the scopes of these two projects differ, under a pure conceptual assessment, it is possible to have some sort of interactivity as of the use of 5G infrastructures for both cases. The accurate 5G localization promoted by LOCUS may be useful in Smart5Grid's potential evolutions.

3.2.6.2. Current status

Enhancing Location Based Services (LBS) of 5G systems and fusing them with location tracking capabilities from other technologies (GNSS, WiFi, Bluetooth) has a number of important applications. LBS are not only important on their own merit but they also have the potential of improving network planning and resources allocation in 5G networks and of obtaining useful analytics on the users' movement. This may also be useful in the wider Smart5Grid context and could offer additional information and experience to potential aims for exploiting 5G.

Based on the project progress LOCUS improves the functionality of 5G infrastructures so that to: (i) provide accurate and ubiquitous location information as a network-native service; (ii) (ii) derive more complex features and behavioural patterns out of raw location and physical events, and; (iii) expose them to applications via simple interfaces. The concept of network-native service could also be examined, in a parallel way, within the Smart5Grid framework.

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[53] Ibid.

[54] European Telecommunications Standards Institute (ETSI) (2016). ETSI GS MEC 003 V1.1.1, "Mobile Edge Computing (MEC); Framework and Reference Architecture", March 2016. Available at: http://www.etsi.org/deliver/etsi_gs/MEC/001_099/003/01.01.01_60_/gs_mec003v010101p.pdf

[55] LOCUS project: Deliverable D5.2, "Design and implementation of virtualization technologies and pattern recognition mechanisms for physical analytics"- final version", February 2022. Available at: https://www.locus-project.eu/wp-content/uploads/2022/02/D5.2_nbm_4-2-22.pdf

Also LOCUS virtualization platform and the proposed system's architecture can be used for improving some part of the respective Smart5Grid's platform, especially those related to the MANO context. In fact, the proposed LOCUS system architecture is an augmentation of the 5G architecture, where network and user data from heterogeneous technologies are combined to extract on-demand analytics; this can propose benefits also upon the Smart5Grid architecture.

In addition, the project has defined several scenarios and use cases[56],[57] which are representative of trends and market drivers, the operators' perspective and indicative vertical application needs. These could be useful for assessment also within the corresponding Smart5Grid's framework.

3.2.7. MonB5G

3.2.7.1. Analysis of synergies and Potential collaboration identified in D7.3

As 5G technology is maturing, and in view of new pervasive mobile services of different vertical industries, it is necessary to support massive numbers of coexisting network slices, with different performance requirements, functionality, and time spans. This puts significant strain on the management and orchestration system that traditional centralized designs, as in Cloud Computing and NFV, fail to cope with. MonB5G[58] answers to these challenges, towards providing zero-touch management and orchestration in the support of network slicing at massive scales for 5G LTE and beyond. It proposes a novel autonomic management and orchestration framework, heavily leveraging distribution of operations together with state-of-the-art data-driven AI-based mechanisms.

MonB5G will split the centralized management system into several management sub-systems, distributing both the intelligence as well as the decision-making across various components. Each technological domain may have one or several distributed management elements.

As mentioned above, the main scope of MonB5G is so about promoting new and innovative methods for the distributed management of network slices in B5G infrastructures, which implies for potential applicability in diverse infrastructures.

MonB5G pillars are: (i) a highly distributed management and orchestration system, deployed over several entities involved in the LCM of network slices, namely MANO, NSMF, MEO, and the slice itself; (ii) data-driven mechanisms, based on novel distributed machine learning algorithms, to enable self-management and self-configuration of network slices, towards reaching the principle of scalable zero-touch network management.

Although the original effort is aligned to the two selected PoCs, it is expected that either zero-touch network and service management with end-to-end SLAs or AI-assisted policy-driven security monitoring & enforcement could find ground for implementation in other use cases as well. In any

[56] LOCUS project: Deliverable D2.6, "Scenarios, use cases and requirements – v2", March 2021. Available at: https://www.locus-project.eu/wp-content/uploads/2021/05/Deliverables-officially-submitted_D2.6_D2.6_nbm_5-3-21.pdf

[57] LOCUS project: Deliverable D5.4, "Prototype of the localization & analytics as a service solution", August 2022. Available at: https://www.locus-project.eu/wp-content/uploads/2022/09/D5.4_4-8-22_nbm.pdf

[58] MonB5G ("Distributed management of Network Slices in beyond 5G") project, Grant Agreement No.871780, https://www.monb5g.eu/

case, the project will provide innovative findings for better network management, which shall be a "key" issue for the networks of the future. In particular, as of the B5G infrastructures, network slicing is expected to remain at the forefront of requirements for implementing market-oriented solutions, so any related experience will be of great value. In this framework, it is expected that potential findings/results from the MonB5G effort may be useful for network slicing applications serving the Smart5Grid framework as well.

OTE participates to both projects. It is expected that both Smart5Gid and MonB5G shall collaborate towards supporting dissemination and communication activities in future events relevant to 5G-oriented research. It is expected that exchanges of experiences and/or knowledge about network slicing issues will be a challenging opportunity for both contexts. Furthermore, as both projects consider as "basis" for their current network deployment the corresponding MANO and MEC frameworks, the proposed potential extension with embedded cognitive capabilities – as currently proposed by MonB5G – creates potential opportunities for further collaboration. MonB5G's extra focus for secure and trustworthy cross-domain operations can be examined in future Smart5Grid's implementations and trials as well.

3.2.7.2. Current status

The project is developing a platform that implements a distributed zero-touch management and orchestration for supporting massive network slicing in B5G networks, featuring autonomic, cognitive (based on data and AI) and closed-loop management and orchestration. MonB5G has already delivered the initial architectural design of the system[59] showcasing initial versions of monitoring, analytics and decision sub-systems, and a set of underlying ML-based management/orchestration mechanisms[60],[61]. MonB5G's methodological approach has considered as a first step the gathering of requirements in different B5G scenarios and the definition of KPIs, thus proposing an initial holistic innovative architecture aiming to handle massive network slicing in these scenarios. MonB5G is built on top of the 3GPP network slicing management framework, by leveraging the management system used for Infrastructure-as-a Service (IaaS). These concerns can also be considered within the Smart5Grid framework, to a certain extent, as for the provision of network slicing.

MonB5G aims to operate in line with current ETSI frameworks, rather than fully disrupt their operation. To an extent, it reuses NFV MANO and MEC components/interfaces, adding reference points for network slice management and orchestration and interfaces for the internal communication of the MS, AE, and DE. However, while preserving the architecture, MonB5G extends the internal functions of some basic components to make them AI-driven. Under this concern, MonB5G's proposed architecture, along with implementation solutions, potentially might also have a technological impact on current management and orchestration platforms, conceptually including Smart5Grid's one.

[59] MonB5G project: Deliverable 2.4: "Final release of the MonB5G architecture (including security)", October 2021. Available at: https://www.monb5g.eu/wp-content/uploads/2021/11/D2.4_MonB5G-Architecture.pdf

[60] MonB5G project: Deliverable 3.3: "Final report on Platform Integration for the MonB5G AE and MS", October 2022. Available at: https://www.monb5g.eu/wp-content/uploads/2022/11/MonB5G_D3.3_Submitted.pdf

[61] MonB5G project: Deliverable 4.2: "Final report on AI-driven techniques for the MonB5G DE", May 2022. Available at: https://www.monb5g.eu/wp-content/uploads/2022/10/MonB5G_D4.2-final.pdf

MonB5G develops a hierarchical, automated, and data-driven network management system that incorporates energy efficiency as a key feature to orchestrate a high number of parallel network slices in a sustainable way[62]. This option could potentially affect some of the intended Smart5Grid's aspects as well.

As mentioned above, MonB5G reuses standards-based MANO and MEC frameworks, extending them with embedded cognitive capabilities. Simultaneously, it further provides trust mechanisms tailored to the targeted multi-stakeholder environment, for secure and trustworthy cross-domain operations. These features can potentially be beneficial for the case of Smart5Grid as well.

Both projects have participated to joined dissemination activities (such as the case of Infocom World 2022 Conference) where they have exchanged knowledge and practices on their current activities.

3.2.8. 5G-TOURS

3.2.8.1. Analysis of synergies and Potential collaboration identified in D7.3

The goal of 5G-TOURS[63] was to get the European 5G Vision of "5G empowering vertical industries" closer to commercial deployment. For that, they implemented 13 innovative use cases with the vision of improving the life in the city for the citizens and tourists, making cities more attractive to visit, more efficient in terms of mobility and safer for everybody.

More specifically, 5G-TOURS aimed to demonstrate how 5G technologies can support multiple vertical use cases simultaneously on the same infrastructure. To achieve this outcome, 5G-TOURS leveraged on the facilities of 5G-EVE deployed in the three cities and extend the 5G-EVE platform including: enhanced Management and Orchestration (MANO), Artificial Intelligence (AI)- based orchestration, Broadcast/multicast support, and Service Layer to interface the verticals/tenants. One of the project's main ambitions was to show the ability of 5G networks to meet extreme and conflicting KPIs while supporting very diverse requirements on the same infrastructure. For that, they defined a methodology for the collection and analysis of requirements that were then translated into technical KPIs used for the evaluation of the 5G-TOURS system.

5G-TOURS identified three main technological development objectives (i.e.: definition of an architecture[64]; creation of a common service layer, and; identification and development of new vertical solutions). Furthermore, the deployment objectives (the deployment of three field-trials with many indoor and outdoor deployments, and the refinement of the 13 use cases) also required modifying and extending the base infrastructure (provided by 5G-EVE) with new components and developments. Finally, the performance objectives (collecting, analyzing, and validating metrics; and determining satisfaction of the quality aspects) implied adding new components for the measurements and new procedures.

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[62] MonB5G project: Deliverable 5.3: "Final report on AI-driven MonB5G energy efficiency techniques", August 2022. Available at: https://www.monb5g.eu/wp-content/uploads/2022/10/ MonB5G_D5.3_submitted.pdf

[63] 5G-TOURS ("SmarT mObility, media and e0health for tOURists and citizenS") project, Grant Agreement No.856950, http://5gtours.eu/

[64] 5G-TOURS project: Deliverable 3.4: "Final architecture and deployment results: Achieved results in the final architecture, technologies and infrastructure deployment", December 2021. Available at: http://5gtours.eu/documents/deliverables/D3.4.pdf

More concretely, 5G-TOURS integrated the results of the projects 5G-EVE (network resources and management tools), 5G-MoNArch[65] and 5G-Xcast[66] (architecture, network slicing mechanisms, dynamicity of the infrastructure, multicast, and broadcast technologies) with new developments such as novel artificial intelligence and machine learning algorithms (for facilitating the management of a multi-service, multi-site and multi-tenant infrastructure).

5G-TOURS also developed a new service layer to facilitate the provisioning of verticals with specific network slices adapted to the needs of each use case and to understand if the requirements are satisfied. The trials were deployed and completed in the three cities: Turin (WP4[67]), Rennes (WP5[68]) and Athens (WP6[69]), with their corresponding measurement campaigns, KPIs collection and QoS/QoE evaluation.

ATOS and OTE partners participated in 5G-TOURS project: ATOS led the 5GTOURS "WP2 – Use Cases Design" and its task "T2.1 – Definition of Use cases Functionality", while OTE was responsible for "T2.2 – Derivation of technical requirements". As a result of the experience acquired, the methodology used by Smart5Grid for the collection of requirements from the use cases was based on the one defined by 5G-TOURS, in particular with respect to the analysis of technical requirements.

3.2.8.2. Current status

Although 5G-TOURS finished in September 2022 and further collaboration is not possible, Smart5Grid project will analyze the thorough evaluation plan designed by 5G-TOURS to scrutinize the viability of its use cases, as it might be useful for the evaluation of the Smart5Grid platform and uses cases later on in the project.

The fact that 5G-TOURS also brought new technological developments, new deployments, the definition and collection of metrics, and the definition of new business models[70],[71] and other aspects that can make deployments sustainable and provide more societal benefits, can also be assessed within future steps of the Smart5Grid effort.

Among specific importance is the proposed framework looking for an impact in the society and exploring how novel 5G technologies can be used to provide services in different scenarios. Work in

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[65] 5G-MoNArch ("5G Mobile Network Architecture for diverse services, use cases, and applications in 5G and beyond" project, Grant Agreement No.761445, https://5g-monarch.eu/

[66] 5G-Xcast ("Broadcast and Multicast Communication Enablers for the Fifth Generation of Wireless Systems") project, Grant Agreement No.761498, http://5g-xcast.eu/

[67] 5G-TOURS project: Deliverable 4.4: "Final Touristic City use case results", May 2022. Available at: http://5gtours.eu/documents/deliverables/D4.4.pdf

[68] 5G-TOURS project: Deliverable 5.4: "Final safe city use cases implementation results", February 2022. Available at: http://5gtours.eu/documents/deliverables/D5.4.pdf

[69] 5G-TOURS project: Deliverable 6.4: "Final mobility efficient city use cases implementation results", May 2022. Available at: http://5gtours.eu/documents/deliverables/D6.4.pdf

[70] 5G-TOURS project: Deliverable 8.3: "Business Model Archetypes of vertical industries and the 5G-TOURS commercial opportunity", November 2021. Available at: http://5gtours.eu/documents/deliverables/D8.3.pdf

[71] 5G-TOURS project: Deliverable 8.5: "Final report on innovation management, dissemination standards and exploitation plans", July 2022. Available at: http://5gtours.eu/documents/deliverables/D8.5.pdf

the project[72] has validated how the integrated ecosystem satisfies the requirements for the services, achieving the required user satisfaction and checking the results through a validation plan and the collection and analysis of the metrics. This can also be beneficial for the scope of the Smart5Grid project.

3.2.9. 5G-HEART (OTE)

3.2.9.1. Analysis of synergies and Potential collaboration identified in D7.3

5G-HEART[73] has actually focused on the vital vertical use-cases of healthcare, transport and aquaculture. In the health area, 5G-HEART has validated pillcams for automatic detection in screening of colon cancer and vital-sign patches with advanced geo-localization as well as 5G AR/VR paramedic services[74]. In the framework of the transport area, 5G-HEART has validated autonomous/assisted/remote driving and vehicle data services[75]. Regarding food, focus has been upon 5G-based transformation of aquaculture sector[76] (worldwide importance for Norway, Greece, Ireland).

5G-HEART has taken important steps for progressing the synergy between telecom and vertical industries. The overall objective of the 5G-HEART is to define and validate the cost efficient 5G converged network concepts, which enable an intelligent hub supported by multiple vertical industries. Figure xx, as depicted below, provides an illustration of the intended objective.

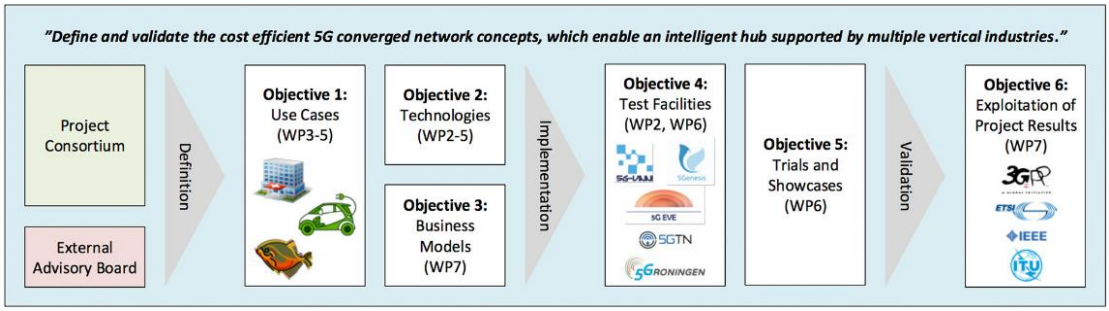

Figure 38: 5G-HEART project overview and its objectives

As the 5G-HEART project defines and validates some cost efficient 5G converged network concepts being able to enable an intelligent hub supporting multiple vertical industries, tha fact of its strong relationship to actual market activities and needs, coming from diverse sectors, is evident. The project is around detailed market-oriented scenarios and offers viable and applicable solutions, tailored to the involved market actors.

In this scope, any sort of potential collaboration between 5G-HEART and Smart5Grid can be mutually beneficial, especially about proposing solutions to serve requirements/needs set by multiple market

[72] 5G-TOURS project: Deliverable 7.4: "Final integrated 5G-TOURS ecosystem and technical validation results", July 2022. Available at: http://5gtours.eu/documents/deliverables/D7.4.pdf

[73] 5G-HEART ("5G HEalth AquacultuRe and Transport validation trials") project, Grant Agreement No.857034, https://5g-ppp.eu/5g-heart/

[74] 5G-HEART project: Deliverable 3.4: "Final solutions for the healthcare vertical use of 5G", November 2022.

[75] 5G-HEART project: Deliverable 4.4: "Final solutions for the transport vertical use of 5G", November 2022.

[76] 5G-HEART project: Deliverable 5.4: "Final solutions for the aquaculture vertical use of 5G", November 2022.

players as well as about using 5G infrastructures for offering direct benefits to the involved market actors.

In addition, as the implementation of the 5G-HEART's trials investigates an extended variety of matters about enhanced mobile broadband (eMBB), ultra-reliable low-latency communications (URLLC) and massive machine-type communications (mMTC), this can provide extra knowledge that can be useful for other 5G implementations, potentially including those of Smart5Grid.

OTE participates to both projects. Experiences gained from market-oriented activities in the scope of 5G-HEART could potentially be useful for related market activities that are to take place within the Smart5Grid effort.

3.2.9.2. Current status

Although 5G-HEART finished in November 2022 and further collaboration is not practically possible, the Smart5Grid project will analyze the proposed approach regarding the use cases as well as potential methodologies for market exploitation that could provide some sort of "background" for similar Smart5Grid's efforts.

Business evaluations have been exercised by 5G-HEART, taking advantage that the project features partners belonging to the whole value chain of their verticals[77]. This has allowed the project to provide impact about the role of 5G in their industry business, focusing on the identification of involved stakeholders and their value propositions. More compelling exploitation and business analysis of certain key use cases and scenarios had a higher impact and value in a constrained resources environment[78]. This way of approach can offer significant benefits to similar actions that are expected to take place by the Smart5Grid partners. Also the applied 5G-HEART's methodology with exact analysis of the different verticals' use cases in order to reach a set of user requirements and network KPIs can be used, up to a certain extent, also in some Smart5Grid use cases.

The 5G-HEART project has exposed and executed integration actions necessary to accommodate 5G capabilities over key vertical areas, improving their operational capability. This exposure goes beyond an incremental technology adoption and, therefore, requires substantial technological and technical accommodation work, simultaneously involving the experts from the 5G side and the verticals' side[79]. Therefore, the work producing this integration can be of great value and exploitation capability, for other research activities as well.

Last but not least, both projects have also participated to joined dissemination activities (such as the recent case of the Infocom World Conference 2022) and exchanged experience and knowledge.

[77] 5G-HEART project: Deliverable 7.5: "Business models and business plans", November 2022.
[78] Ibid.
[79] 5G-HEART project: Deliverable 7.6: "5G technology roadmaps and exploitation plan", July 2022.

3.2.10. 5GENESIS

3.2.10.1. Analysis of synergies and Potential collaboration identified in D7.3

As indicated in D7.3, an analysis of the project was performed in order to determine if some of its developments, concepts or ideas could be reused by Smart5Grid, as this project implemented a V&V framework for Network Services (NS), something that Smart5Grid is doing for Network Apps.

3.2.10.2. Current status

5GENESIS concluded its activities at the end of 2021 and no direct collaboration was possible in the end.

3.2.11. New 5G PPP projects identified

3.2.11.1. 5G-ROUTES

3.2.11.1.1. PROJECT DESCRIPTION

5G-ROUTES [80] is a 5G-PPP Phase 3 project whose aim is to validate through robust evidence the latest 5G features and 3GPP specifications (R.16 & R.17) of Connected and Automated Mobility (CAM) under realistic conditions. In particular, it will conduct advanced large-scale field trials of most representative CAM applications to demonstrate seamless functionality across a prominent 5G cross-border corridor (Via Baltica-North), traversing Latvia, Estonia and Finland.

3.2.11.1.2. ANALYSIS OF SYNERGIES

Both projects are framed in the 5G PPP Phase 3, but respond to different calls:

5G-ROUTES, ICT-53-2020 call "5G-PPP 5G for Connected and Automated Mobility"

Smart5Grid, ICT-41-2020 call "5G innovations for verticals with third party services"

The topics that both projects address are quite different, so collaboration in communication / dissemination activities is not foreseen. However, ATOS, as partner involved in both projects, has identified some synergies in technical aspects that might result in a "joint" development of an asset.

3.2.11.1.3. POTENTIAL COLLABORATION IDENTIFIED

In 5G-ROUTES, ATOS is developing a CAM Repository Enabler which provides a way for UCs to provision a multi-domain scenario with the required NFV artefacts in a simplified way. It is aligned with the latest ETSI OSM release #12 and introduces a novel way to provision multi-domain scenarios by means of synchronizing instances of the CAM Repository via the Integration Fabric being developed in 5G-ROUTES.

The idea is to extend and adapt this asset in the context of Smart5Grid project as a Network Apps repository with advanced verification functionalities.

The asset will be part of two different components in the Smart5Grid architecture:

- the **Local Registry**, a subcomponent of one of the NetApp controllers of the project which is in charge of storing all the artefacts that compose a NetApp package, as well as their provisioning in OSM;

[80] 5G-ROUTES project: https://www.5g-routes.eu/

- the **Verification Engine**, a component of the V&V framework which verifies NSs and VNFs descriptors, as well as the Network Apps from the Information Model created in Smart5Grid.

Besides adding a new layer support Network Apps, Smart5Grid will extend the verification part of the asset developed in 5G-ROUTES, improving the syntax checks of NSs, VNFs, and NetApp descriptors, as well as integrity checks between the services defined in the descriptors and the network topology.

3.2.11.2. BRIDGE

3.2.11.2.1. PROJECT DESCRIPTION

BRIDGE[81] is a European Commission initiative that serves as an umbrella organization for different H2020 and HEU projects that tackle challenges in the areas of the energy vertical (smart grid, energy storage, island and digitalization). This initiative creates a path for knowledge sharing among projects as well as delivers different reports, whitepapers and documents that can contribute to or enhance future energy vertical project proposals and current ongoing projects. In addition, it allows the different projects that fall into it to communicate, coordinate and cooperate in four different distinct working groups (Data Management, Business Models, Regulations and Consumer/Citizen engagement.).

The initiative has been running successfully for the last few years, serving as a platform to connect projects and experts. Even though there have been some gaps (lack of activity for some periods) currently BRIDGE is once again having its Working Groups actively working on a variety of issues/challenges that concern and are relevant to all related projects, participating in its Working Groups.

3.2.11.2.2. ANALYSIS OF SYNERGIES

Smart5Grid project develops solutions within the energy vertical and is also a project funded by the European Commission under Horizon 2020 programme (these are already two very overlapping points).
Even though Smart5Grid is more targeted towards the telecommunication vertical, many synergies can still be seen with the energy vertical as the focus of all the Working Groups also concerns the demos within the project. Insights from them can enhance and contribute towards BRIDGE ongoing analysis, questionnaires and reports, while projects within BRIDGE may find the S5G project interesting and decide to collaborate be it through Workshops and Meetings or in a more "technical manner" (engaging in third party experimentation).

3.2.11.2.3. POTENTIAL COLLABORATION IDENTIFIED

In BRIDGE, Entra Energy is participating in two of the Working Groups as a representative of another project they are part of – FlexiGrid (864048), thus giving a Smart5Grid representative also access to what is going on in these groups as well as the possibility to collaborate where insights from third party projects or organizations are needed to carry out the activities of BRIDGE groups and subgroups.
One of the Working Groups Entra Energy takes part in is the Consumer and Citizen Engagement Work Group which is divided into three subgroups (smart tools, indicators of engagement, strategies of engagement) and one general working group that coordinates the work of the subgroups. Current potential collaboration activities include S5G filling in BRIDGE questionnaires, sharing info about

[81] BRIDGE: https://bridge-smart-grid-storage-systems-digital-projects.ec.europa.eu/

them and other BRIDGE initiatives in S5G social channels as well as reaching the participants of the Working Group with invitations to take part in S5G events and even in our third-party experimentation opportunities.
Another one of the Working Groups that Entra Energy is part of is the Business Model Work Group. It is expected to start at the beginning of 2023, so more information on it and potential collaboration activities can be further explored then.

4. Market Aspects and Preliminary Exploitation Activities

In the next chapters we will present the near- and long-term challenges faced by the energy sector. We will discuss how the energy sector digitalization can help addressing these challenges. 5G technology and Network Applications can act as catalysts for the sector digitalization unlocking real value for the energy companies.
Since the value potential exists, there is opportunity for stakeholders, like companies focusing in the development and deployment of Network Applications, to move into this new market. However, due to the complexity and dependencies spanning the energy infrastructure, telecom networks and applications, not one player can deliver the full solution. Instead, there will be a complex value network of several stakeholders each focusing in a different solution segment. In this complex environment, we need to look beyond single company business modelling and focus in ecosystems.

4.1. Initial Market Analysis and Aspects

4.1.1. Challenges and Opportunities for Energy Utility Companies

The transformation of the Energy Utilities

A set of near- and long-term challenges create the perfect storm for energy utility companies. A growing demand for electricity, a changing mix of energy sources and the introduction of renewables, increase pressure towards sector sustainability, cost control, cybersecurity threats and more.
Digital transformation is the key to addressing these challenges, and cellular connectivity is a major enabler for important use cases, including predictive maintenance, generation monitoring, connected electric vehicle charging and more.

Growing demand due to increased electrification

Electricity demand growth is expected to continue at a 2% compounded annual growth rate (CAGR) over the next two decades [1].

In wealthy nations, demand growth is offsetting efficiency improvements, while in developing countries, rising incomes and industrialization are contributing to the demand growth. Pressure to lower carbon emissions is forcing several industries like steel, paper mill, chemicals who are heavy consumers of power to migrate from fossil fuels to electricity.

As a result, utilities need to expand production capacity while also optimizing infrastructure utilization to keep up with increasing demand.

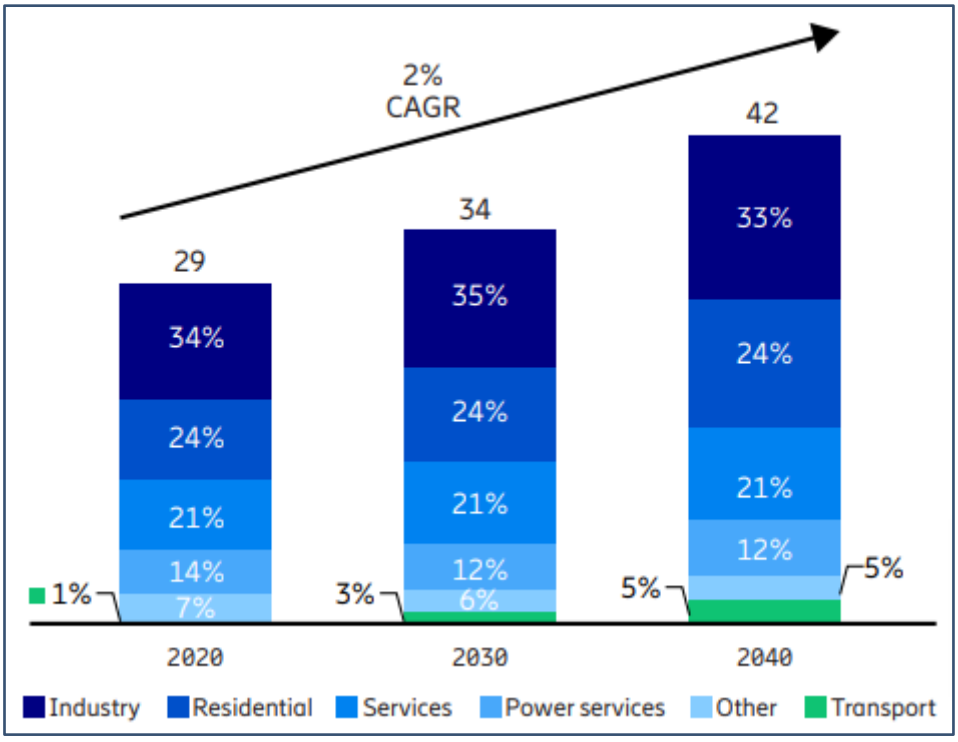

Figure 39: Global electricity demand by sector. Source: IEA, Arthur D. Little

Changing energy production mix and growing renewable sources

From 2020 through 2040, renewables are expected to grow from 29% of energy generation to 45%, for a CAGR of 4.8%, which is larger than all other electric power generation energy sources [2].

European regulation is pushing towards an increase in the share of renewables in the production mix, as there are proposals for their share to reach 40% by 2030. Grid capacity is stressed by demand to connect solar generation as consumers start to become prosumers.

Generation from renewables, due to their volatile nature, is stressing the stability of energy grids, creating a need to have precise predictions on how much power will be fed into the grid at any given time.

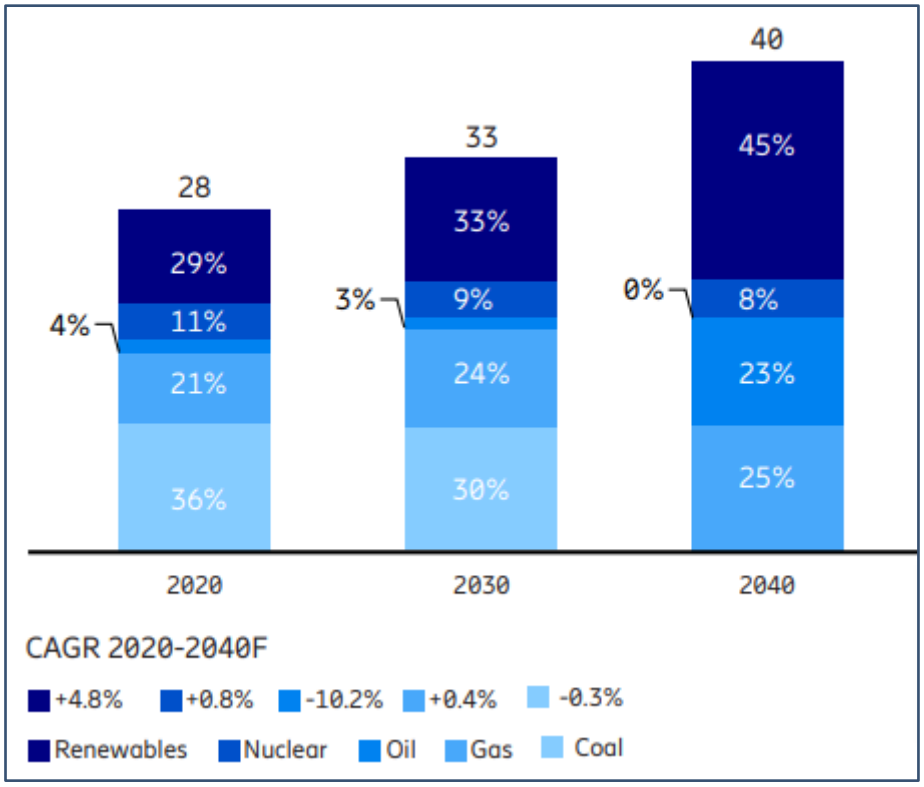

Figure 40: Global electricity generation by source. Source: ING, Utility Dive, Renewable Energy World, IEA, World Resources Institute, Arthur D. Little

Increasing numbers of faults

Due to the high reliance of modern societies in electricity, even developed nations face a high societal cost due to faults in their power networks.

General availability of the power network in Sweden is high, at around 99.98 percent. This corresponds to one 100-minute-long power failure for the average end user. These faults result in a substantial cost to society, in the region of EUR 150 million annually for Sweden alone (Swedish Energy Agency,2018).

The total number of fault events in Sweden's power grids is around 40,000 per year (Swedenenergy, 2017). These power failures have several causes, including adverse weather, equipment problems, damage as a result of excavation, for example. However, **one-third of faults are caused by unknown reasons**. This is due to a lack of information and measurement. Such faults may cascade through the system and cause disturbances and widespread outages.

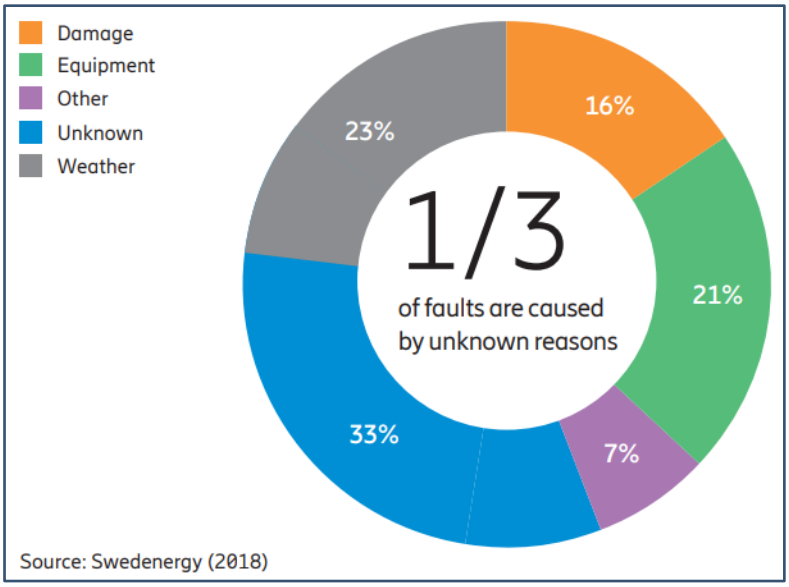

Figure 41: Reasons for Power Grid faults

It is very important to have mechanisms in the network which are able to locate, identify, isolate and fix faults and to switch on electricity in the shortest time and for as many customers as possible.

Today, most medium- and low-voltage networks use non-communicative protection mechanisms, such as overcurrent relays and distance relays. A principle for automated line protection that is becoming more common is line **differential protection**. The added benefit compared to other protection methods is the increased sensitivity and ability to see the direction of the current. This is growing in importance due to renewables. However, differential protection is more demanding, as it requires a communication channel to transmit momentary values to the other end (from one remote substation to another), in a fast and reliable way. This requires a communication connection with really low latency, such as fiber or 5G.

Currently, power grids tend to be enabled with data communication at the highest voltage level (primary substations), and sometimes at the customer premises through smart electricity meters, as shown in the following figure.

For cost reasons, the lower voltage distribution levels (secondary substations) remain unconnected with data. This is related to the high number (more than 170,000 in Sweden) of secondary substations.

As a consequence, line differential protection is not commonly used at this lower level, while it is used at the higher levels where data communication is available.

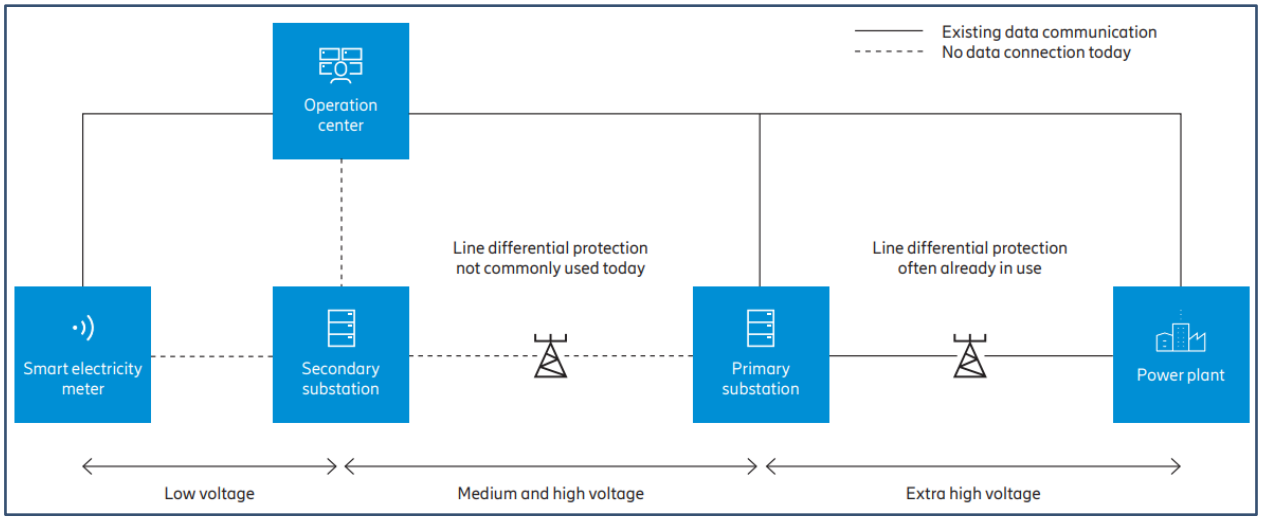

Figure 42: New communications needed for lower voltage distribution network

One Swedish DSO estimates that it is possible to **reduce the duration of interruptions by anywhere between 50 and 75 percent** with the use of ICT, resulting in a potential annual increase of revenues accepted by the regulator of up to EUR 40 million.

Power failures can result in major equipment damages, such as to reclosers, substation transformers, circuit breakers and power line equipment. As an example, a damaged substation may generate costs in the region of EUR 100,000 (ABB estimates).

The economic impact related to faults affects not only utilities companies but also society and industry customers. In Sweden during 2018, customer costs were estimated to be almost EUR 150 million as a result of power interruptions (Source: Swedish Energy Markets Inspectorate).

According to a study from the University of Gothenburg [3], increased length of an outage normally leads to rapidly growing costs for consumers and enterprises. One of the DSOs estimates a cost of EUR 150,000 per minute in Stockholm.

Utilities embrace digital transformation to tackle growing set of complexities

Traditionally, the infrastructure of the energy utilities is modernized over very long timescales (e.g., the average grid infrastructure is between 40 – 50 years old), thus creating increased security and reliability risks.

One of the major challenges of power grids is electricity transmission losses, which could reach very high numbers (19% in India, 50% in Haiti). A solution to this problem is to decentralize production from a few big power plants to many small local energy sources, to ensure that energy is consumed as close as possible to its source [4].

Electric vehicle charging is using superchargers to reduce needed time for a full charge, therefore consuming an immense amount of energy. Such an instant power demand creates a big strain for the grid. Through the analysis of collected "big data" in real-time, the reaction time of the Smart Grid to changes can be reduced, therefore ensuring stable energy supply.

Threat of terrorist attacks targeting the power infrastructure could be mitigated by the introduction of Microgrids, creating self-sufficient energy communities.

All of these challenges are driving utilities to embrace digital transformation to solve them, which in turn creates a massive change to their infrastructure and brings some complex problems of its own.

To cater for future demand, improve quality and adhere to environmental policies, power distribution networks need significant investments. Investments of EUR 1.5 billion per year are expected for the Swedish market, of which 10% (EUR 150 million) is Information and Communication Technology (ICT) related [5].

The inevitable digitalization of the energy sector also brings new challenges, as the threat of cyber attacks exposes large parts of the society to a controlled blackout.

The digital transformation of the power industry is already under way, as the revenue share those utilities spent on digital transformation grew from 30% in 2020 to 38.4% by 2021 [6].

In order to manage large data volumes, real-time bi-directional data flows from smart meters and sensors, and create a connected and automated smart grid, cellular 5G technology will be a major enabler [7].

5G wireless technology offers several advantages towards the digital transformation of utilities:

- 5G is **standards based** and benefits from a huge global ecosystem, therefore ensuring it is a future proof solution, reduces costs associated with proprietary technologies, while also avoiding vendor lock-in.
- Through public mobile network operators, neutral hosts or private networks, 5G can extend the **coverage** over any geographic area (nationwide or indoor venue) to support connectivity of every device and sensor. This is especially important for rural areas, which are out of reach of fiber networks (or economically unfeasible to cover).
- 5G has built-in **security** and **reliability** mechanisms, that are important in the case of networks serving critical infrastructure. Furthermore, in the case of private or hybrid network deployments, organizations can keep their sensitive data on site.
- 5G builds upon previous cellular technologies, improving **performance KPIs** including low latency, and high throughput.
- Cellular technologies, such as 5G, are also **scalable** able to reach any network size, including massive numbers of IoT devices.

A concern regarding the ability of wireless communications service providers to meet DSOs' needs, is the availability design of the network. For example, while most MNOs configure their networks with uninterrupted power supply (UPS) systems to support a power outage of up to 4 hours, DSOs require support for at least 12 hours in a total outage situation.

Concluding, 5G if properly designed, can provide reliable and secure transmission and distribution of power grid data, enabling fast response for a multitude of use cases addressing challenges across the value chain.

Many of these use cases can be realized today, such as, real-time data exchange, remote monitoring and control, fault isolation, service restoration through automation, real-time load balancing, connecting remote windfarms, connected EV charging, building energy management & optimization, push-to-video, and remote drone inspections. More advanced use cases could be exploited in the future, such as, automated remote drone inspections, fully automated and connected smart grids, and advanced predictive maintenance.

4.1.2. Digitalization Use Cases

Some examples of use cases where 5G could enable the digitalization of the power industry are discussed below.

Automatic grid fault detection

Automatic grid fault detection minimizes the need to manually locate faults and power interruptions for electricity customers, in the event of a failure.

Smart grid technology, supported by cellular connectivity, can enable utilities to rapidly identify and address these short outages to reduce power interruptions for customers.

According to one U.S. report, smart grids that enable automatic grid fault detection significantly reduced outages by up to 51% along with the number of customers affected by outages by up to 45% [8].

Falling conductor detection in mid-air

Broken overhead electrical conductors that reach the ground present a wildfire and public safety risk. The faster the broken conductor can be detected and de-energized, the lower the risk of fire or danger to people.

Traditional detection methods (e.g., detection of signatures from harmonic and interharmonic energy caused by arcing that is associated with a downed conductor) do not begin their detection process until the conductor is already on the ground and arching. It can take several minutes for these detection methods to identify a downed conductor once it has made contact with the ground.

A new detection method uses synchrophasor data streamed from both ends of a protected line segment to calculate the rate-of-change of conductor voltage (dV/dt) and changes to sequence voltage magnitude and angles to evaluate if a conductor has broken. Using this method, it is possible to detect the presence of a broken conductor and signal protective relays to de-energize the affected line segment in less than 500 milliseconds (which is considerably less than the time it takes for a broken conductor to hit the ground: 1.25 seconds after a break occurs), thereby mitigating the fire and public safety hazards associated with an energized conductor arcing on the ground [9].

Baseline results established with **wired connectivity** between the various protection equipment elements in the test bed achieved average falling conductor initiation-to-trip time for five iterations of falling conductors at Locations 273.7 ms.

Using a private LTE network for **wireless data streaming** and control signalling achieved average falling conductor initiation-to-trip time between 307 ms to 390 ms, results which are well within the limit of one second for an 8-meter-high distribution tower.

Using a lower latency 5G wireless network could further optimize the response time for this use case and would also be more scalable as 5G supports a higher density of user devices.

Intelligent load flow control

Utilities will need to expand the grid and reduce congestion on the current infrastructure to handle increasing demand and integrate renewable energy sources into the grid. To achieve these goals, they will need to adopt the smart grid, which allows power companies to automatically reroute electricity during equipment failures or outages.

One study models how smart grid technologies can manage congestion in Europe's transmission systems [10]. A broad application of sensor-based Dynamic Line Rating, as well as modular static synchronous series compensator technology for load flow control can reduce the volume of redispatches and costs by roughly 40%-50% each, compared to the reference scenario.

Moreover, the combination of Dynamic Line Rating, MSSSC and Superconductors reduces the congestion and redispatch costs by more than 90% and the congestion-related curtailment of renewables by 3 TWh by 2030.

Remote site inspection

Drone inspections can eliminate the need for human inspectors, avoiding hazardous manhours and improving asset productivity.

For commissioning, warranty or regular maintenance, drones are 95% more efficient and effective at identify defects, tracker misalignment, shading, tower and substation conditions that manual inspections might miss. Additionally, drones reduce man hours and turbine downtime for maintenance checks by more than 75% [11].

Legacy equipment modernization

Legacy communications systems, such as, iDEN, TETRA, P25 are still used as a primary means of communications within the utility and power industries. However, as these technologies are decades old, they are difficult to maintain and do not support use cases requiring mobile data. Legacy communication systems limit the ability for field technicians to exchange high quality pictures and videos to supervisors, requiring them to frequently travel to sites to inspect issues.

EDF, Thales and Ericsson have partnered on CONNECT, a project to bring secure cellular connectivity to all of Électricité de France S.A's (EDF) nuclear energy sites in France. Thales, deployed secure communications services while also guaranteeing the overall system integration and secure networking.

Transforming operations and systems with digital technologies can achieve performance gains of 20% to 40%, while improving safety, reliability and customer satisfaction [12].

Predictive Maintenance & Asset Management

Predictive maintenance can increase uptime for all types of generation, including renewables. Cellular connectivity can collect data from sensors deeply embedded in equipment at scale. That data can be

analyzed to identify the optimal time to provide maintenance and detect potential issues early, before the asset breaks down, so it can be addressed, keeping power generating going.

A study conducted in a joint collaboration between Ericsson and Arthur D. Little shows that introducing predictive maintenance can reduce the number of maintenance sessions the turbines and generators require annually at the plant by as much as 25%. Since maintenance of these assets require them to be taken offline to be serviced, the loss related to downtime is affected just as much by up to 25%.

One such approach of using advanced analytics in transmission and distribution asset management to improve performance, reduce asset management costs, and capture value is presented below [12]:

- Step 1: Capture and clean up data
- Step 2: Quantify health and criticality levels
- Step 3: Tailor asset-management strategy

To determine the **health or condition of an asset**, an operator will need to assess multiple technical variables—probably somewhere between 10 and 40, depending on the asset type. It will also need to consider factors relevant to its specific situation, such as technical thresholds set by local regulatory authorities, and temperature if it operates in a region with an extreme climate. As an example, the following figure illustrates the parameters and factors used to determine the health of transformers.

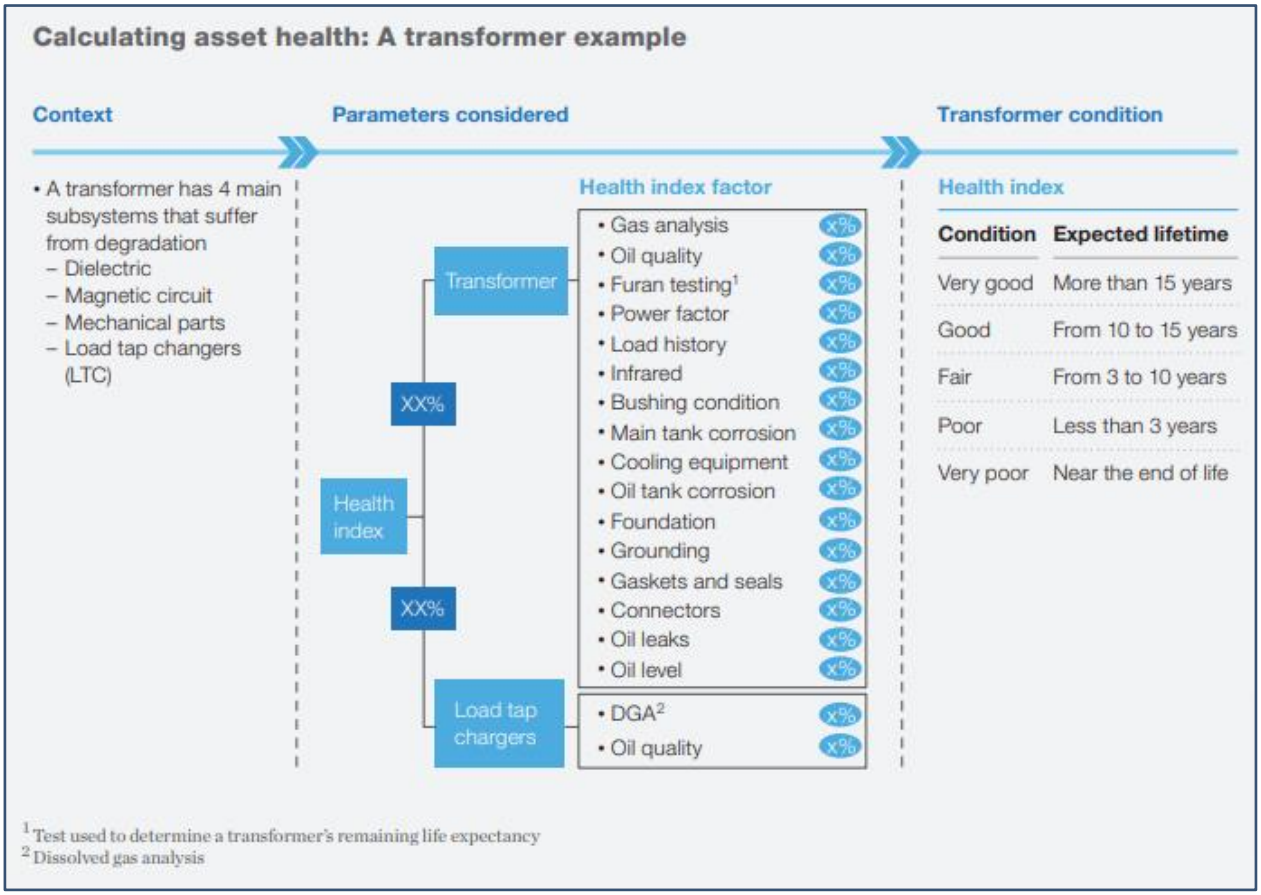

Figure 43: Calculating asset health: Transformer

By combining insights into the health and criticality of each asset, an operator can determine its risk level, as shown in the example for distribution feeders in the following figure. Having assessed the risk level for all of its assets, the operator can then move to the third and final step.

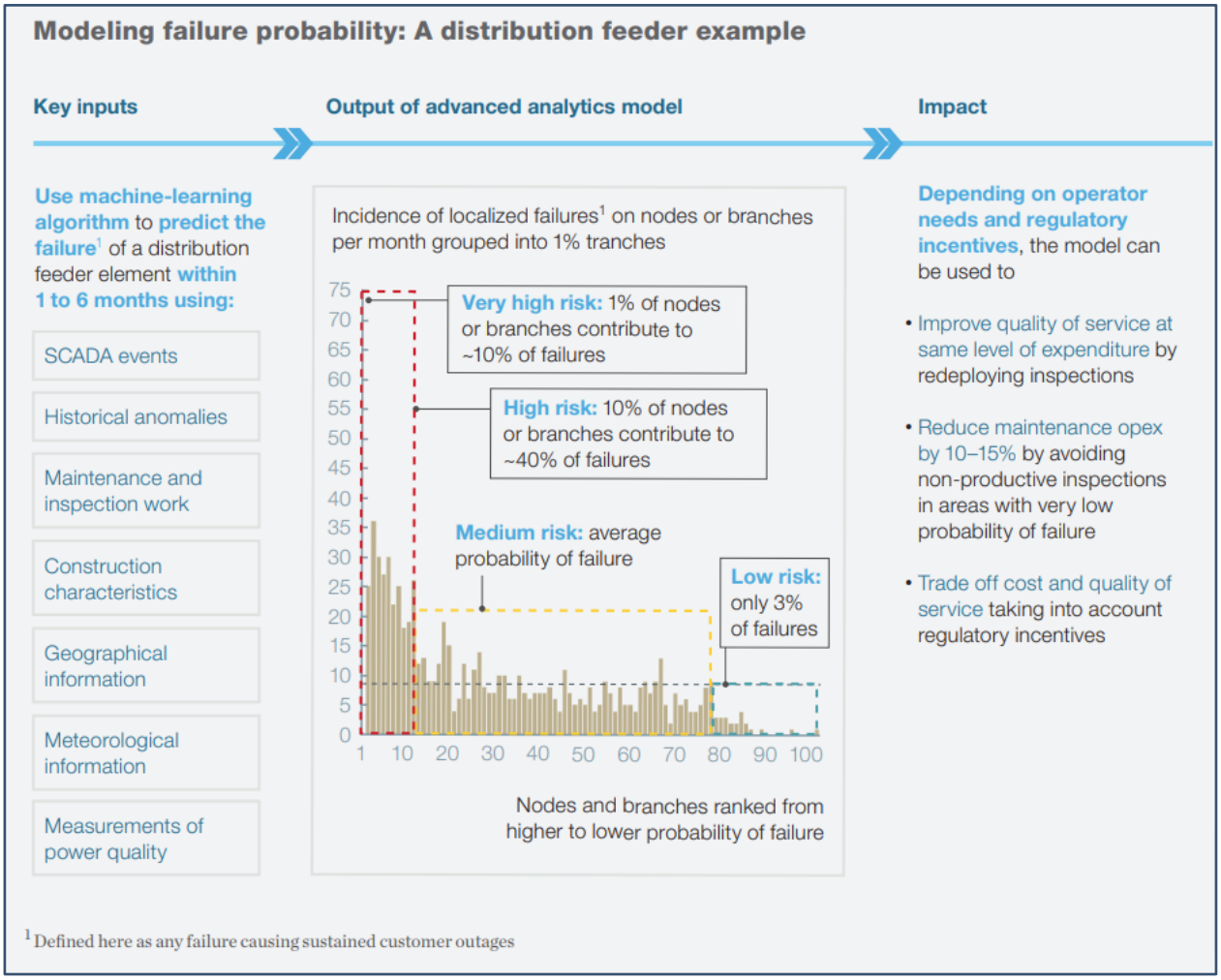

Figure 44: Modelling failure probability for distribution figures

This step involves reviewing monitoring and inspection frequency, adjusting routine and scheduled maintenance practices, and considering corrective maintenance and replacement suggestions.

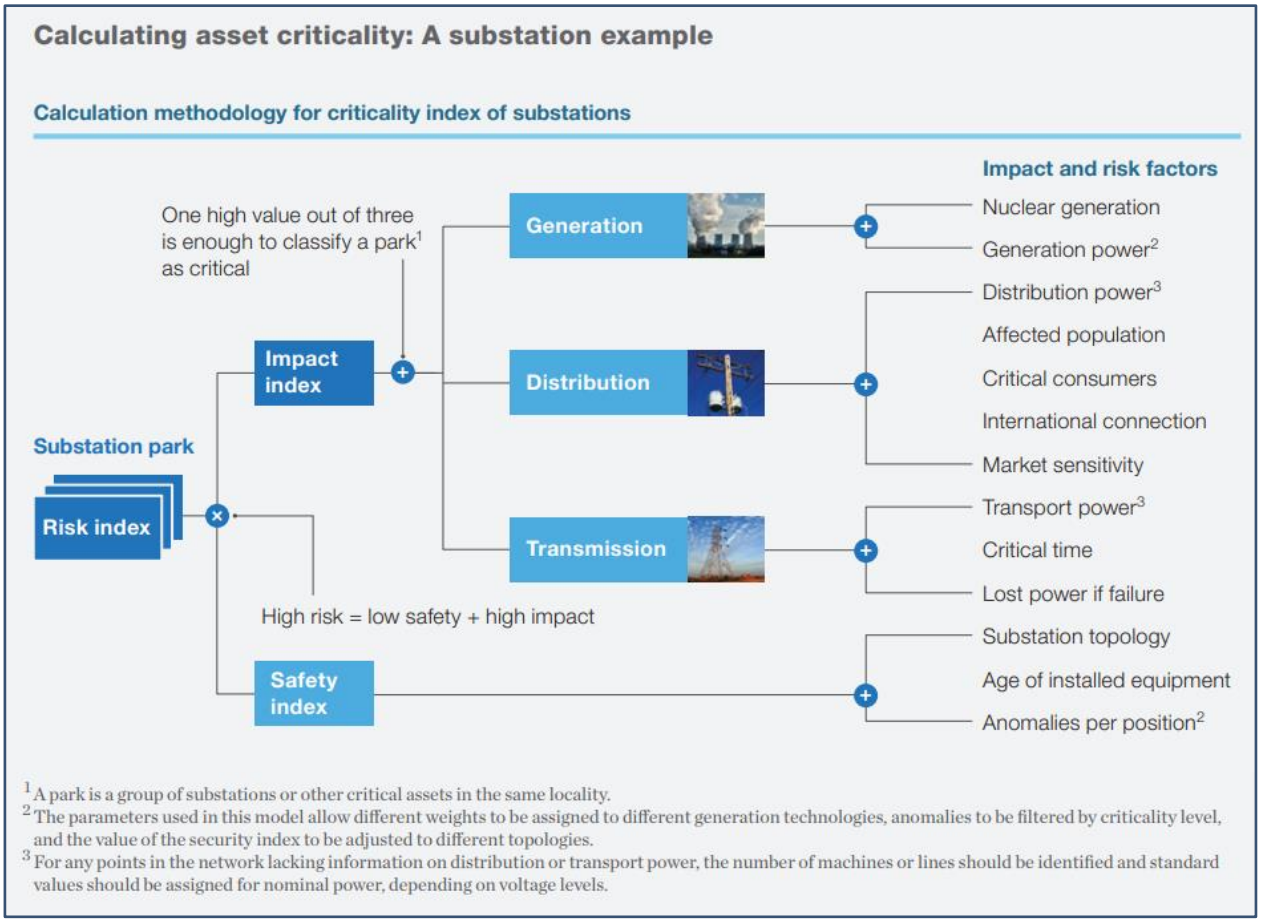

Figure 45: Calculating asset criticality: Substation

One operator by using analytics decided to replace some ailing assets earlier than expected because they were critical, while allowing others to fail before they were replaced so that resources were not wasted on maintaining less critical assets. The operator also increased the frequency of inspection for some relatively healthy assets because any failure would have had a disproportionate effect on its network. Even though activity levels rose for the most critical assets and those needing replacement, the operator managed to reduce its total expected costs by 10 percent.

4.1.3. Stakeholders and value chain

As energy markets become more liberalized, technology is developing at a rapid pace and the number of stakeholders is increasing, while their relationships become more complex. In the following discussion, we will focus on traditional and emerging stakeholders in the energy value network.

Traditional Energy Stakeholders

A simplified version of an electricity supply chain can be divided into primary fuel, generation (and trading to suppliers), transmission, distribution and supply.

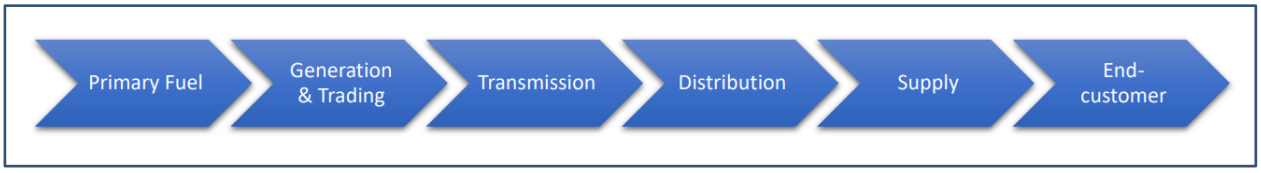

Figure 46: Traditional linear value chain.

Generation refers to the actual production of energy. The role of centralized generation will decrease when smart energy solutions are introduced as they will introduce new market participants, enable distributed generation and new demand-response opportunities.

Trading refers to selling generated energy to suppliers, which in turn sell it to end customers.

Transmission is the transport of electricity on the high-voltage interconnected system towards the distributors or the final customers. The actor performing the transmission role is called the Transmission System Operator (TSO).

Distribution is the transport of electricity in medium-voltage and low-voltage distribution systems towards the delivery to customers. The actor performing distribution is called the Distribution System Operator (DSO).

Both transmission and distribution system operators are so-called natura monopolies. This means that it is not cost effective to build many different electricity networks in the same area, and since there is only one operator per area, it is called a natural monopoly. To prevent natural monopolies from abusing their monopoly power, the operators are regulated.

Electricity suppliers sell the energy they bought at wholesale from the generator traders to the end customers. Suppliers are also called retailers, marketers or energy trade companies, and sometimes also offer additional service bundles, such as, gas, water, telecoms services, etc.

Emerging Energy Stakeholders

ICT technology providers include equipment vendors, application developers, ICT standardization bodies, and play an increasing role in the modernization of the energy industry and Smart Grids. They enable innovation that will transform and provide improvements by introducing:

Two-way communication, advanced control methods integrating data collection & monitoring, data analysis, and calculation of corrective actions based on both deterministic and predictive methodologies.

Energy Service Companies (ESCOs), also called energy efficiency companies, with the task of improving the end customer's energy efficiency. They implement and customer energy efficiency and load management projects, but can also take the additional role of the retailer.

Non-Business Stakeholders

Non-Business Stakeholders include regulators and policymakers, acting in local, national, EU and global scales. In addition, they include non-governmental organizations, such as, lobbying bodies for different verticals, environmental / climate organizations, research (universities and institutes) and local societies.

Based on the above discussion, a mind map of the stakeholders of the energy industry is presented on the following figure.

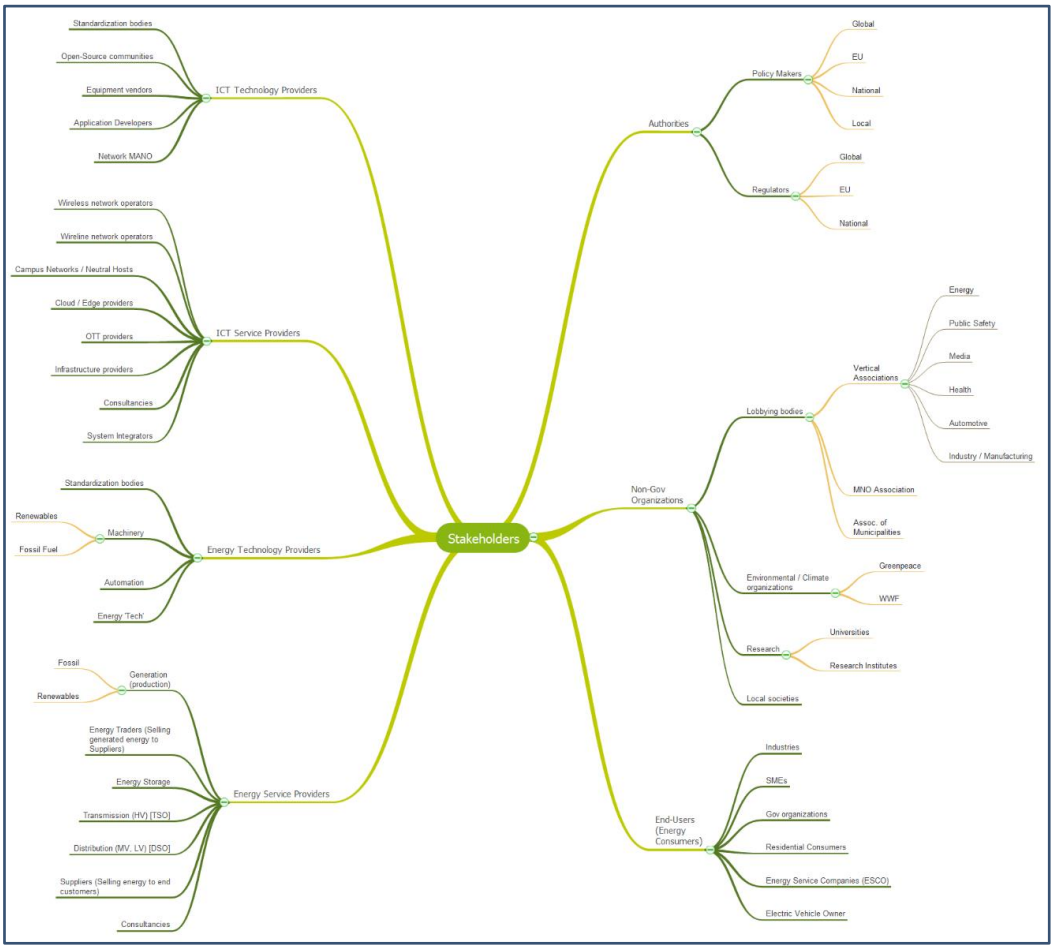

Figure 47: Mind map of energy industry stakeholders

The increased number of stakeholders occupying new roles in the ecosystem, lead to the transformation of the traditional linear value chain to a new, more complex, "circular" value chain of the future [13].

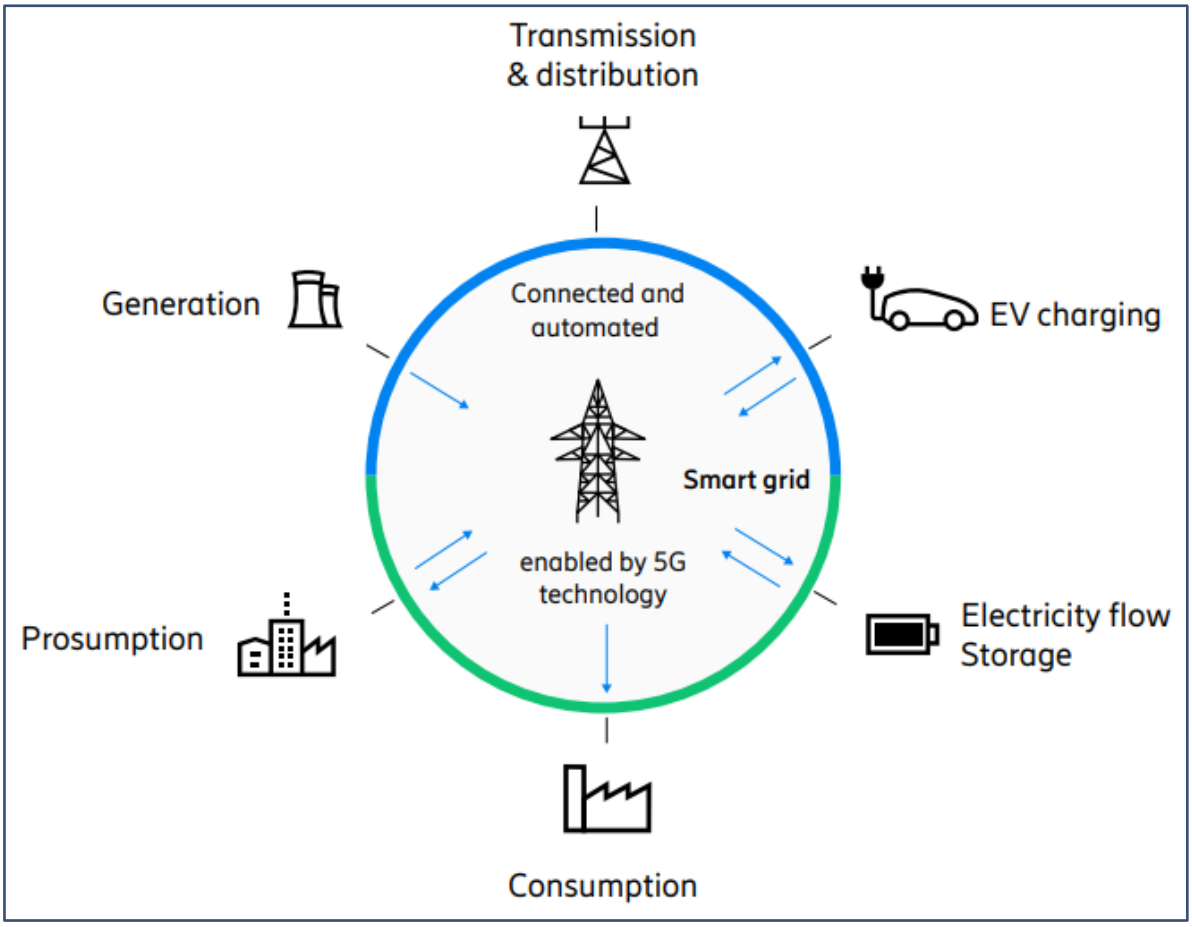

Figure 48: Circular value chain of the future

4.1.4. Business Models

Business modelling for a single firm

Despite the popularity of the business model concept, there is no widely accepted definition of a business model in the management literature.

The typical interpretation of the term "business model" refers to a company's plan for making a profit. It identifies the products or services, the business plans to sell, the identified target market, and any anticipated expenses.

The process starts from a firm's strategic plan that explains the specific long-term goals a firm expects to achieve and how. From its strategic plan the firm derives the business strategy, which sketches the steps needed to achieve the long-term goals. The next step in the process is the definition of a

business model which identifies value propositions, customer segments, and concrete steps for the execution of the business strategy and describes how a firm creates, delivers and captures value in economic, societal and other contexts. Embedded in its business model each firm will define one or more business plans and formulate associated business cases that support the execution of the business strategy.

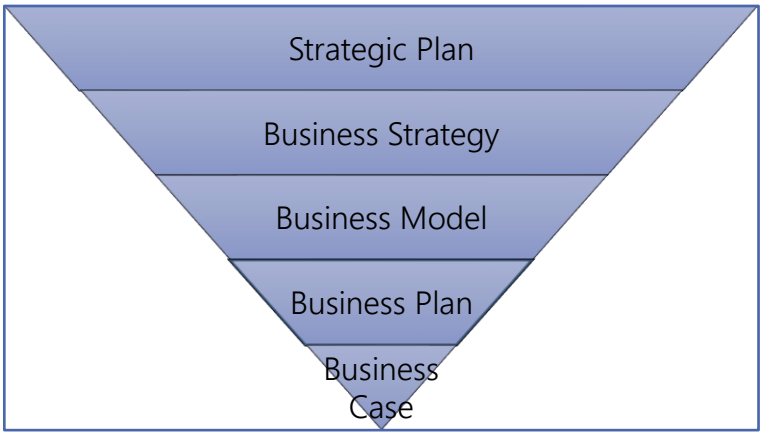

Figure 49: From strategic plan to business model

This linear process, however, rarely works as the technological and business environments are changing very fast, and the company continuously needs to reposition itself within the value network. In addition, rarely can a company alone deliver the full value for a product or service to the end customer. It is necessary to align with other companies of the ecosystem and synergically present a value proposition exploiting each firm's expertise in meeting customer expectations.

Specifically for Smart Grids, Pereira et al. [14] propose a number of new business areas, including:

1) value creation and capture through the flexibility of management services, as the Distribution System Operators (DSOs) are willing to provide new services and integrate new technologies, and expand the scope of their activities and responsibilities;

2) data business is another opportunity area for digital electricity systems. Data business can facilitate direct access to new data that DSOs benefit from when integrating smart meters and sensors as part of grid modernization actions; and

3) business models enabled by blockchain technology and smart contracts such as the Brooklyn blockchain in New York [15] are also attractive to the energy companies [14].

Overall, digitalization and smart grids open up the possibility for more value-creation opportunities to transform the conventional consumption-driven paradigm of the electricity sector.

Different frameworks exist for representing how businesses realize added value and generate profit. The following frameworks are, some of the most often used representations [16]:

1) **Business Model Canvas (BMC)**

2) **Value Network Analysis (VNA)**

3) **E3 value Model (E3)**

Business Model Canvas (BMC) is a strategic management tool and template for developing new business models or documenting existing ones. It is a visual canvas with elements detailing a company's or product's value proposition, key activities, infrastructure, partners, customers, and finances. It helps companies to align their activities by illustrating trade-offs [17]. It consists of a formal description of 9 building blocks within a business model: customer segments, key activities, revenue streams, value propositions, channels, customer relationships, key resources, cost structures and key partnerships. The BMC clearly defines the (possible) key partners within a value network, though does not explicitly define the value flows between the segments, nor does it define the value streams between external partners; it is hence actor centered.

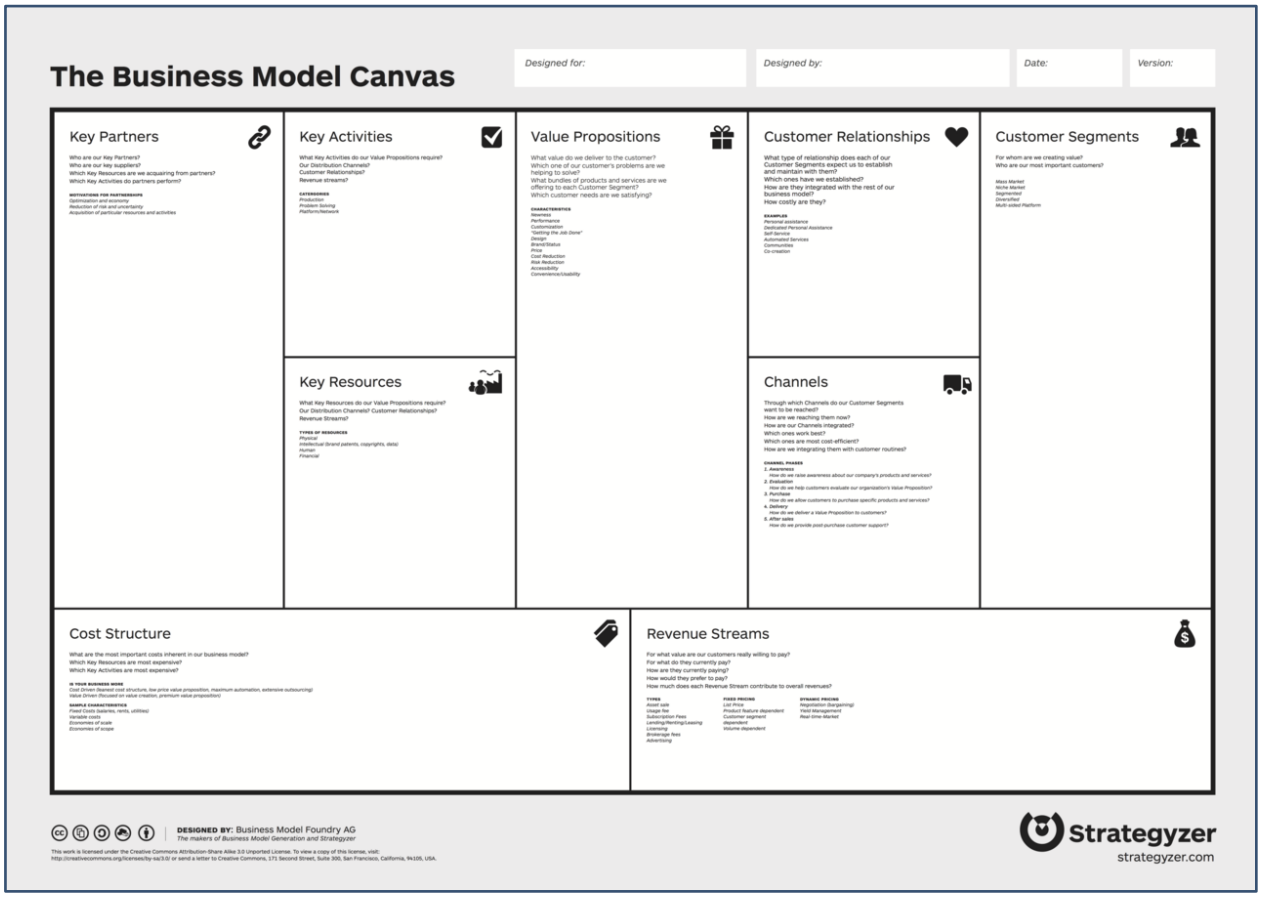

Figure 50: BMC overview: nine business model building blocks

Value network analysis (VNA) is a methodology for understanding, visualizing, using, optimizing internal and external value networks and complex economic ecosystems [18]. "The methods include visualizing sets of relationships from a dynamic whole systems perspective. Robust network analysis approaches are used for understanding value conversion of financial and non-financial assets, such as intellectual capital, into other forms of value. The value conversion question is critical in both social exchange theory that considers the cost/benefit returns of informal exchanges and more classical views of exchange value where there is concern with conversion of value into financial value or price".

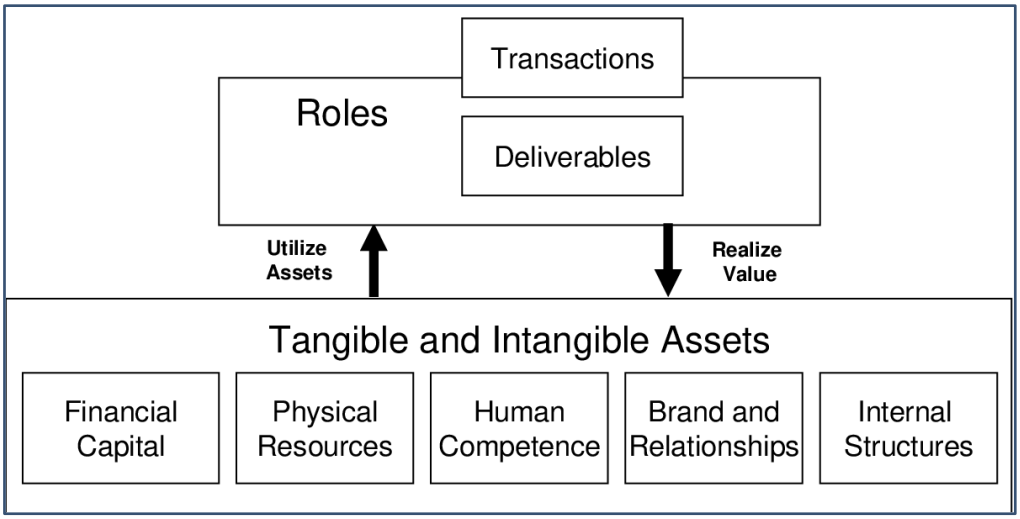

Figure 51: VNA Overview

VNA takes a whole different approach compared to the BMC; it focuses on the exchange ("transaction") of value ("things" or "deliverables") between roles ("participants"), which can both be tangible or intangible. The value network is represented in a graph in which the nodes are the actors and the edges are the exchanges. This approach is clearly network-centered, focusing upon the interactions between the roles.

The **E3value (E3) methodology** is a stepwise approach to develop business models for networked value constellations [19]. These constellations are networks of enterprises who offer something of economic value to end users. Networks consist of end users (the customers), suppliers, and the suppliers of these suppliers. Similar to the VNA approach, the E3 value model uses a visual notation to represent the value exchanges between different actors, though intangible exchanges are mostly neglected in this approach. "The goal of the model is twofold: a) to create a shared understanding of the various business strategies and value constellations at hand, and b) to analyze a business strategy and its operations in terms of networked value constellation for economic sustainability". Additionally, the E3 model provides a higher level of detail than VNA using additional elements such as value ports and value interfaces; value ports are used to provide or request value objects to or from its environment and are grouped in value interfaces as shown in the following Figure.

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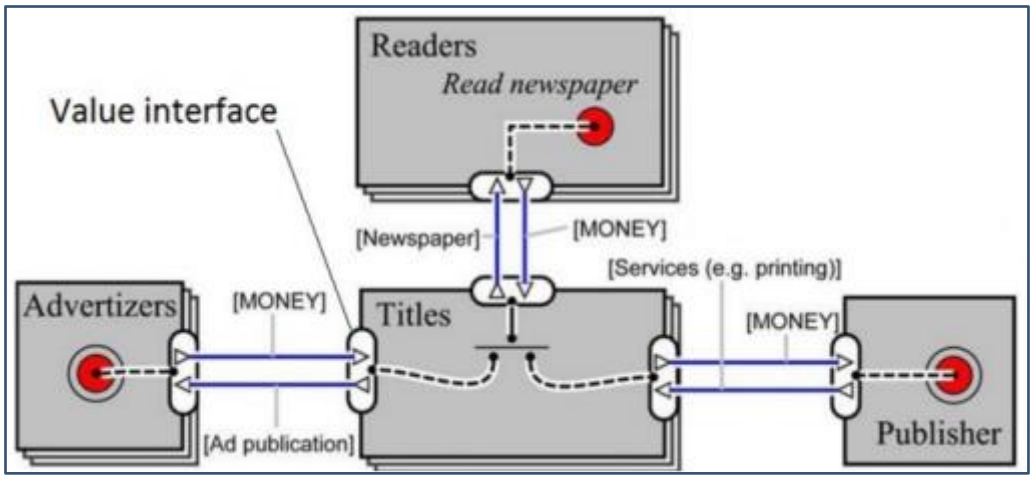

Figure 52: E3 overview: An example of a value interface grouping a number of value ports into value interface

It is important to know is that different models have different goals and may have specific uses. The following table aggregates the key elements which were detected in the three discussed representations (BMC, VNA, E3).

Parameter	BMC	VNA	E3
Partners	x	x	x
Tangible value streams between partners		x	x
Intangible value streams between partners		x	
Activities	x		x
Scenario analysis	x	x	x
Economic viability			x

Table 12: Analysis of the most relevant models that allow the representation of value flows

Value networks are complex. They encompass much more than the flow of products, services, and revenue of the traditional value chain. Therefore, it is important to not only look at the tangible and thus quantifiable value streams, but also to the intangible value streams such as knowledge transfer which cannot be directly expressed in monetary terms.
Existing models, such as VNA and the E3, to represent value networks typically use a static approach, representing only a fixed point in time, missing the ability to show long-term effects and evolutions. To address this limitation a research project was set up that defined the concept of **dynamic value network (DVN)** configurations and suggested a uniform representation based upon a time-oriented approach which will help companies to estimate the impact of future business decisions [16].

The Smart5Grid project, focuses on the opportunity that Network Applications and 5G bring for the digitalization of the energy vertical and energy grids. Therefore, instead of reusing business models for Smart Grids in general, we will focus specifically in the value proposition of Network Applications.

The typical business models are based on specific value propositions delivered from one company, and aim at modelling one company's operation, to achieve its goal. The emergence of 5G and beyond technologies and solutions, bring the need for additional means to develop business models that work for the many firms that are creating value together in 5G and beyond ecosystems.

Business modelling in ecosystems

An ecosystem is generally defined as "a complex network of interconnected systems". The definition of the *business ecosystem* specifies the type of relation and cooperation among the firms in the ecosystem (from transactional to strategic), in which the intention is not just to aggregate value (1+1=2), but to generate additional value (1+1>2). This enables all firms in the ecosystem to acquire more value than they would be able to capture independently.

The many potential commercial relationships between firms bring substantial complexity. Previous business models tended to be linear, whereas today's cooperation tends to be more circular and cooperative, building upon multilateral cooperation based on the skills and capacities of each interacting player in the ecosystem. As a result, ecosystem-based value creation can be modelled and presented by means of value networks.

An example of this trend is the softwarisation of the telecom infrastructure, which implies a transition from pure telecoms technologies to information and communication technologies. Before 5G, the linear relationship of a vendor and an operator was enough to model the delivery of telecom services in the market.

5G and beyond network technologies introduce fundamental technological transformations compared to earlier generations, which dramatically increase the number of alternative business models available. This creates significant complexity in deriving appropriate business models that ensure profitability for each of the firms in the ecosystem, while delivering the expected value to customers.

With the emergence of 5G, the disaggregation of telecom technologies, third-party network applications, emergence of new actors, we witness the need to transition from a linear value chain to an ecosystem approach for modelling value creation.

Existing and new entrants in the market need to develop "platform based" disruptive business models, assessing the opportunities for suppliers, developers and integrators. The end-to-end solution covering the need of a certain vertical industry could equally be brought to market by a 5G equipment vendor, a mobile network operator, or an ICT integrator. These multiple scenarios create may different ways to arrange the value chain, with different contributions and profit split among the participants.

These multi-actor platforms are similar to the ecosystem that has been developed around applications for mobile phones (Play store, apple store), where we have different actors for the hardware (phone vendors), the operating system (apple, google), and the applications (third-party developers).

Consequently, the justification for the need of ecosystem modelling is twofold: 1) evolution of technology and customer needs require increased collaboration by independent firms, i.e., implicit

increased interdependency, and; 2) revenues and market growth will only be unleashed by collaborative aggregation of value contributions. The power of the ecosystem comes from the fact that each actor can derive profitable returns without the need to own or operate all components of a solution.

An attempt to model this complexity in the 5G ecosystem has been the white paper "5G Ecosystems", which partitions the ecosystem in a *5G provisioning ecosystem*, and a *5G vertical ecosystem* [20]. The 5G provisioning ecosystem caters to developing, delivering and providing 5G services, while the 5G vertical ecosystem applies 5G services in combination with other technologies and offers them to vertical customers and users.

Roles in the 5G provisioning ecosystem include Service Providers, Network Operators, Hardware and Software Suppliers, Cloud providers, Datacentre Providers and Solution integrators. Roles in the 5G vertical ecosystem include Software Providers, Data Processing and Hosting Providers, Service integrators, Computer Consultancies, as well as vertical sector specific roles from sectors such as industry automation, healthcare, or Automotive.

Operating within such an ecosystem brings challenges, such as, increased competition, continuous disruption, danger of obsolescence, rapid market share erosion, etc. However, benefits include increased innovation, the ecosystem effect in multiplying value creation, and rapid market growth.

Due to the increased complexity, multiple player roles and large number of possible model configurations, it is probably unfeasible to develop a single 5G business model catering to all cases. Instead, we should focus in deriving different business models for each opportunity, allowing for different market segmentations, vertical applications, etc., and modeling the role of each of the participants.

One approach for describing and assessing the formation of an ecosystem is the implementation of the following five steps (suggested by 6G IA BVME-SG). The high-level description of the sequence of steps illustrates the different process that needs to take place for the analysis and realization of an ecosystem:

- **Step 1 – Expand**: Understand Business Ecosystem Model and Actors contributing to value creation.
- **Step 2 – Focus**: Specific Market Environments & Business Dynamics. Company's business role in very specific ecosystem formulations. Identification of proper business partners.
- **Step 3 – Design**: Company Business Model Definition. Validation of alternative business ecosystems. Optimal company business model.
- **Step 4 – Develop**: Developing Company Business Cases. Value proposition, business plans and revenue models to estimate market opportunities.
- **Step 5 – Iterate**: Identify improvements and changes early and with less costs incurred.

Even though Network Applications for the energy vertical enable new services, it is still an open question which stakeholders will develop them. It could be argued that DSOs and TSOs should concentrate in their core business and suppliers and third parties should be the ones developing the

applications. If there are profitable business opportunities in developing Network Applications, then those market players that will not participate in their development will vanish due to competition from those who do. A lot of these applications will benefit industry actors by bringing efficiency improvements, and in order to get a clear picture of how much an end customer is willing to pay, we should try to evaluate the economic value brought by these efficiency improvements.

4.1.5. Value Network-based Models

Value network-based approaches have been widely used to capture the complexity of telecom business contexts, which involve many interacting firms with non-sequential relationships across markets. Value network is a network of relationships that generates economic and other types of value through dynamic exchanges between two or more participating players [21]. As discussed, the exchanges may be of tangible or intangible nature.

A value network is a business analysis perspective that describes people and technical resources within and between businesses. The nodes are connected by interactions that represent tangible and intangible deliverables. These deliverables take the form of knowledge or other intangibles and/or financial value. Companies are usually part of a value network since very rarely one company produces something totally by itself without any suppliers and sells it directly to the end customer [22].

The concept of value chain is still used today, but it has been criticized for its one-dimensional view of seeing companies as a linear flow. Thus, the concept of a value network has been proposed instead [23].

This notion takes into consideration that multiple companies in each step can participate in the production and delivery of the final product or service. A value network is defined as "a system of partnerships and alliances that a firm creates to source, augment and deliver its offerings". By orchestrating the different parties of this network, a superior value is created and delivered to the target market.

Presenting a complete value network is a difficult task, since there are many alternatives on how the network can be arranged. The multitude of different actors and value-adding activities, present the opportunity for numerous combinations in order to form a complete value network.

An example of a value network centered around network applications targeting the energy vertical is presented in the following figure.

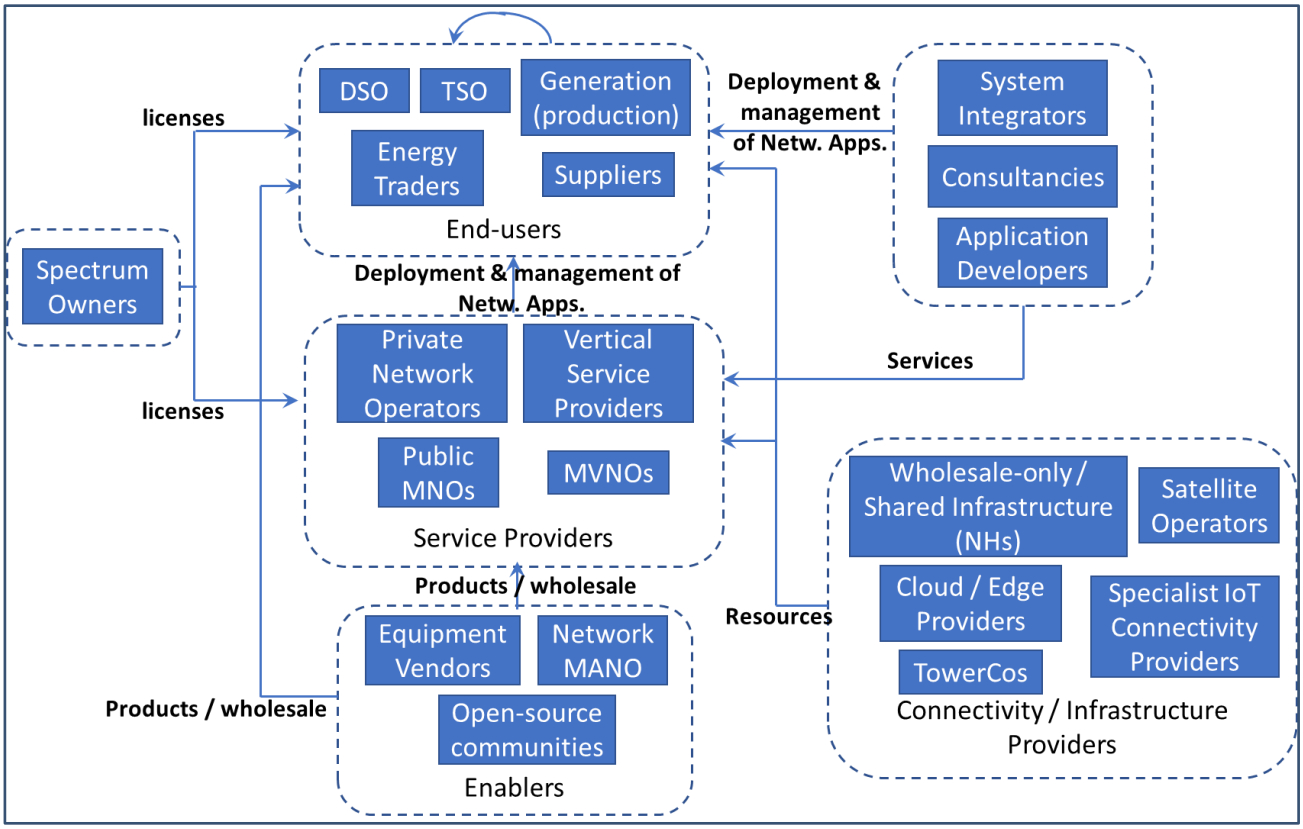

Figure 53: Value network for the provision of Network Applications to the energy vertical

Definitions:

- The direction of the arrows in the model represents the direction of service flow.
- Revenue flow is considered to be in the opposite direction. In some cases, revenue sharing exists between two players, which is bidirectional.
- The solid rectangular boxes represent the roles.
- The dashed-line boxes represent a player. A player may take up one or more roles.

The following players could act as a Network Application provider, having the central role in designing, deploying and operating the applications:

- End-users themselves, such as TSOs, DSOs, Generation, etc.
- Service Provider stakeholders, such as Public MNOs, Private Network Operators, MVNOs, Vertical/Industrial Service Providers.
- System Integrators, Consultancies and Application Developers

The products and services of Enablers such as Equipment vendors and Network Management & Orchestration solution providers, are necessary for the functioning of the ecosystem.

Resources from Connectivity/Infrastructure providers, such as Neutral Hosts, Satellite Operators, Cloud providers may also be used in the provision of the Network Applications.

Service providers, such as Public MNOs, Private network operators, vertical service providers are in a good position to provide Network Applications targeting a vertical, since they provide the underlying network infrastructure.

On the other hand, Consultancies, System Integrators and Application Developers with knowledge of the vertical industry are also in a good position to develop the applications.

Regarding the end users, such as the DSOs and TSOs, even though they have first-hand knowledge of the opportunities and problems that need to be solved, developing and deploying applications is usually outside their comfort zone.

During the next project period we will analyze the different stakeholder's capabilities to assume the "prime" role in deploying solutions based on Network Applications. Based on this analysis, we will then select which value chain options to use as the basis of the business modelling.

4.2. Preliminary Exploitation Activities

The exploitation strategy of Smart5Grid is based on three complementary paths:

(i) A **cooperative exploitation path** aimed at ensuring the sustainability and wider uptake of the Smart5Grid solutions, leveraging interested and committed stakeholders,

(ii) Development of **exploitation plans by each individual partner**, in-line with each partner's business and research strategy; and

(iii) **Exploitation of the NetApps** produced by the project. The open-source platform and the demonstrated Use Cases are also exploitable assets targeting specific vertical market segments, such as energy, telecom, and ICT sectors.

In the next section we present the updated exploitation plans of the consortium partners.

4.2.1. Exploitation plans for Telecom Operators

WI3 is interested in further evaluation of the proposed solutions to offer a more "green" ultra-broadband access evaluating the profits and benefits of applying Smart5Grid vision to enable control over communications of the critical electrical infrastructure and guarantee the eco-friendly development. WI3 will exploit knowledge coming from the proposal and will focus most of its efforts on specifically exploited solutions to introduce the new models to achieve better management of the smart grids using the 5G network and the new available NetApps. This innovative pro-active approach will allow to manage systems more and more complex, according to the evolution of the new model applied to the Energy context. An important incremental market is expected for this sector for this vertical; furthermore, it could be possible to extend the new approach to another vertical context such as the smart cities (e.g. to improve the number of the solutions for sustainable mobility using electric vehicles, etc.). The outcomes of the Smart5Grid will be important for WI3 to explore other potential markets and how to deal with slicing management for different services to be offered by physical infrastructures and by cooperation between different involved actors.

OTE (Hellenic Telecommunications Organisation S.A.), member of the Deutsche Telekom (DT) Group of Companies, is the incumbent telecommunications provider in Greece. OTE as the leading company of the OTE Group of Companies, offers its customers a wide range of technologically advanced services and ICT solutions in the residential and business market segments, including 5G/4G+,

FTTH/VDSL, Intelligent Network services and a wide range of value-added services. In particular, the OTE Group invests heavily in new generation networks, creating novel infrastructures which will boost the Greek economy and create growth potential.

In this specific context, OTE is highly interested in accelerating the development, deployment and validation of modern and innovative telecommunication services and/or related facilities/solutions, as those intended to be developed by the Smart5Grid project, especially within the specific framework of innovative 5G / "Beyond 5G" B5G – or 6G – facilities. Thus, OTE intends to exploit the anticipated project findings in terms of delivering pioneering services/solutions with strong user engagement by further promoting its competencies in the field of the telecom networks market arena as well as in the respective verticals, at both national and European level (i.e., within the context of the DT Group, where relevant). Via his involvement to the Smart5Grid's framework, OTE foresees the development and/or the improvement of some of his existing products/offering, in particular by "tailoring them" to the 5G – or the B5G – needs and requirements.

Targeted deployment scenarios that are to be promoted by the context of the project effort can support compliance to the well-defined KPIs (especially those promoted by current 5G/6G research), in order to enhance OTE's role in the modern telecom market. In addition, as OTE is involved in major technical works and trials intending to validate the applicability of the proposed technical solutions, these will be further assessed as "enablers" for the promotion of corporate innovation. Results coming from the project, especially those from use case 4 (UC4) which is directly supported by OTE via the provision of necessary 5G infrastructures, are expected to be tested and further validated, so that to comply with the real network infrastructures of the company. In this scope, related solutions are expected to be evaluated and/or modified accordingly, to the extent possible, so that to be able for direct implementation in OTE's services portfolio.

OTE will take care so that to establish a viable route to market for the Smart5Grid-based "key" bundles and the overall smart grid environment. In the course of the project, OTE will also examine potential opportunities to establish a cooperative exploitation framework with some members of the consortium being involved in joined test and trials (for example, targeting upon the preparation of joined exploitation plans and commercial prospection actions). The innovative features of the expected findings will also help to design and promote new business models within the framework of the company's core activities.

As the Smart5Grid project is an important part of the ongoing EU-funded research effort, especially towards promoting the development and implementation/use of NetApps in modern 5G environments, OTE intends to assess related findings in parallel with those coming from similar European projects where the company participates, so that to better establish a plan for providing solutions to interested third parties that could potentially be assessed as new "clients" in new offerings.

However, the most important feature is due to the fact that Smart5Grid offers an excellent opportunity towards implementing both 5G and B5G innovations in modern vertical markets, especially within the smart grid area. This will "open" new horizons for extending traditional ICT-based services to a more converged framework, now serving the power energy sector; in this scope, involved energy actors – in particular Transmission System operators (TSOs) and Distribution System

Operators (DSOs) – will have the opportunity to establish new business channels with OTE, in new market areas, as 5G allows for dynamic power system monitoring (if it is to save energy, to reduce losses and to enhance the reliability of the power grid).

In addition, the diversity of power grid services requires for a flexible and orchestrated network, while high reliability requires isolated networks and millisecond-level ultra-low latency requires networks with optimal capabilities. By responding to such critical challenges, 5G networks constitute an ideal choice to enable smart grid services; furthermore, 5G network slicing will allow the power grid to flexibly customize specific slices with different network functions and different SLA (Service Level Agreement) assurances according to the needs, so that to "meet" different network requirements of various services. 5G will also contribute to the effective integration of a multiplicity of devices to smart grids, allowing the proper handling of immense data sets and permitting for exact monitoring and management of energy needs of various underlying systems, with explicit benefits in applications and the related market services.

In the project framework, the dedicated WP6 which is led by OTE is about the implementation of two important use cases (i.e., UC3, UC4) that perfectly serve the above context.

OTE will so exploit the expected Smart5Grid's concept by verifying the proposed platform and then by attempting to apply related innovative findings into the company's market (current or future) solutions, thus strengthening customers' confidence and enhancing his corporate competence in the field of telecommunication networks, in the energy vertical sector. Project's exploitable assets, once properly tested and validated, will be demonstrated to the exhibitions that OTE representatives will participate and anticipated customers will be further engaged with Smart5Grid-based developments and products.

The scope of UC3 is the millisecond level precise distributed generation monitoring which addresses the domain of the distributed energy operation and maintenance, with a specific focus on renewable energy resources (RES) plant management. This will allow the real-time (RT) monitoring of a RES plant (i.e. a wind farm) by using the emerging capabilities of 5G telecommunication networks. The 5G technology is essential for UC3 as, previous generations of wireless technology do not fulfil imposed criteria for low-latency and high reliability in millisecond basis while, simultaneously, the massive deployment of Distributed Energy Resources (DERs) in the grid together with IoT devices implies for appropriate technologies to assist related transformation processes and to support both flexibility and scalability. This creates a widespread IoT ecosystem that potentially includes millions – or even billions – of devices operating on a range speed and, most importantly, having different bandwidth while implying for a great variety of quality and service (QoS) requirements. To achieve such targets, technologies before 5G cannot provide the needed coverage, latency, security and cost optimization. In addition, scalability can only be achieved through the utilization of 5G infrastructure, where more RES and IoT devices can be connect to the NetApp without deteriorating the performance of the services.

At this part it is also worth to mention that the OTE Group considers RES as a "key tool" for the decarbonization of its operations, so OTE promotes a wider set of explicit or implicit measures to support this policy target. Therefore, the development of smart electricity grids (transmission and

distribution) will facilitate the large-scale penetration of RES electricity and will create new business paths and opportunities for growth, if effectively "joined" with ICTs and 5G networking.

The scope of UC4 is the real-time monitoring of a geographical wide area where cross-border power exchanges take place and addresses the energy reliability and security domain of the broader energy vertical. More specifically, in UC4 the interconnection flow between Greece and Bulgaria is to be monitored by leveraging the advantages that 5G telecommunication infrastructure provides, via the supervising actions of a newly established Regional Security Coordinator (RSC) in Greece. RSC's role shall be the promotion of regional cooperation and the support of strengthening of the neighbouring power systems and market operations in the region. To achieve the enhancement of the interconnected power system operation, live monitoring of the power flows between the two countries is of vital importance. Phasor Measurement Units (PMUs) located at the High Voltage network of Northern Greece, monitoring the interconnection area with Bulgaria, will be used as the "input" in the monitoring process. By incorporating time-stamped synchronized PMU measurements, high data granularity is expected to be achieved. A virtual Phasor Data Concentrator (vPDC) is to be developed for data gathering process. The utilization of 5G in UC4, due to UC4's criticality, contributes to the connectivity between the PMUs and the vPDC, offering its low latency and the high reliability needed. As the DER penetration rate increases at EU level, this also increases the complexity of the power system making its RT operation and control functions quite demanding and "difficult to handle". Intending to respond to this requirement, it is essential to consider a Wide Area Monitoring (WAM) system, being able of capturing and alleviating dynamic phenomena that can create hazardous conditions and/or instabilities in the entire power system. WAM systems mainly leverage the high accuracy of PMUs and the low latency of the 5G telecommunication networks. The proper inclusion and use of 5G facilities in such scenarios can help TSOs to realise effective and dynamic monitoring of their power systems, allowing them to operate under secure conditions and be robust towards abnormal dynamic contingencies that threaten the overall system balance. As in the previous use case, here 5G not only offers a means to fulfil the latency, bandwidth and reliability requirements imposed by the criticality of the application but also constitutes a more flexible and cost-efficient way of communication.

Last but not least, apart from the above options and any potential exploitable benefits rising from the framework of the described use cases, OTE's SmartGrid activities also intend to serve towards the corporate environmental policy and the role that smart grids can perform as ICT services (e.g., energy management, dynamic operational monitoring of smart grids, etc.) can be utilized to increase resources' efficiency and reduce carbon emissions of clients.

VIVACOM is fully integrated operator that provides mobile, fixed telephony, fixed broadband and pay-TV services nationwide to residential and business customers. Vivacom is part of United Group which is the leading multi-play telecoms and media provider in South East Europe, providing customers with a full range of telecommunications services. In September 2020 Vivacom was the first to launch 5G mobile network in Bulgaria, initially in all 27 district cities. In 2021 Vivacom continues its investments in 5G deployment with network coverage extended to over 200 settlements

throughout the country. Vivacom have received multiple awards for its state-of-art networks and technological advancement. Vivacom's mobile network was named fastest in Europe for 2020 according to results from tests taken with Speedtest® by Ookla® for Q1-Q2 2020 and Q3-Q4 2020. In 2021 Vivacom received award for fastest 5G network in Bulgaria for Q3-Q4 2021, according to Ookla® analysis. Vivacom's 5G network has the best coverage in Bulgaria based on publicly available information of 5G coverage by number of settlements as of January 7, 2022. Vivacom is interested in further exploitation of the 5G paradigm and cloud infrastructure, as enabled by the Smart5Grid in such a way that it becomes beneficial to the company's technical expertise besides considering the project needs. This will allow for exploitation of the development for improving network control and IT infrastructure. Also, through Smart5Grid, Vivacom will be in position to gain more awareness on 5G-based network control, virtualization and management. The outcomes of the Smart5Grid will enable exploration of potential new market opportunities including slicing management for different services to be offered by physical and cloud infrastructures.

4.2.2. Exploitation plans for DSOs/TSOs

ENEL has a unique opportunity for E-GI&N and its linked third parties, through the Smart5Grid, to exploit the expertise of Consortium partners and ensure that 5G capabilities meet the requirements of the vertical energy use cases, i.e. device density, data rate, availability of the communication and latency. Starting from the activities foreseen in this project, E-GI&N can be able to extend field trials to additional 5G use cases, while gathering expertise in using such novel technologies. The experimentation can open the way to a new way of data quality monitoring, ensuring the adequate reactivity of the involved field devices for ensuring the expected technical quality of the electricity distribution service and, consequently, providing of a better service for the citizen thanks to the reduction in the number and duration of interruptions. Last but not least, the collaboration with strategic partners from both energy (ENEL, EDI and EDE), Information Technology (ENG, ATOS), telco (OTE, WI3 and NIS) and a plethora of SMEs can derive fruitful partnerships in jointly extending, deploying and offering the Smart5Grid NetApps as a commercial offer in the European and Latino-American market.

IPTO is responsible for the operation of the electricity transmission grid in Greece with over 11 thousand km of system covering the whole of mainland Greece and an increasing portion of the Greek Islands. According to Law 4001/2011, IPTO undertakes the role of TSO for the Hellenic Electricity Transmission System and as such performs the duties of System Operation maintenance and development to ensure Greece's electricity supply in a safe, efficient, and reliable manner. In this context, IPTO's exploitation plan includes assessing the feedback of the pilot projects, with main focus on the Greek-Bulgaria use case and make concrete use of the results in its operation functions, and more specifically, to the backbone of the Greek power system which consists of 11,510 km Transmission Lines and 328 High and Extra High Voltage Substations connected to the System. Furthermore, IPTO plans to assess the scalability and financial feasibility of the Smart5Grid pilot projects and communicate the results to the respective stakeholders mainly policy makers, industry partners and other TSOs. This would be conducted via internal reports, scientific and media publications.

ESO is responsible for the common operational planning, coordination and control of the Bulgarian power system and its parallel synchronous operation with neighbouring systems. Its purviews include

transmission grid operation, maintenance and reliable functioning, auxiliary network servicing, as well as maintenance and repair services in the energy sector. It also manages the power transit through the national grid and runs the electricity market. ESO will use the Smart5Grid project's results after an evaluation in its daily operations activities and in coordination and control of cross-border electricity flows.

4.2.3. Exploitation plans for ICT Industrial Partners

ATOS is a global leader in digital transformation with 110,000 employees and annual revenue of € 12 billion. European number one in cybersecurity, cloud and high-performance computing, the group provides tailored end-to-end solutions for all industries in 73 countries.

Atos Research & Innovation (ARI) department is the source of innovative ideas coming from EU and national funded projects. The results from these projects play a vital role to booster the innovation process within the organisation and to enhance the portfolio of products and technologies offered to its customers. ARI holds regular meetings with the corresponding Industry (Telecommunications Media, and Technology (TMT) in this case), with a bidirectional purpose: on the one hand, ARI team learns about the company's strategy, the company portfolio, and the partners and customers' demands; on the other hand, ARI team provides insight about the latest European research trends, the projects and consortia the ARI team is involved in and the results coming out of the projects. Both sides discuss convergence and ways of collaboration, developing a roadmap to accomplish agreed objectives.

Within *ARI,* the *Smart Networks and Services (SN&S)* team is the one participating in Smart5Grid project. Its expertise revolves around technologies that enable the development of the next generation telco networks: software networks, telco service-based and microservices management architectures, Multi-Access Edge Computing (MEC), v-RAN (virtual Radio Access Network), smart network management, etc.

In Smart5Grid, as WP2 leader, Atos SN&S team has led the design of the Smart5Grid platform´s architecture as well as the specification of the Smart5Grid NetApp. The Atos team is also developing some elements of the Smart5Grid platform:

- the **Local Registry,** a subcomponent of one of the NetApp controllers of the project which is in charge of storing all the artefacts that compose a NetApp package, as well as their provisioning in OSM;
- the **Verification Engine,** a component of the V&V framework which verifies NSs and VNFs descriptors, as well as the NetApps from the Information Model created in Smart5Grid.

In this context, Atos foresees the following exploitation scenarios as the most suitable to be explored during the project lifetime:

- Enhancement of the Atos TMT portfolio. To the further explored.
- Contribution to OSM. More details about this exploitation scenario can be found in section "Standardization Activities"
- Integration in other existing and future research projects. As mentioned in section "5G-ROUTES", Atos is already extending a component developed in the context of 5G-ROUTES project to be used in Smart5Grid. When possible, the same approach will be used with the assets resulted from Smart5Grid in order to grant the sustainability of such assets.

ENG offers energy utility market services such as Billing and Back-end for gas and electricity sales, Operation Management for gas and electricity distribution, Business Intelligence Systems, Real Time Meter Data Management for Enhanced Analytics and Drones Integration and Management to support WorkForce Automation and O&M for utilities. The exploitation plan for Smart5Grid would include: i) to include and to integrate a large extent of the Smart5Grid services and technology platform in order to enlarge its own commercial offer towards the utilities, which could be interested to integrate Smart5Grid value added, and ii) the team involved in Smart5Grid is directly in charge of infusing and transferring technological bricks to the business lines of ENG. These offerings will thus benefit from the technology developed in Smart5GRID. The NFV-oriented development and NetApps deployment will leverage NFV chaining and orchestrate to customise network services and rationalise their management in manner to enrich the 5G portfolio of the business ENG units.

4.2.4. Exploitation plans for Universities / Research Institutes

i2CAT vision is to achieve a leading ICT research and innovation role with a special focus on market needs. Our ambition is to become an internationally recognised strategic partner driving Internet initiative across economical, industrial, and social sectors and boost the innovation and technology transfer competitiveness. Experience and knowledge gained in the European funded projects is an essential element to earn the required intellectual capital. i2CAT, as a research centre, collaborates closely with the universities. This collaboration helps us to make sure a continuous knowledge transfer to the next generations of experts via offering workshops, courses, and scholarships to university students. i2CAT's private foundation has built a good industry footprint from key players in the telecom industry specially via its board of trustees (Juniper, Cisco, Orange, and Vodafone, among others). Presenting project outcomes is a regular exercise to raise awareness among important industrial partners and to impact technology evolution. i2CAT considers this project of crucial importance, as it is aligned with the 5GBarcelona initiative of which i2CAT is a core partner. The goal of 5GBarcelona is to establish an incubator for the 5G ecosystem in the region, revolutionise the regional economy, and promote the innovation of small and medium enterprises. i2CAT will exploit the project's results to become a key ICT technological partner and help SMEs build an advanced integrated 5G ecosystem in the Barcelona innovation hub.

UCY (KIOS CoE) exploitation goals are on the scientific and technological development of the solutions with applications on power systems operation, stability and control, energy-communities and microgrids, green energy supply to integrated critical infrastructures, cyber-physical systems. UCY (KIOS CoE) will facilitate and support both the academic and research widening of the project results, promote them to the local stakeholders and sustainable energy promoters; adapt and advance the scientific knowledge gathered within the project development for educational and research purposes within the local network and the industry partners, define new research directions that could be exploited by PhD or Master programs. On top of the above specific exploitation goals are detailed below:

- UCY/KIOS CoE integrates an Innovation Hub cluster, under which regular meetings with Industry Partners (e.g., from the Energy Vertical) takes place in line with ongoing or potential

new collaborations. During these regular meetings the KIOS CoE teams learn about their industry partners' business needs, and they also provide insights about the latest EU research trends in the field, the projects and consortia and what is the direct KIOS CoE involvement in the results coming out from those projects. These direct interactions with all major local stakeholders in the energy industry also develops into further synergies of collaboration with concrete implementation objectives. Specifically, the power team of KIOS CoE (UCY) will further explore the path of exploitation of those outcomes from the Smart5Grid project that were created with the direct contribution of the KIOS CoE team in future collaboration with the local industry.

- In Smart5Grid the power team of KIOS CoE (UCY) is leading two tasks, one related to use-cases and architecture requirements, and one related to pre-validation of the Smart5Grid solutions in pre-piloting testing environments. As part of the second task, KIOS CoE (UCY) team also developed a tie-line monitoring tool, a wide area differential protection tool and a wide-area controller for distributed energy resources (DER) to provide ancillary services to the grid. Specifically, those tools are
    - enhancing and closing the operation loop (control action*) of the solutions proposed under the pilot of UC3 (millisecond level precise monitoring and control* of distributed energy resources) for providing ancillary services in the intraday balancing electricity market; and,
    - extending the applicability of the pilot in UC4 (wide area monitoring for cross-border power flow) to wide area monitoring and protection as a cost-effective, scalable, and flexible deployment solution that the 5G technology could bring for the energy vertical.
- The above-mentioned exploitable items developed by the KIOS CoE team under smart5Grid aim to enhance the KIOS CoE IPR portfolio for which several paths of exploitation will be further explored (e.g., consultation services to local energy stakeholders, external training offered to local energy stakeholders, among others)
- Furthermore, the UCY/KIOS CoE team aims to explore the possibility to integrate some or all of these solutions in other existing or future projects. A special attention in this respect will be given to the exploitation of the KIOS CoE testbed infrastructure that was built for the pre-piloting phase of the Smart5Grid, which can be used for pre-piloting facilities in other projects such as to facilitate proof of concept tests which could clarify may an investment in 5G-enabled applications for power systems is reasonable or not.

UoA's main goal is to improve the education, work on up-to-date research questions which are emerging from the field and provide support for the power systems and energy player via consultancy capacity as well as with its accredited laboratories. This will be achieved by gathering information about the topic which later will be integrated into the curriculum. In the other side convince promising young engineers to choose these areas for their BSc, MSc thesis work or PhD thesis topic. Furthermore, meet the international solution providers and test their products to provide state-of-the-art knowledge to the power systems and energy players during consultancy services.

4.2.5. Exploitation plans for SMEs

ATH is an Italian SME focused on developing software-only 4G and 5G core networks, tailored to use cases and vertical deployment needs in the context of private mobile networks. With its globally awarded BubbleCloud solution, Athonet achieved to deploy a 4G EPC and 5G CN in Amazon Web Services (AWS), available as SaaS through the AWS marketplace to customers. As a well-established

solution provider for 4-5G private networks, Athonet expects to benefit from the results of Smart5Grid not only to promote top level 5G products including MEC networking solutions (S-PGW in 4G and 5G-NSA, UPF in 5G SA) for allowing traffic breakout at the edge of commercial networks for highly demanding local applications, but also to accelerate the market growth, and, to a broader extent, to increase the awareness and business opportunities of 5G MEC and private cellular networks for industrial applications, utilities and smartgrids, which are the verticals where Athonet is deeply involved in since its foundation.

INF is an innovative SME company, established in Athens, Greece, specialising on the design and development of chatbots, either as custom-made standalone applications or as subscribed-based services (Chatbot as a Service) via the privately owned chatbot platform, operating also in 5G and IoT enabled environments. Chatbots are applications that simulate human conversation, based primarily on conversational flows and occasionally enriched with DL/NLP technologies for more sophisticated automation of use-cases.

INFOLYSiS, in parallel to its commercial activities, is committed to driving research results forward by experimenting with novel technologies and infrastructures, such as 5G, SDN/NFV at the network edge and container-based virtualization in IoT areas (mainly of IoT interoperability) in order to advance the chatbot capabilities and expand its applicability in novel ICT use-cases such as 5G and IoT enabled environments, smart home solutions and smart cities.

INFOLYSiS through Smart5Grid project will further exploit Smart5Grid results by increasing INFOLYSIS's presence and penetration in the respective area of 5G research and will facilitate the processes to make the project achieve maximum visibility and to maximise its impact within the business and scientific communities, as well as within the chatbot apps commercial market and SMEs ecosystem, so as to guarantee a fast adoption of the project outputs and easier commercialization of its future chatbot based products and services.

INFOLYSiS participation to the Smart5Grid project, as communication and dissemination leader, and in conjunction with the participation and outcomes of relevant 5G related projects (5GENESIS and EVOLVED-5G) will further

- Foster INFOLYSiS IoT and 5G R&D activities coupled with chatbot technologies
- Encourage the development of chatbot based applications using the 5G network capabilities.
- Enrich the know-how and the research expertise of the company in 5G technologies in the energy sector.
- Potentially create new chatbot based products and services targeting new markets and sectors.
- Exploit Smart5Grid results within related scientific and industry communities
- Enhancing its participation in the evolving SMEs ecosystem and chatbot apps markets.
- Participate in new SME accelerator communities and incubator programs through which INF will further communicate Smart5Grid developments, results and experimentation opportunities
- Use expertise gained in the research activities of ongoing 5G related projects in which INFOLYSiS participates for further enriching and promoting Smart5Grid activities and achievements.

- Acting as a liaison among different projects' common activities (e.g. third parties experimentation using ICT-41 projects NetApps infrastructures) and promoting the engagement of SMEs in mutually beneficial activities
- Communicating Smart5Grid's activities to associations and working groups in which INF is member (e.g. NetworldEurope, SME WG, Comms WG, NGIoT communication task force) diffusing in this way project results among several SMEs and startups that may act as external third-party experimenters.

UBE exploitation intentions are aligned under the UBITECH ENERGY Research and Innovation Strategy defined in the company, which aims at providing innovative tools and technology stacks to improve smart grid integration and digitalisation in the energy sector. As highly competent in the energy services sector, UBITECH ENERGY is well positioned to exploit its strong image and connections to promote the project´s outcomes both internally (targeting its more than 100,000 business technologists worldwide) and externally (through its wide client base and associated partners). To do so, and as a part of its internal dissemination strategy, a broad range of dissemination assets will be generated (posters, flyers, videos). Through its wide network of business and academic institutions that is cooperating will hold customer innovation events, customer specific innovation workshops or internally in the company through established technical innovation mechanisms such as R&I organisations and Scientific Communities.

8BELLS recognised early the emerging decoupling of software and hardware via NFV and whitebox networking technologies, and the introduction of successful, open-source software stacks for telecom networks that leverage on MEC solution. The participation of 8BELLS in the Smart5Grid proposal is fully aligned with the company's strategic decision to investigate and to focus on the market research about the software-driven telecom segment in various verticals. In this context, 8BELLS is interested about Smart5Grid outcomes through enhancing the technology, the developed NetApps and economic enablers in Europe and internationally.

SID will exploit the results of Smart5Grid by extending and expanding its products and solutions with cutting-edge tools for enabling security on critical infrastructure exploiting 5G capabilities. The integration of 5G capabilities into the drones' technology will be a technological leap for the enterprise allowing to expand its portfolio on domains that have a great market value and market potential. Lastly, SID will highlight events and private domain in Cyprus, the European and international market in order to promote the development and sales of Smart5Grid exploitable components.

NBC is a start-up in the area of Edge Orchestration. NBC will provide their NearbyOne Solution, that addresses the problem of NFV and Application orchestration at the Edge of the Network. NBC will use the achievements of the project to i) extend the interfaces of the tool so to integrate with the Smart5Grid platform and enable the onboarding of 3rd party verified and validated NetApps (through its integration with the V&V framework); and ii) improve their solution and extend the number of Nearby Blocks (applications and NFVs) available in their catalogue with specific focus on Smart Grid technologies. This is a sector that is of special interest for NBC due to its market size and importance. Hence, progress and results will be shared with the consortium and discussed with selected customers in innovation venues.

EE is an independent producer of renewable energy that owns and operates small wind and hydro power plants. EE targets to reach potential energy shareholders (i.e. Smart Grid Operators, Independent System Operators, Energy Aggregators, Regional Distribution Organisations and ESPs) and existing stakeholders that will be interested on the Smart5Grid outcomes, utilising the extensive experience gained from various EU projects participation and through the partners' networks.

STAM focuses its exploitation plan on leveraging on the acquired expertise and research experience from Smart5Grid project. Starting from the experience of the field pilot, STAM will be able to develop additional applications addressing future energy scenarios and their impact on DSO operation issues. In that respect, STAM, as an innovative SME focusing on security solutions and wireless communications, will apply the knowledge gained and the technologies explored in the whole range of its products.

SC is a Bulgarian private firm that specialises in software development, offering a wide range of high-quality services in the development, delivery, and maintenance of software in Europe and USA. Through the large range of our customers, Smart5Grid develop services, applications and tools will be exploited in the operational environment of power systems players (producers, TSOs, DSOs, etc.), that SC is already in contact.

SETECHO is an innovative technology and service provider company that develops novelties and delivers smart energy solutions. Through its international partnerships and alliances with global players in the sector of energy and smart technology, SETECHCO will exploit the Smart5Grid NetApps to existing energy stakeholders and new entries to the distribution and transmission grids.

UW aims to transfer the knowledge acquired during the project to current flagship products, such as the Smart lamppost and in possible new products in the Energy sector, exploring the recent partnership (H2020 POCITYF and FTI 5GaaS projects) with the major Portuguese energy producer Energias de Portugal (EDP). Ubiwhere firmly believes that Smart5Grid will expand market opportunities in the Energy and Telecommunication sectors and will contribute for the company to position itself as an international reference in these two areas acting not only as a technology provider and integrator but also as an enabler.

AXON aims to directly exploit project's results to enhance its technical and scientific capabilities. After the completion of the project AXON will provide relevant software modules to its existing customers, while continuing at a much faster pace to further expand the existing suite of solution offerings to other SMEs, Enterprises and Public administrators, reaching over 50% of the customer base. Therefore, AXON is highly interested in exploiting all the acquired competences for the development of new markets and businesses. Smart5Gird provides such an opportunity to reinforce AXON's current services portfolio in the security and data integrity fields, within the national and international market. Furthermore, the project will offer to the company valuable intellectual property (IP), new expertise to application and security services in the fields of security performance assessment, evaluation and optimisation, and the opportunity to develop initial and unique functionalities. These outcomes will benefit the company's business strategy by advancing consultancy material and know-how in these domains.

NOSIA Smart5Gird presents an ideal opportunity to exploit the significant expertise and the tools that NOSIA has developed and in addition to significantly expand them and adapt them for their analytical requirements set forth by the energy context. Moreover, NOSIA wants to develop early analytical expertise in the domain, which will exploit in different settings ranging from scientific development and the expansion of the current state of the art, up to further developing methods and tools that answer real problem requirements.

4.2.6. Cooperative Exploitation

Some of the project innovations are co-developed by several partners together. For these project results, the consortium is targeting synergies between partners in order to facilitate bringing them to the market. The involved partners are focusing on the market potential of these results, adjacent markets that could also be targeted, exploitation actions, etc.

For the innovations identified with market potential, the partners will also sign an IPR sharing agreement. This agreement, which is being developed, takes into account several parameters, such as:

- IP brought into the project by the partners
- Tools necessary for development contributed by the partners
- PMs each partner is contributing to the joint development

The jointly developed solutions that are so far considered for cooperative exploitation are the following:

- Verification & Validation (V&V) platform
- NetApp Controller 2
- NetApp UC1
- NetApp UC2
- NetApp UC3
- NetApp UC4

While the plan to study the above is in progress, we focus here on the UC2 NetApp controller.

The plan in order to achieve a fruitful joint exploitation for the UC2 NetApp controller is based on different actions:

The first one is linked to the ENG internal process for the integration of new knowledge and products inside the company offering lifecycle.

The second direction takes into account the possibility of jointly exploiting the project results with some of the Smart5Grid project partners. This latter option requires further business feasibility analysis and specific agreements to be implemented.

So, to address both of the ways indicated just above a plan is defined in the next list of actions.

1. To internally transfer the new research knowledge resulting from Smart5Grid project to different company units but in particular to the Energy &Telco Utilities one and the departments involved in 5G production assets. In this option two main ways are used into the company:

a. To work with ENG ICT Enrico Della Valle internal school, where is possible to provide: specific course for company employees enabling them to use the NetApp Controller and related technologies.

b. To create a focus meeting for presenting the main achieved results to internal ENG audience.

2. In order to be embedded inside the software existing product in Engineering a preliminary phase for the integration, customization and test in appropriate environments will be performed after the first phase for the knowledge transfer of the acquired know-how in this final part of the project.

3. If the results of the testing phase will be appropriate then telemetry component will be included inside the company offering.

Other potential ways for including telemetry component, individually or jointly exploit with other project outcomes, into the company offering are envisaged. New opportunities for the project results exploitation could emerge during the knowledge transfer phase from the comparison with the energy business units.

4. The joint exploitation with other Smart5Grid partners needs a further investigation in terms of business feasibility. This analysis will be performed in the cases of the joint exploitation respect to the different component that composes the NAC and also outside to the platform.

5. To discuss and find agreements with other Smart5Grid partners for what concerns any technology and IPR transfer that may be necessary to adopt for the industrial exploitation of results from Smart5Grid. Moreover, agreements with other Smart5Grid partners to find a list of possible software solutions for which the telemetry component is needed.

6. If the business feasibility study will result appropriate for the involved companies and the right agreements will be reached, then the last step will be to improve and customized the solutions to be launched in the market.

The study of the market potential of the Network Applications also takes into account the barriers, advantages and potential acceptance of these as analyzed in deliverable D2.3

5. Standardization Activities (OTE)

Most vertical industries are transforming their processes and innovating their business model, and for that purpose they are actively exploring and adopting a wide range of new technologies. In particular, the adoption of 5G for overcoming limitations and challenges of connectivity and flexibility of other technologies is regarded instrumental for their success. The new 5G landscape of architectures, evolving features and superior performance levels enables possibilities for vertical industries in its digital transformation, and therefore 5G has become a subject of priority focus all along their innovation life-cycle for new applications and solutions, from business opportunity identification to new application's design, solution integration and technical and business validation.

Standards are at the core of the EU single market. Over the last 30 years, the European Standardisation System has delivered more than 3600 harmonised standards allowing companies to demonstrate compliance with EU law, plus many more European standards and technical specifications to promote inter-operability, the safety of EU citizens and protection of the environment. European standards have delivered great benefits for companies and consumers, creating a level-playing field in the single market for businesses and increasing consumer confidence.

Europe's competitiveness, technological sovereignty, ability to reduce dependencies and protection of EU values, including our social and environmental ambitions, will depend on how successful European actors are in standardisation at international level. This not only involves strong standardisation skills across industry and academia, but also requires European standardisation to become more agile, flexible and focused to anticipate the standardisation needs. At the same time, European standardisation must respond to an increasingly rapid innovation pace and needs to deliver standards fast, while preserving high-quality outputs[82].

Standards help researchers and innovators bring their innovation to the market and spread technological advances by making their results transparent[83]. In spreading the diffusion of new technologies, standards provide economic opportunities, facilitate realisation of sustainable development goals and give confidence to consumers that an innovative technology is safe. They codify the technology requirements and inform both manufacturers and consumers on what to expect. They allow technologies and materials to be interoperable: since a standard provides details on the use and content of a technology or a material, it is much easier to know when and how it can be used in combination with other technologies.

Standards enable dissemination of knowledge both within and outside the relevant industry community as they can "bridge the gap" between research and products or services allowing the diffusion of the technology in the market and increasing the probabilities of its take-up. Standardisation facilitates the deployment of new technologies, interoperability between new

[82] European Commission (2022): "Communication on An EU Strategy on Standardisation Setting global standards in support of a resilient, green and digital EU single market", COM(2022) 31 final, 02.02.2022. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022DC0031

[83] Hatto, P. (2020): *Standards and standardisation: a practical guide for researchers*. European Commission, Directorate-General for Research and Innovation Publications Office, 2020. Available at: https://data.europa.eu/doi/10.2777/10323

products and services. Innovations can more easily gain market acceptance and consumer trust if they comply with existing standards for safety, quality, performance and sustainability.

For the period covered in the present deliverable, most of the standardization-related effort has been about monitoring ETSI ISG MEC, ETSI ENI ISG and the 3GPP SA WG2 Architecture. More detailed contributions have taken place in the scope of ETSI ISG MEC.

5.1. SDOs Attended

5.1.1. ETSI ISG MEC

As described in its official website [84], ETSI's Industry Specification Group "Multi-access Edge Computing (MEC) offers application developers and content providers cloud-computing capabilities and an IT service environment at the edge of the network. This environment is characterized by ultra-low latency and high bandwidth as well as real-time access to radio network information that can be leveraged by applications. MEC provides a new ecosystem and value chain. Operators can open their Radio Access Network (RAN) edge to authorized third-parties, allowing them to flexibly and rapidly deploy innovative applications and services towards mobile subscribers, enterprises and vertical segments".

5.1.2. ETSI ENI ISG

The ETSI ENI ISG (Experiential Networked Intelligence Industry Specification Group) seals with detailed specifications for the structuring of a Cognitive Network Management system upon the context of the introduction of a metric for the optimization and the adjustment of the operators' experiences over time by taking advantage of the beneficial uses of Artificial Intelligence (AI) techniques[85] (like machine learning and reasoning[86]). ETSI ENI ISG is open to ETSI members and non-ETSI members, so it can collect feedback by a wider part of the modern ICT market[87]. Among this group's priorities are actions for improving the operator's experience so that the latter to become capable of both recognizing and incorporating new and changed knowledge affecting their network control and allowing interactivity with management systems to adjust services and resources offered based on changes in user needs, environmental conditions and business goals[8889]. This results positively on operators' capabilities of making appropriate decisions on their daily operations. ETSI ENI ISG fully benefits the 5G networks with automated service provision, operation and assurance, as well as optimized slice management and resource orchestration.

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84 See: https://www.etsi.org/technologies/multi-access-edge-computing

85 See, *for example*: ETSI GR ENI 018 V2.1.1 (2021-08): "Experiential Networked Intelligence (ENI); Introduction to Artificial Intelligence Mechanisms for Modular Systems"

86 Also see: https://www.etsi.org/technologies/experiential-networked-intelligence

87 Also see, *among others*: Wang, Y., Forbes, R., Cavigioli, C., Wang, H., Gamelas, A. *et al.*, (2018): Network Management and Orchestration Using Artificial Intelligence: Overview of ETSI ENI. *IEEE Communications Standards Magazine* 2(4), pp.58-65, December 2018, doi: 10.1109/MCOMSTD.2018.1800033.

88 Also see: ETSI GR ENI 001 V1.1.1 (2018-04): "Experiential Networked Intelligence (ENI); ENI use cases". (Available at: https://www.etsi.org/committee/1423-eni).

89 Also see, *among others*: ETSI GR ENI 004 V2.2.1 (2021-12): "Experiential Networked Intelligence (ENI); Terminology for Main Concepts in ENI". (Available at: https://www.etsi.org/committee/1423-eni).

ENI has also launched Proof of Concepts (PoCs) aiming to demonstrate how AI techniques can be used to assist network operation including 5G[90]. The use of AI techniques in the network will solve problems of future network deployment and operation[91]. ENI has published the first version of the System Architecture with Context Aware Policy Management, Categorization on Networks using AI Intent aware network Architecture, Data mechanisms, Evaluation of Categorization, functional concepts, Prominent control loop Architectures & Artificial intelligent mechanisms. Two versions of the Proof of Concept (PoC) Framework and three versions of the Use Cases, Requirements and Terminology in Release 2[92]. A second version of the System Architecture has also been published[93],[94]. ETSI ENI is also working on reports on the measuring of Evaluation of Classification, Intent knowledge within the Architecture and Data mechanisms, Data telemetry[95]. OTE has monitored the activities of the above ETSI ENI ISG as this group helps operators to facilitate their network deployment and make it more intelligent and efficient within the broader scope of introducing of technologies such as SDN, NFV and network slicing allowing networks to become more flexible, powerful and configurable.

In particular, the ENI System is an innovative, policy-based, model-driven functional architecture that improves operator experience and apart from network automation, it assists decision-making of humans as well as machines to enable a more maintainable and reliable system that provides context-aware services that more efficiently meet the needs of the business[96].

The ENI system enables intelligent service operation and management, and provides the ability to ensure that automated decisions taken by the system are correct and are made to increase the stability and maintainability of the network and the applications that it supports. The ENI system automatically collects network status and associated metrics, faults, and errors, and then uses artificial intelligence to ensure network performance and quality of service are met at the highest possible efficiency (e.g. with the minimum required resources). An ENI system can also be used to find bottlenecks of service and/or failure of network. Both of these benefits are done on-demand, in response to changing contextual information. Such aspects may be relevant to the proposed 5G Service Based Architectures (SBAs) and the particular one proposed by the Smart5Grid project.

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[90] Also see, *among others*: Zeng, Y., Strassner, J., and Gamelas, A., (2021, March): ENI Vision: Improved Network Experience using Experiential Networked Intelligence (ETSI White Paper No.44). Available at: https://www.etsi.org/images/files/ETSIWhitePapers/etsi-wp44_ENI_Vision.pdf

[91] For example, an interesting scope has been proposed in the framework of the document ETSI GR ENI 010 V1.1.1 (2021-03): "Experiential Networked Intelligence (ENI); Evaluation of categories for AI application to Networks". (Available at: https://www.etsi.org/committee/1423-eni).

[92] Also see: https://techblog.comsoc.org/2022/01/15/etsi-release-2-of-experiential-networked-intelligence-eni/

[93] ETSI GS ENI 005 V2.1.1 (2021-12): "Experiential Networked Intelligence (ENI); System Architecture". Available at: https://www.etsi.org/deliver/etsi_gs/ENI/001_099/005/02.01.01_60/gs_ENI005v020101p.pdf

[94] For more details also see: https://www.communicationstoday.co.in/etsi-announces-second-release-on-self-adapting-autonomous-networks/

[95] A full list of specifications published can be found at: https://www.etsi.org/committee/1423-eni

[96] ETSI ENI ISG is working closely with the technologies defined by other ETSI groups including Fifth Generation Fixed Network (F5G), IPv6 integration (IP6), Multi-access Edge Computing (MEC), Network Function Virtualization (NFV), Secure AI (SAI) and Zero touch network and Service Management (ZSM).

Automation in decision making to serve requirements for the energy vertical together with the implementation of AI-based tools may be of particular interest in network platforms of 5G and beyond.

5.1.3. 3GPP SA WG2

The 3rd Generation Partnership Project (3GPP) is the primary body for developing technology specifications for cellular networks. It self-organises through its Working Groups coordinated by the Chairs of the Technical Specifications Groups (TSGs). The TSGs prepare, approve and maintain the 3GPP Technical Specifications and Technical Reports, under the chair-ship of an elected leadership[97]. 3GPP has further evolved the 5G radio and network related architectures, introducing modern generic service enabling technologies and integrating more requirements from different industrial sectors.

The SA WG2 Architecture is in charge of developing the Stage 2 of the 3GPP network[98]. Based on the services requirements elaborated by SA WG1, SA WG2 identifies the main functions and entities of the network, how these entities are linked to each other and the information they exchange. Within the 3GPP Technical Specification Group Service and System Aspects (TSG SA), the main objective of 3GPP TSG SA WG2 (SA2) is to develop the overall 3GPP system architecture and services[99] including User Equipment, Access Network, Core Network, and IP Multimedia Subsystem (IMS). The Radio Access Network architecture is under TSG RAN's responsibility. SA2 has a system-wide view and defines the main entities of the system architecture, and how these entities are linked to each other. SA2 also defines the main functionality and the information exchange between these entities. The group coordinates with other 3GPP WGs and all relevant Standards Developing Organizations (SDOs), industry fora, and Market Representation Partners (MRPs) for its specification work.

WG SA2 is currently responsible for the 5G System and Evolved Packet System (EPS) Architectures including the 3GPP enhancements for multimedia services (including emergency services), IoT, and other market sectors/vertical industries related use-cases. The ongoing SA WG2'S work upon defining future architecture model will affect deployment of future 5G systems as well as those "Beyond 5G" (B5G), via the promotion of various innovative aspects.

OTE has monitored the activities of the above SA WG2 Architecture. Feedback coming by 5G architectural implementations, also including the Smart5Grid's actual one will be taken into account for further evolutionary processes of the respective network architectural background. SA2 WG's activities have been monitored via the various reports notified and being freely accessible on the respective part of the 3GPP portal[100]. There is a variety of approved reports that provide interesting feedback towards future developments of technology[101].

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[97] For further details see: https://www.3gpp.org/3gpp-groups

[98] Also see: https://www.3gpp.org/specifications-groups/sa-plenary/sa2-architecture

[99] For further details see: European Telecommunications Standards Institute (ETSI): ETSI TS 123 501 V16.6.0 (2020-10): "5G; System architecture for the 5G System (5GS) (3GPP TS 23.501 version 16.6.0 Release 16)". Available at: https://www.etsi.org/deliver/etsi_ts/123500_123599/123501/16.06.00_60/ts_123501v160600p.pdf.
Also see: https://www.3gpp.org/DynaReport/23501.htm

[100] These can be found at: https://www.3gpp.org/DynaReport/Meetings-S2.htm

[101] These can be found at: https://www.3gpp.org/ftp/tsg_sa/WG2_Arch/Approved_Reports

5.1.4. OpenSource MANO (OSM)

ATOS is an active member to OSM (https://osm.etsi.org/) and frequent attendee to the regular TECH meetings and hackfests organised by the community. As participant in 5G-PPP programme projects, ATOS constantly looks for enriching its contributions to OSM from the results of those 5G-PPP projects in which the organisation is involved, maximising, at the same time, the outreach and impact of these projects. This participation constitutes, therefore, a two-way interaction that generates benefits for both communities, OSM and the project´s one.

5.2. Activities and Contributions

5.2.1. ETSI ISG MEC

As ETSI ISG MEC participant, ATH actively contributed to the ETSI MEC GS033 specification[102] on IoT APIs, submitting and having approved the following items:

- MEC(22)000396
- MEC(22)000395
- MEC(22)000394
- MEC(22)000393
- MEC(22)000392
- MEC(22)000386
- MEC(22)000309
- MEC(22)000290
- MEC(22)000092
- MEC(22)000091

The work item introduces a MEC IoT Service (MEC IOTS) providing means to incorporate heterogeneous IoT platforms in an ETSI MEC system and exposing IoT APIs to enable the configuration of the various components of the overall IoT system. In particular, the specified IoT APIs allow for IoT platform discovery, IoT device provisioning, and user transport configuration.

In the context of Smart5Grid, we may assume that the remote energy production/distribution facility comprises an ETSI MEC host other than the 5G network elements needed to implement the necessary functionalities at the edge. Moreover, we may assume that IoT devices are used for monitoring the remote power plant, and that we aim at managing the generated data within the edge facility. In this case, the standardized IoT APIs may be used by a NetApp Controller to associate IoT devices with an appropriate traffic rule, possibly implemented/enforced by a combination of Network Apps and user transports offered by a IoT platform available at the edge facility, but not visible to the MEC system. The main benefit of leveraging the IoT APIs is that the overall IoT system can be configured at a much lower cost and federating heterogeneous IoT system components.

5.2.2. OSM

In the context of the Smart5Grid project´s use case *Remote Inspection of Automatically Delimited Working Areas at Distribution Level* (Use Case #2), ATOS is investigating how to scale and monitor some metrics of Cloud Network Functions (CNFs) using the OSM orchestrator. Thinking that it may

[102] See: https://portal.etsi.org/webapp/WorkProgram/Report_WorkItem.asp?WKI_ID=56918

be of interest for the OSM community, this feature was presented by ATOS in the one of the OSM TECH meetings, where usually different features and proposals to improve OSM are presented.
The scenario presented was how to scale and monitor some of the services that compose the Smart5Grid NetApp according to the metrics defined in the NetApp descriptor. A series of ideas about how to face the issue were suggested by the meeting attendees (contributors to the community), as this problem hasn´t been addressed by the community yet. The ideas proposed were the following:

- CNF comes with a Prometheus exporter used to expose CNF metrics. We want those metrics to land in OSM Prometheus, so that there could be model-driven scaling.
- CNF relies on an external Prometheus exporter that is getting CNF metrics and making them available to OSM for closed loops.

ATOS is currently working on a practical use case to demonstrate if it is possible to carry out this kind of actions with CNFs in OSM. The results will be presented in one of the next OSM TECH meetings.
It is important to highlight that, thanks to this presentation, Smart5Grid project was included within the OSM Ecosystem, as a Research activities that are using or contributing to OSM [see: https://osm.etsi.org/wikipub/index.php/Research#Smart5Grid]

6. Conclusion (ALL)

This deliverable presented the WP7 progress of Smart5Grid project in Y2 (M11-M23) as per the Impact Plan and the KPIs presented in D7.2 ("Plans for Dissemination and Communication, Standardisation, and Interaction with 5G-PPP"). All the Communication and Dissemination activities performed during the second reporting period have been reported in detail while most of the key KPIs set in D7.2 for Y2 have been met.

Moreover, we present market analysis focusing on the challenges of the energy vertical and the value that can be unlocked with sector digitalization. 5G technology and Network Applications have the potential to act as catalysts for the sector transformation. Due to the increased number and diversity of stakeholders, the value chain is being transformed from linear to circular and ecosystem business modelling becomes necessary. The consortium partners are following their individual exploitation plans while the project is also focusing in cooperative exploitation of the produced innovations.

Synergies with other 5G-PPP projects and WGs contributions were reported and updated as per the Smart5Grid's technical advances and use cases.

Finally, the Standardization activities and contributions to various SDOs have been reported considering the current stage and advances of the project. In particular, the consortium has continued its activities mainly by monitoring several ESOs dealing with 5G-related challenges as well as by providing some contributions based on the progress of the actual work. As trials have been initiated and are mainly planned for Y3, further results and/or contributions are expected in the course of the project.

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