OneNet Open Call Beneficiaries

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957739

1.1 GEOGRID by Software Company

1.1.1 Project Description

1.1.1.1 Challenge & aim

The software packages commonly used by the system operators are mostly focused on those tools that can guarantee the reliable power system analyses. The ways in which the results could be offered to the wider audience, are being heavily neglected. In order to mitigate these events, the tool that would be developed in the scope of this proposal intends to cover both of the mentioned aspects of work. The detailed power system analyses (corresponding to the main advantages of the currently commercially available tools) and the comprehensive way of presenting results, guaranteeing the novel functionalities that would be offered to any potential users.

The aim of GEOGRID is to prototype a multisided platform to complement the F-channel platform for the additional modelling of the grid, power system analysis and illustration of the results on the georeferenced GUI through GIS server application. The proposed use case will particularly focus on residential prosumer and other low voltage installations which are usually not scope of the modelling by TSO or DSO, simulating a portfolio of Prosumers equipped with PV, flexible storage as well as EV smart charging (V1G and potentially V2G) providing a large variety of flexibility options into balancing and TSODSO congestion management processes particularly, as well as usage of DER flexibility potential on a higher levels, especially by TSO operators. To achieve that, SOFTWARE COMPANY EOOD (SC) will develop the necessary simulation models, as well as geographic visualization of simulation results, exposing results and linking to other services being developed under F-channel platform via GIS technologies. The proposed solution will be coupled with the F-channel platform for performing the necessary calculations in the power system, such as the power flow analyses, voltage state estimations and the N-1 reliability assessments. This will give the system operator the level of insight that was not available ever before, with the benefits being almost immeasurable. Finally, the GIS layers and the blueprints of the interlinked layers could be further used on other similar projects, through the developed geo server and associated database/s.

1.1.1.2 Proposed solution

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Power system is obviously evolving and rapidly changing the last few decades. This change will continue, and a vision of the fully decentralized system will soon become the reality. The new vision, based upon the distributed production of the energy in the renewable sources, brings the new challenges with it, where the particular attention should be given to the need for providing the necessary, additional amount of flexibility to the system. Flexibility, in new power system paradigm is no longer strictly connected to the high voltage, controllable resources, but is also distributed in a lower level entities. This brings us to the problem of identifying and exploiting those new distributed FSPs, but also it brings a huge chance of making flexibility services capable for finer "tuning" of the targeted power system parameters. Like the change from old low resolution robust TV screens, into subtle, high resolution screens, which change both quality of usage and perspective for the end users. In order for this to be achieved, the strong cooperation between the TSO and the DSO needs to be established, with each of the operators being aware of the state of the system beyond those voltage levels that were previously of interest to them. In order to avoid misinterpretation of the results/information by the end users, the solutions proposed in the scope of this proposal would use the geographical map for showing any of the requested information, as the universal medium that literally all of the potential clients would find clear and easily understandable, being scalable and useful for any future application. An additional feature that could further assist the operators in the appropriate fulfillment of the tasks they are assigned would be the modification of the aggregation level, meaning that the operators would not have to deal with the enormous amount of data (even in the visual form, it could be tedious and slow down the process significantly) shown in the entire map of the power system. Instead, the level of granularity that will be used when presenting the data to the end users will solely depend on the zoom-level of the client's window, with the higher level of zoom also providing the higher level of map granularity, i.e., the higher resolution in which the results are shown. To simplify, if the user would not be satisfied with the resolution of the map, they could simply zoom in and, by that, reduce the geographical scope of the map that they are shown, but also increase the resolution all the way to the single entities in the system. Finally, regarding the potential for replication of the described solution, it should be stated that it is rather high, since the necessary input data for the proper implementation of the solution would not differ much from the standard set of data that is available to every system operator – the technical characteristics of the system, the geographical characteristics of the power system (above all, the coordinates of each system element, including the single energy entities) and the weather forecasts for the area of interest. Of course, the latter could prove to be more difficult to obtain than the prior two, but, if this information would be

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at disposal, the developed tool could be adapted to accommodate nearly every real-life power system and to fit the needs of the various potential users, starting from the system operators, but also including both academic and the industry-oriented projects that could get important insights by using this tool.

The goals that would be covered by the proposed solution would match the ones requested by the Scenario 1 of the OneNet Open Call (i.e., Deep power system analysis through GIS server application). The details on the ways in which these goals would be reached are presenting in the following sections.

It is clear that the vision and the requests of this scenario are founded upon the two main goals that are supposed to be achieved by the proposed solution. The first of those would be the development of the mathematical model that could incorporate the sufficient details on the characteristics of the distribution system down to the lowest level entities (in the Call, the households, the solar units and the wind turbines are listed as those entities that should be taken into consideration). The second main goal would be the development of the connection to the GIS server that would be used as a tool for combining the geographic and the technological characteristics of the system, allowing the results to be shown on the accurate map of the selected region. Since the description of the tool that is submitted via this proposal includes both of the mentioned improvements, it can be said with confidence that it is aligned with the scope of the Call.

This section will be separated into three paragraphs, each of them dealing with one of the KPIs listed in the previous part of the proposal. First of all, the model itself would be developed in such a way that its modification and the adaptation to fit the needs of the user at the easiest possible way, with the exact format to be defined by the potential employers. What is certain, however, is that the proposed under development tool will include the model of the sufficient granularity and level of details to fulfil the requirements stated in the Call. Also, it should be highlighted that all of the codes for performing the necessary analyses would be written in one of the Open Source programming languages, giving the opportunity for the quick and simple modifications in case of need, whether for some of the more prominent corrections or for the adaptations to some cases that are not initially foreseen by the project in question. The second objective of the GEOGRID is the development of the GIS server and map in which the entire power system of the analyzed region would be shown. The main aspect upon which the focus is placed is the possibility of changing the amount of the data and number of elements shown in the map with the change of the zoom-level of the map itself. Along with

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this, the map will also include the option of spatial query, i.e., by definition, the option of providing the user with the required set of information upon the simplest actions, such as the clicking at or hovering the mouse cursor above the element of interest to them. Finally, the custom-tailored GUI, that is envisaged so that it could reflect the customer needs verbatim, is founded upon the idea of allowing the client to use with the most efficient way the developed tool. The appearance of this GUI will be defined in cooperation with the employer, but what is already decided is that it would give the users an overview of the map of the system, allow the simple initiation of any actions that user may want to undertake and print out the on demand automatic report of the results by the specifications provided by the user.

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Development of the solution will be divided into 5 tasks:

1. Development of the georeferenced grid simulation model which contains consumer's (different types and connection schemes of prosumers) detailed physical models of the connected production units (microgrid simulation models), for different types which can be integrated with the rest of the F-channel modelled grid on Crete.
2. Development of the load profiles of a typical industrial consumer, commercial consumer, and residential consumer for characteristic days in summer, winter, and system peak.
3. Development of the database tables based on a GIS server, its connection towards the developed microgrid simulation models as well as load behavior models and its integration into the F-channel GIS server.
4. Development of the GUI to support the simulations and calculations with GIS map results presentation.
5. Overall GUI integration within the F-channel app existing GUI.

1.1.1.3 Expected results

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This solution will allow for full inclusion of residential and industrial prosumers, with its detailed simulation models into the overall power system simulations (TSO network model + DSO network model + prosumer model). It will enable inclusion of the lowest level energy entities into the list of flexibility service providers. The common simulation model of the selected part of the system in the required resolution, together with the GIS server upon which the necessary data will be uploaded and the custom-made GUI will make the overall solution useful and handy for both TSO and DSO short and mid-term planning departments through the f-channel platform. More on this will be given in the separate chapter of this application that will go into the individual KPIs and the deliverables that should be provided during the project realization.

The two main improvements that are aimed in this proposal are the development of the power system simulation model that will include the voltage levels down to the lowest ones, and the creation of the GIS server that will be used for the visualization of the obtained results. In accordance to that, those two improvements can be treated as the first two KPIs that can be used to measure the success of the work that will be done in GEOGRID project. The third KPI that is relevant to this proposal revolves around the user-friendly GUI that is imagined as a mean of making the usage of this tool rather simple and intuitive representing the final step in making the services offered by the tool that is getting developed accessible to any interested stakeholder.

1.1.2 Company Description

Software Company Ltd (SC) is a Bulgarian private firm that specializes in software development. Since 1996, the company has offered a wide range of high-quality services in the development, delivery, and maintenance of software in Europe and USA.

SC's key market advantage is the ability to leverage a wealth of experience in this sector, a network of local and international partners, and a very competitive pricing strategy to deliver quality software solutions. The company is also ISO 9001:2015 certified.

SC has experience in gathering requirements, designing, building and testing software related to electricity networks, renewable energy, medical imaging, business intelligence and others. In addition, the company is experienced in developing and customizing business intelligence applications, as well as software for managing databases and data mining.

- SC has worked with a number of partners from Europe and USA in the following areas:

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- Transmission and Distribution grids applications/software
- Green Energy and Energy Efficiency software
- Medical Software – PACS and RIS
- Custom software development
- Web sites and Internet aware software
- Database management software, Data Warehousing, Business Intelligence

Software Company has successfully participated in several FP7 projects while participates in ongoing Horizon 2020 projects related to transmission and distribution grids such as: FLEXITRANSTORE (http://www.flexitranstore.eu/), INTERRFACE (http://www.interrface.eu/), FARCROSS (https://farcross.eu/), ENERGYSHIELD (https://energy-shield.eu/) and others.

1.2 OneNet - ActiveProsumer by WiseWire

1.2.1 Project Description

1.2.1.1 Challenge

The green and digital transformation of power systems considers the replacement of large conventional generation plants with decentralized generation based on renewable energy and the adaptation of information and communication technologies (ICT) to enable intelligent operational functionalities for future energy systems. Current trends indicate a fast transition for the electrical grid from a fully centralized architecture to a decentralized one. This transition, however, demands the cooperation and increased flexibility and adaptability from all related stakeholders (i.e., system operators, energy market, and active prosumers). At the same time, prosumers are currently faced with rapid changes and increased energy costs while they are unable to actively participate in the energy market and grid operations actions. This can lead to a non-cost-effective operation of both the prosumers and the grid.

Therefore, innovative solutions are required which breach the gap between the power system operators and active prosumers to achieve a synergistic and mutually beneficial operation at both the market and the network levels of the future power systems. These solutions need to support the active participation of prosumers and the efficient and reliable grid operation while maximizing the allowable penetration of renewable energy.

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1.2.1.2 Proposed solution

The ambitious vision of the OneNet project contributes towards the evolution of the European power system by developing new market, products, services, and ICT systems. To support this vision, the OneNet – ActiveProsumer project will develop new innovative grid services based on ICT technologies to fully exploit demand-response, storage, and distributed generation while creating fair, transparent and open conditions for the consumer; thus, enhancing the engagement of household consumers towards the cost-effective and reliable operation of power grids.

The key objective of OneNet – ActiveProsumer project is to enable the participation of actual prosumers in distribution grid management by allowing the provision of flexibility services to the grid. Towards this direction, the project will focus in two enabling pillars. The first pillar focuses on the development of a fast, secure and reliable communication between the prosumer and the DSO control center, while the second pillar emphasizes on intelligent power control methodologies.

Initially a secure two-level communication framework will be developed. This framework will be responsible for a) the internal communication at building level to allow the coordination of flexible resources within the prosumer infrastructure, and b) the external communication allowing the exchange of measurements and coordination signals between the prosumer and the DSO. The internal communication at the consumer level will be established over the prosumer local area network (LAN) and will be managed by the WiseWire Energy Box (see Figure 8.2.1) which will receive fast measurements and send coordination signals to key power equipment at building level (i.e., PV inverter, battery inverter, fast-reporting smart meter, etc.). The external communication will be established between the prosumer (WiseWire Energy Box) and the DSO control center (ABCM-D platform) through the WiseWire Cloud platform (see Figure 8.2.1). The communication will employ MQTT for communication, a widely utilized protocol in IoT applications offering scalability and a cost-effective solution for plug-n-play applications. Proper API frameworks will also be developed to facilitate the data exchange between the prosumers and the DSO control center.

The intelligent power management schemes that enable the provision of ancillary services by the prosumer will be developed and integrated in the local processing unit of the WiseWire Energy Box and the cloud within the WiseWire Cloud platform. The intelligent power management algorithms will monitor and utilize forecasting and optimization methodologies to control the flexible resources of the building while ensuring the capability of provisioning of ancillary services efficiently and effectively. These services will maintain a regulated active and reactive power exchange between the prosumer and the grid according to the DSO coordination set-points.

The proposed solutions will be integrated into an actual prosumer located in Nicosia, equipped with a rooftop photovoltaic system, a battery storage, and a fast-reporting smart meter. The prosumer will continuously interact (e.g., every 30 seconds) with the DSO control center (ABCM-D platform of OneNet), to exchange power

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measurements and coordination signals. The fast measurements will be provided to the ABCM-D platform to allow the representation of the prosumer operation in the digital twin of Cyprus grid. The coordination signals generated by the ABCM-D platform will be communicated to the actual prosumer, which in turn will manage its own flexible resources to provide ancillary services accordingly.

The infrastructure, architecture and concept of OneNet - ActiveProsumer project are presented in Figure 8.2.1.

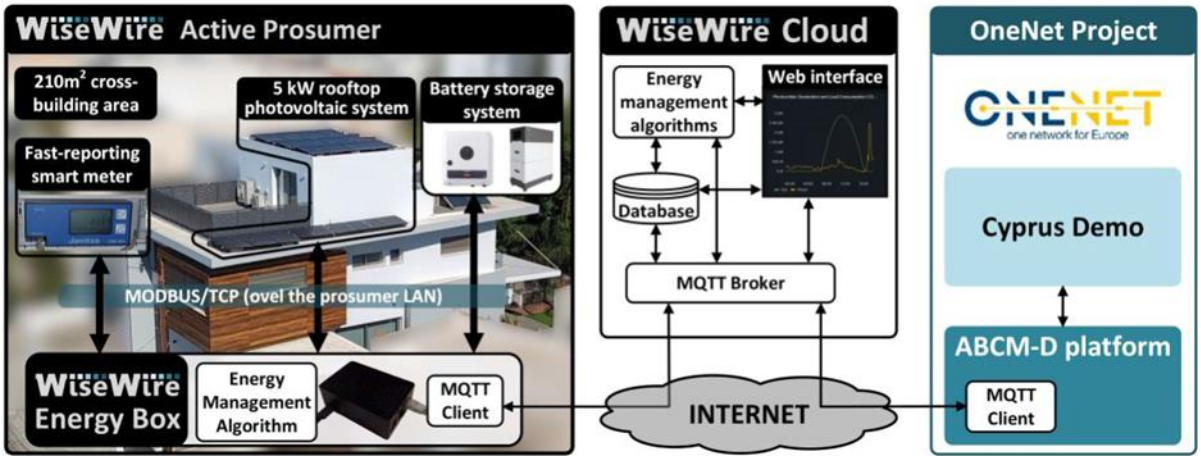

*Figure **Error! No text of specified style in document.**.1.1 – The infrastructure, architecture and concept of OneNet - ActiveProsumer project.*

1.2.1.3 Expected Results

The scientific outcomes of the project will include cutting edge intelligent control and management methodologies and are expected to act as the foundations of the next generation grid services and products that can increase and fully exploit the flexibility at the prosumer level in a fair and transparent manner as well as ensure prompt demand response for the system operators. In turn, the newly developed technologies that incorporate cloud services and enable active prosumer participation are expected to have a key role in the changing energy system architecture and are envisioned to be considered as necessary pieces for the future customer-centric grids. At the same time, the proposed integration of intelligent control methodologies at the consumer level aims to increase consumer's gains from energy cost savings. Further, the provision of ancillary services by the prosumers enables the market participation of flexible electricity consumers with the aim of reducing their electricity cost up to 20% with great social-economic benefits. On the other hand, the increased

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flexibility provided to the system operators is expected to significantly increase the utilization of grid capacity by 15%, reducing the investments for upgrading the infrastructure and allowing higher penetration of renewable resources. Distributed flexibility services can also be utilized by the operators to enhance the efficiency by reducing the grid losses by 5-10%. Finally, the facilitation of the active participation of the consumers in the energy generation is expected to significantly increase the adoption rate of renewables and support the transition to a greener energy sector.

1.2.2 Company Description

H. Wise Wire Energy Solutions Limited (WiseWire) is a start-up company offering innovative solutions and consultancy services in the area of smart grids and energy efficient buildings. The company is based in Cyprus and was founded in 2020 with an aim of transforming innovative research results into marketable products and services. The team has strong scientific and technical expertise with significant experience in research-innovation projects. The mission of the company is to create innovative solutions and services for the green and digital transformation of buildings and energy infrastructure. WiseWire's solutions aim to advance the integration of renewable energy sources and maximize their penetration into the energy infrastructure, reduce the electricity cost for the consumers, and enable zero emission buildings. WiseWire is participating in research and innovation activities and focusing on creating novel ICT-based solutions to enable sophisticated and scalable energy management functionalities and their commercialization.

1.3 WISeGrid by Watt-IS

1.3.1 Project Description

1.3.1.1 Challenge

Critical issues like global warming, depleting fossil fuel reserves, and greenhouse gas (GHG) emissions require attention for ensuring a sustainable future. New technologies and solutions need to be deployed to reach the ambitious targets set by the European Commission. Hence, the vast expansion of renewables (that are variable in nature and have a certain degree of unpredictability) together with the cross-sectorial electrification of the energy systems form a pillar in the sustainable development agenda of most countries, requiring a smarter and more flexible electricity grid, which comes hand in hand with an optimized coordination between system operators. The clean energy transition and the introduction of new consumption dynamics that arise with new

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technologies such as heat pumps or electric vehicles (EVs) are deeply associated with the digitalization of the energy systems, where unprecedently high amounts of data are being generated from smart meters. Such data is esteemed to unlock the full potential to better manage the energy value-chain, including the grid. In fact, more data means the possibility to develop deep analytics that can deliver valuable services such as a more accurate and closer to real-time forecast and management of the demand and supply, the adoption of short-circuit preventive measures and the avoidance of unnecessary system costs. Facing this scenario, an optimized coordination between DSOs and TSOs is paramount to sustain an effective and efficient management of the grid. Hence, identifying and sharing the information that enables better operational planning between their networks is a needed upgrade that will not only allow for a more efficiently managed and resilient grid, but also fora higher capacity to incorporate additional variable renewable energy resources that will bring us closer to the sustainability and climate goals that need to be achieved. Having outlined the existing "Challenge(s)",Watt-IS participation in the OneNet project has the objective to contribute towards an improved coordination between the DSOs and TSOs regarding information exchange about the grid "operational planning" and flexibility related services, to facilitate the definition of necessary actions in order to avoid grid constraints, avoid unnecessary investments and ensure a secure, reliable and efficient grid operation.

1.3.1.2 Proposed solution

Within the scope of the OneNet open call Watt-IS, jointly with the project stakeholders (E-REDES & REN/NESTER) have outlined the proposed solution that will involve the refinement and implementation of a set of APIs, along with the support Backend and Frontend layers, that will facilitate an optimized coordination between the Portuguese DSO and TSO regarding information exchange focused on grid "operational planning" and flexibility service requirements. The set of APIs and related services will be implemented in order to exchange the following information between the Portuguese DSO and TSO: i) daily (next 72h) consumption and generation forecasts; ii) daily (next 72h) forecasted short-circuit information; iii) weekly, monthly and annual maintenance plans, iv) flexibility service providers prequalification and v) daily flexibility needs forecasts (next 24h). These development swill support the Portuguese Stakeholders in the implementation of the different System Use Cases (SUC) that are part of the OneNet Portuguese pilot, namely: System Use Case 01 (REN/NESTER)–GUI &Integration with REN/NESTER APIs-The goal of this SUC is to evaluate if a given Flexibility Service Provider, connected to the TSO or DSO network, is capable of delivering a given product and therefore enter in the flexibility market. In order to do that, two types of pre-qualification should be considered: Product Pre-qualification (in this case, performed by the TSO) and Grid Pre-qualification(performed by the system operator of the network that the FSP needs to be connected to).Regional Use Case(REN/NESTER) –GUI & Integration with REN/NESTER APIs and OneNet Connector-This use case has the same goal of SUC 01, although, the pre-qualifications will occur between system operators of the western cluster, exclusively via the OneNet Connector. System Use Case 02(REN/NESTER)–GUI &Integration with REN/NESTER APIs-This SUC supports the

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coordination between the DSO and TSO so that they can determine how much flexibility they will need to acquire, for a short-term timeframe. System Use Case 06 (E-REDES & REN/NESTER)-The SUC 06foresees the possibility for weekly, monthly and year ahead grid maintenance plans to be exchanged between the DSO (E-REDES) and the TSO (REN/NESTER). System Use Case 07 (E-REDES & REN/NESTER)-The SUC 07 foresees the possibility for daily energy consumption and generation forecasts (including Wind, Solar (PV), Hydro, Pump Storage, Thermal, Other sources, Load P, Load Q) to be shared between the DSO (E-REDES) and the TSO (REN/NESTER). System Use Case 08 (E-REDES & REN/NESTER)-The SUC 08 foresees the possibility for the short circuit levels regarding the contribution of distribution and transmission networks to be shared between the DSO (E-REDES) and the TSO (REN/NESTER).

1.3.1.3 Expected results

With the successful implementation of all of the foreseen SUC's within the Portuguese pilot, the DSO and TSO will be empowered to have more efficient and stream lined data exchange mechanisms focused on: i)"operational planning"-being possible to exchange and update between them weekly, monthly and annual maintenance grid plans; ii)"forecasts"–allowing for a more efficient exchange of daily (next 72h)consumption, generation and short circuit forecasts; iii)"flexibility related services"–making possible for Flexibility Service Providers (FSP) prequalification, both at the DSO and TSO level, and exchanging daily (next 24h)flexibility needs forecasts. With these foreseen developments Watt-IS has the objective to contribute towards the achievement of a more efficient information exchange process between Portuguese System Operators, but also to facilitate the creation and development of a new layer of grid flexibility services that, as previously discussed, are key to support the vast expansion of renewables together with the cross-sectorial electrification of the energy systems. Based on the experience gained in the OneNet project Watt-IS expects to have the possibility to deepen the collaboration with the Portuguese System operators in the flexibility services analytics area, but also to expand collaborations with other System Operator within the EU in the field

1.3.2 Company Description

Watt-IS is a Portuguese data analytics company that develops and applies Artificial Intelligence based Data Analytics on top of smart metering data to provide high-value services to energy utilities, grid operators and other partners. They provide advanced data analytics services in a SW as a Service (SaaS) approach(or integrated into user engagement platforms) focused on energy efficiency, leveraging on an existing smart metering infrastructure deployed and managed by System Operators (DSOs& TSOs). Watt-IS main goals are to be able to increase customer satisfaction through innovative services provided and, with that, reduce churn rates and generate new revenue streams to their partners always with a focus on energy efficiency and the reduction of

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GHG emissions. They have built a cloud-based data analytics architecture & supporting infra-structure that integrates different data analytics modules focused on the needs of energy retailers and grid operators. These data analytics services can be made available via integration with white-label visualization platforms, in a SaaS approach, or via API's following a Data Analytics as a Service (DAaaS) approach Watt-IS provides a wide range of data analytics services that aim to create value at the various layers of the energy value-chain, such as i) Load disaggregation from smart meter data; ii) targeted energy efficiency measures; iii) Load Forecasting; iv) estimation of the Demand Side flexibility potential of individual/group of clients; v) identification of solar PV and EV assets, among others. Currently, Watt-IS is supporting DSO's, energy retailers and other stakeholders, providing real and non-real-time data analytics services to thousands of end clients, processing metering data for commercial settlements, developing user engagement platforms and providing DAaaS data analytics through API's incorporating advanced machine learning/AI services.

1.4 FLEXUM by ODINS

1.4.1 Project Description

1.4.1.1 Challenge

The University of Murcia has power peaks larger than the 4MW. Approximately a 35% of that peak could be well related to the conditioning, what would represent a value larger than 1MW. This is obviously an approximate calculation, and more importantly, it is subjective to the possibility of acting over the majority of buildings on campus, but still, it is a promising value for the demonstration purpose.

These peaks have a substantial economic impact as such power peaks for a consumer like the University of Murcia result on larger energy bills and on a high extra cost of the maintenance of the micro-grid of medium voltage of the campus.

On the other hand, these peaks can also interfere in the normal operation of the grid given its size and can generate network congestions under certain circumstances.

1.4.1.2 Proposed solution

FLEXUM will design, implement and evaluate a flexibility service provision (FSP) to achieve demand adjustments and responses for alleviating the network congestions at medium and low voltage network levels in the Spanish scenario located in Murcia (Espinardo). Using both already existing and new sensing/actuating equipment, the solution will use the shiftable loads and the controllable loads of the UMU infrastructure mainly composed by connected HVACs and electric vehicle chargers to provide demand responses and flexibility

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capacity. Using the UMU infrastructure, ODINS will be able to act as a Flexibility Services Provider (FSP) to develop and demonstrate flexibility services.

The main project results will be a FSP component, a flexibility engine and demand-response services based on a novel IoT platform developed in H2020 PHOENIX project. The engine will use artificial intelligent algorithms to quantify flexibility and will also design and suggest flexibility strategies for final consumers using a simple friendly dashboard. The flexibility engine included in the IoT platform will be compatible with communication protocols of DSOs and TSOs. ODINS will implement a FSP component in the IoT platform to enable the bidirectional communications of congestion signals and demand events from the OMIE local market platform. Moreover, the FSP component will be design with high interoperability to be compatible with other grid systems.

This project will develop flexibility services and demand responses for the main buildings of the university with existing energy meters, sensors and actuators, so automatized demand response operations could be implemented to alleviate peaks on the local grid network. This will stay on campus and will allow on the long term to plan actuations that modify the demand. This will serve as an exemplary exercise for other large consumers in the region of Murcia and the whole country. Also, it will facilitate open data that stakeholders such as energy utilities, or ESCOs could use to prepare for the new scenario where energy flexibility and demand responses are the norm.

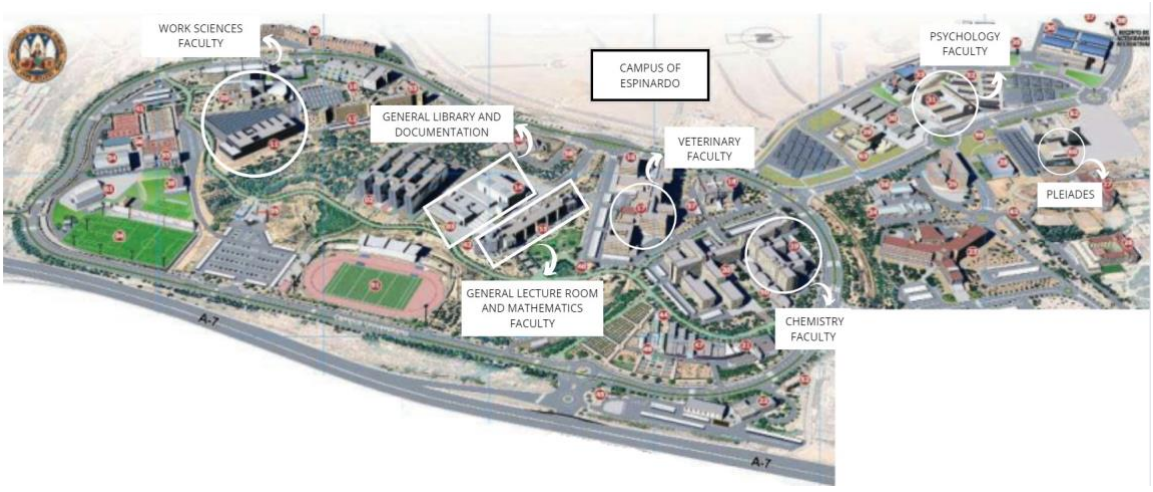

*Figure **Error! No text of specified style in document.**.4.1 – Main test environment (UMU Campus)*

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1.4.1.3 Expected results

The ambition of FLEXUM is to offer to OneNet a series of beyond state-of-the-art developments to provide the following innovative advances:

1. Optimization of operation of UMU infrastructure to maximize flexibility.

2. Intelligent operations to improve the thermal inertia of multiple UMU buildings.

3. Development of smart plans for contracting flexibility.

4. Forecasting engines to anticipate to flexibility requests.

This project will develop a flexibility demonstrator to experiment demand adjustments and responses for alleviate the network congestions at medium and low voltage network levels in the Spanish scenario located in Murcia.

1.4.1.4 Preliminary tests (previous real tests)

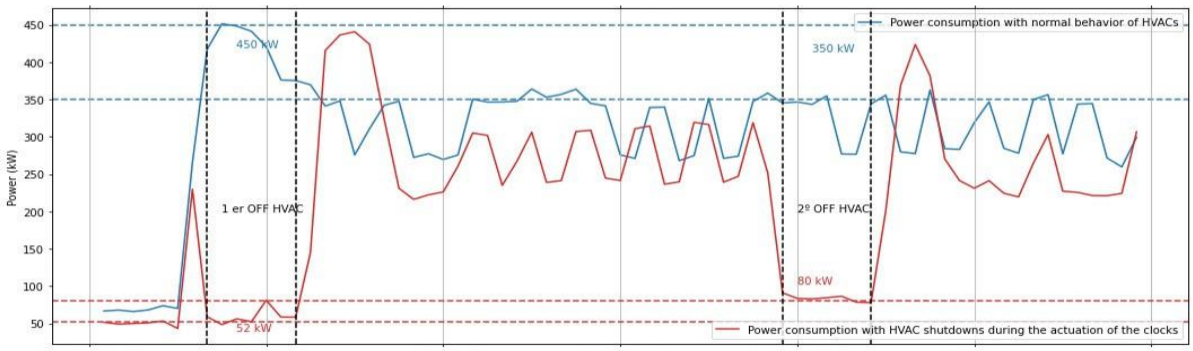

Figure ***Error! No text of specified style in document.****..2.2* – General Lecture Building and Mathematics Faculty

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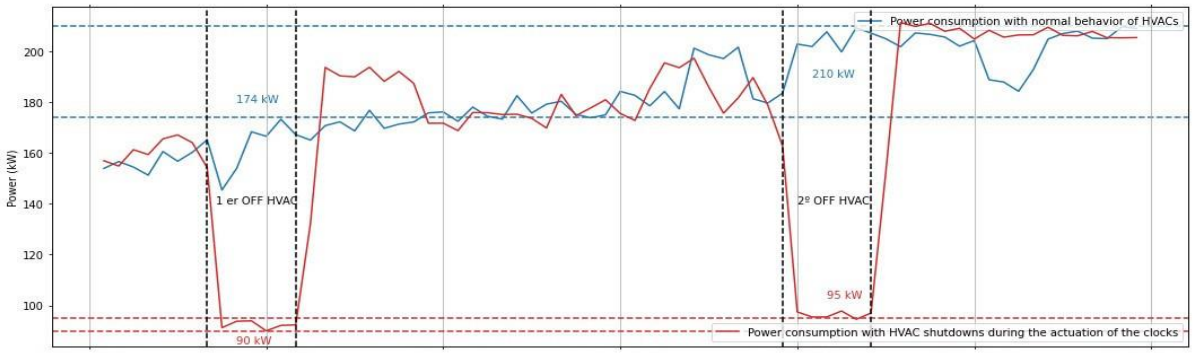

Figure ***Error! No text of specified style in document.****..3.3* – General Library and Documentation Faculty

1.4.2 Company Description

OdinS has strong expertise in research and development of embedded systems and data management platforms. OdinS provides secure, flexible and interoperable products able to monitor and control remotely infrastructures in multiple business sectors such as Energy/Grid Management and Smart Cities/Buildings. OdinS has a wide background in the R&I fields of Internet of Things, Edge/Cloud Computing, Cybersecurity and Data Analytic which have been proven in EU research projects. Concretely, OdinS has experience in H2020 projects related to FLEXUM.

- Smart2B (GA 101023666, H2020-LC-SC3-EE-2020) https://cordis.europa.eu/project/id/101023666/es

- PHOENIX (GA 893079, H2020-LC-SC3-EE-2019) https://eu-phoenix.eu/

In the FLEXUM project, the main goal of OdinS will be the development, deployment and evaluation of FSP component, flexibility engine and services using ICT innovations (i.e. IoT, AI and Data-driven Platforms) as well as the interoperability with the local market platform developed by OMIE in the OneNet project to achieve the improvement of short-term and long-term congestion management in cooperation with the Murcia demo provider.

1.5 FLAGS by Stemy Energy

1.5.1 Project Description

1.5.1.1 Challenge

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The energy market is shifting from the traditional paradigm typified as a passive distribution and one-way communication from the electricity supplier to the consumer (G-DL) to a new energy paradigm focusing on an active role of the customers. Consumers, their daily routines, and the social context in which they operate, should be more central for the DSOs (Distribution System Operators), where the focus is still mainly on technological issues and economic incentives. Stemy's solution, with a new user-centric approach, is the first of this kind of solutions within the energy sector.

Stemy's technology supported by an algorithm with AI, self-learning capacity and big data applied in controlling the energy consumption of each consumer optimizing CAPEX and OPEX and the participation on the existing energy and flexibility markets through the energy assets installed in the buildings. To be noted, it is the first aggregation platform able to optimize energy efficiency while providing flexibility to the grid.

This cost optimization is based on the learning capacity from the energy behavior, comfort levels, building performance and price signals received from the energy markets. This is achieved by acting automatically on the equipment in the building: advising on how to improve the consumption and on adequate investments to obtain greater benefits, suggesting the best rates and powers to contract. Apart from monitoring, forecast is enabled through self-learning algorithms, the Stemy's AI predicts performance, DER performance, weather (temperature, irradiation, and wind), markets (price and flexibility request), behavior & preferences of the final user (e.g., temperature reference). It has the capacity to manage the flexibility of all electrical devices at the consumer level in a cost-effective way, through a simple and connected low-cost technology which connects and operates the charging devices and DER: hot water, HVAC, water pumps, batteries, EV charging posts (V2G, G2V), refrigeration, water filtering, water heating, milling and chemical processes.

Additionally, the platform connects the user with the Energy market, fostering RES and is able to aggregates electricity resources with high precision and in real time, allowing participation in frequency response markets that require an immediate response (in seconds after that the request is sent by the operators).

1.5.1.2 Proposed solution

The project will develop a demonstration located in Cantoblanco (Madrid, Spain). The buildings have a maximum consumption of 500kW. They count with an installed power of 2,7MW of heating and cooling systems, which use to consume ~2,16MWh per day. The annual total consumption is ~1314 MWh.

The approach of the project can be summed in three main actions: 1) onboarding, solution design and installation, 2) operation and tests, 3) result analysis and dissemination.

The onboarding process will be done through Stemy's "Comunidad Flex".

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The installation will intervene the fuseboards (installing Ampere, a Flex-ready monitoring device of Stemy) and the heating/cooling system (installing Carrier, a Flex-ready HVAC control device of Stemy).

Then the operation will be done by Stemy's aggregation platform. During this phase there are three main actors:

The network operator (i-DE), who operates the distribution network and assesses the needs and constraints of the network. Thanks to a local flex market, operated by OMIE, DSO can request power consumption modifications to consumers to avoid congestions in the grid.

- A set of buildings which consume electricity and have some energy resources.
- The flexibility provider, who is Stemy. On one hand, Stemy oversees providing the flexibility to the network operator according to the market request. On the other hand, Stemy is in charge of operating the energy resources of the buildings to optimize their performance and fulfill the market commitments.

The relationship between these three agents is key to help achieve the stability of the grid: the network operator will send flexibility signals to the flex provider so it can operate the portfolio of their aggregation platform to accommodate the network needs according to the constraints given by the users. This is done thanks to a deep knowledge of consumers and their consumption patterns and thanks to the synergies generated from aggregating multiple types of resources. Once the flexibility signal is sent to the flexibility provider, the network operator will monitor the affected network to validate the signal and assess the impact of it.

Stemy's aggregation tool can respond effectively to flexibility signals within seconds so it can help the grid at many markets. In the meanwhile, the users will have two interfaces, one app and one web to interface with the "Comunidad Flex".

1.5.1.3 Expected results

To fulfill the scenario and provide flexibility at distribution level the main goals and KPIs defined are:

- Monitor disaggregated consumption and control the buildings' heating and cooling systems in seconds.
- Communicate with the network operator (i-DE) to be able to receive flexibility signals, which will translate in modifying the consumption of the energy resources.
- Respond to the flexibility signals to alleviate congestions by managing loads.
- Prove participation in distribution local markets.
- Generate data from the demand response to flexibility trials and the comfort levels of the users to evaluate impact. For the evaluation of the comfort levels, STEMY will have the temperature measurements that the users will experience at every point of actuation.
- Exploit results after the project, in Redream H2020 project and other offices.

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1.5.2 Company Description

STEMY ENERGY S.L (STEMY) is a Spanish company established in 2018, with headquarters in Madrid. Currently, STEMY counts on 26 employees Stemy encourages consumers to optimize their energy use to have a lighter footprint on the planet – particularly if that means big savings on their energy bills. For that purpose, over the last 10 years, they have developed a self-learning smart energy solution called SPLODER, which is a cloud-based platform able to optimize existing energy infrastructure one consumer at a time without affecting the customer experience, whilst streamlining the flexibility of the grid. Thanks to SPLODER end-users can participate in energy markets helping the stability of the electricity system and creating the bases of the renewable system of the future. The consequences are clear: reduction of the energy bill up to 30% from day one and radically reduction of the carbon footprint. In order to connect with SPLODER, end users need to have some inexpensive/simple sensors installed by the electricity meter. Additionally, actuators need to be installed with those high-power usage devices which ODINS will want SPLODER to control automatically, examples of these could be heating and cooling systems, hot water control electric car charging points.

STEMY is involved in other H2020 , R&I and national projects.

- REDREAM 2020-23. H2020 project, https://redream-energy-network.eu
- SPLODER 2020-21. R&I project
- SUSTAIN-H 2021. Participation in new local congestion markets in the UK

1.6 Decentralized digital heating as a flexibility provider by Northeast Flow Oy

1.6.1 Project Description

1.6.1.1 Challenge

The consumption and production should be balanced in a modern electric grid. Estimating consumption can already be a challenge by its own, but the increase in intermittent renewable energy like wind and solar further complicates balancing. This calls for innovation in many areas of the electricity markets & its ancilliary services, demand side response being one of them.

Electric heating, although mostly seasonal, provides an exceptionally well flexible load from the grids' point of view. Buildings itself store heat well, and short pauses in heating with a duration of minutes or even hours have next to no effect for the living conditions, thus being able to go unnoticed.

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1.6.1.2 Proposed Solution

Northeast Flow (further NEF) is using computing power locally in places with a need for heat. This is doesn't necessarily increase the total energy consumption. In NEF vision they have a large number of computing sites over a large geographical area and are able to provide customers comfort while also helping the grid to stay in balance.

NEF currently leverages bitcoin-mining due to its location-agnostic properties in building a decentralized data center that uses the by-product of computing, heat, to provide buildings comfortable inside temperatures during cold times. NEF is able to reduce the use of oil, gas and coal and thus even reduce the absolute CO2-emissions. The service-oriented business model also provides an unique opportunity for heating customers to join in the flexibility markets.

As a result in this project NEF expect to have a functionality to control their computing units according to grids' needs, while at the respecting the parameters of the building. NEF is also looking to gain more understanding and knowledge about the flexibility/electricity markets in general.

1.6.2 Company Description

Northeast Flow provides intelligent heating as a service. The heat is produced and distributed locally at a site using excess heat of computing, so the same energy is used for two purposes, resulting in a double benefit. Currently NEF has one technical pilot and three commercial pilots running in different locations around Southern Finland. The sites consist of commercial buildings and one residential building. NEF also reports its clients about monetary & carbon savings and is developing its concept further.

1.7 ODINA-TS by Beedata

1.7.1 Project Description

Data and analysis is increasingly becoming an integral part of the everyday electricity system and more specific in data exchanges among Transmission System Operators (TSO), Distribution System Operators (DSO) and consumers. With a growing emphasis on data-led decision making across different organizations, trust in the quality of data is vital. Low quality data is propagated along the organization via erroneous data-driven decisions. A common error-prone use case would be forecasting. Fitting forecasting models with erroneous data would lead to predicting erroneous scenarios. With the AI data quality toolbox developed in the project Beedata expect to improve the quality of the data managed by the data provider.

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The AI data quality toolbox will have two main tasks: Identification of erroneous data and imputation of erroneous data. In order to implement these modules it's mandatory to use the data from the provider to identify use cases and properly train the core models.. In this deliverable evaluation results of the outlier detection and imputation methods (big data) are provided.

Data quality services are focused on analyzing data in order to detect, identify, quantify and fix issues in the provided data. Type and source of issues are multiple and diverse. In this specific project, the use cases are focused on aggregated data from the European Network of Transmission System Operators for Electricity (ENTSO-E) , association of grid operators in Europe, and complementary on smart grids data from other use cases.

1.7.1.1 Challenges

ODINA-TS proposal addresses the "Scenario No 6.: Advanced Data Quality Analysis of Data Exchange Platforms", by implementing an actively monitoring and performing outlier detection to flag errors in time series data to act as an early indicator for abnormality in the databases of the Transparency Platform, in the power system analysis, the effective collaboration between actors, and in the implementation of flexibility services.

The main challenge to be addressed is to design and implement a tool for data quality measurements divided in two main steps; i) Identification of missing or erroneous readings, ii) Imputation of missing or erroneous readings.

1.7.1.2 Proposed solutions

Outlier detection methods

Two different data scenarios areconsidered for the outlier detection methods and different approach is proposed per each scenario:

A) Big data scenario: Big number (>5K) of single high variable time series. That would be the case of the load or generation from distribution grid through SCADA or energy management systems, and smart meters measurements of consumers and prosumers. The method is based on using Daily Patern based method to detect the abnormal patterns in data that are considered outliers or anomalies or errors or noise or faults or defects. In this case the method is based on using a daily pattern based approach in order to identify abnormal dates in the time series. Clustering is the core of the pattern based approach. The core of the clustering approach is based on the Gaussian Mixture Model (GMM). The result is the ability to work in a context where the size of training sample grows as time went on, leading to more training time, more computation resources, failing to detect outliers on time.

B) Small data scenario: Small number of time series data. That would be the case of national load, generation, and the other time series data from the Transparency Platform, as well as or small business cases from the other

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scenarios (<5K). The method is based on obtaining a baseline model based on LSTM autoencoders, which is a self-supervised method based on neural networks. Our neural network anomaly analysis is able to flag the upcoming bearing malfunction well in advance of the actual physical bearing failure by detecting when the data readings begin to diverge from normal operational value.

Description of the imputation method

Each of the time series have specific domain properties and outliers. Although all the time series are energy domain related, each of them has different dynamics depending on different factors. The dynamics of time series can depend on economics, weather, logistics, etc. The used imputation is based on a variation of the kNN regression method over subsampled data. The subsampling criteria is mainly related to recent similar days in terms of calendar and load profile. Calendar similarity is based on labor/non-labour property or weekdays. Daily load profile similarity is calculated using euclidean distance between partial available load and partial load of all the other days. The ones with low euclidean distance between daily profiles are picked as similar profile days. The closest labor or non-labour days with a similar load profile are used by kNN method to evaluate neighbors' similarity. Similarity is used as a weight of the contributions of the neighbors. The imputation result is the weighted average of the neighbors value. The weight is 1/d where d is the distance to the neighbor.

Each of the stages have different customization settings. Detection method customization is used to properly fit the method to the different kinds of time series provided by ENSTO-E.

1.7.1.3 Evaluation results

Outlier detection evaluation

Synthetic outliers are used as the data provided by ENTSO-E is not already classified and has no kind of label to be used as outlier identification. Synthetic data is an industry workaround to evaluate scenarios which are in the domain knowledge but with no available data. Synthetic outliers are created to evaluate the model under outlier scenarios not present in data. Outliers are domain specific but typical outlier patterns are:

- Spikes
- Plateaus
- Null values
- Anomalous patterns

The results of the evaluation method previously described is presented as benchmarking analysis. Recall will be the (from 0 to 1) main indicator and accuracy will be analyzed in each specific caseBenchmarking has been done to compare the results of the outlier detection algorithm against other methods used in the industry.

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- Local Outlier Factor (LOF). The LOF algorithm is an unsupervised anomaly detection method which computes the local density deviation of a given data point with respect to its neighbors. It considers as outliers the samples that have a substantially lower density than their neighbors.
- Median Absolute Deviation (MAD). The Median Absolute Deviation is a robust measure of the variability of a univariate sample of quantitative data.

Table 8.7.1 - Specification of the outlier scenarios

Time Serie	Type of Outlier	LOF	MAD	PatternBased
ActualTotalLoad	global_spike_plateau	1	1	1
ActualTotalLoad	contextual	0.04	0	0.8
ActualTotalLoad	collective	0	0	0.95
AggregatedGenerationPerType_NUCLEAR	global_spike_plateau	1	1	0.89
AggregatedGenerationPerType_NUCLEAR	contextual	0.12	0	0.72
AggregatedGenerationPerType_NUCLEAR	collective	0	0	0.27
AggregatedGenerationPerType_SOLAR	global_spike_plateau	0.4	1	0.9
AggregatedGenerationPerType_SOLAR	contextual	0.04	0.6	0.99
AggregatedGenerationPerType_SOLAR	collective	0	0.44	0.85
ForecastedDayAheadTransferCapacities	global_spike_plateau	1	1	1
ForecastedDayAheadTransferCapacities	contextual	0.82	0	0.62
ForecastedDayAheadTransferCapacities	collective	0	0	0.52
TotalCapacityNominated	global_spike_plateau	1	1	0.51
TotalCapacityNominated	contextual	0.03	0	0
TotalCapacityNominated	collective	0.01	0	0.41

Imputation evaluation

See the imputations results in Table 8.7.2:

Table 8.7.2- Specification of the outlier scenarios

TimeSerie	Type of gap	nRMSE
ActualTotalLoad	five_days	0.00787
ActualTotalLoad	partial_days	0.00207
ActualTotalLoad	single_days	0.00355

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ActualTotalLoad	single_hours	0.00063
AggregatedGenerationPerType_NUCLEAR	five_days	0.00485
AggregatedGenerationPerType_NUCLEAR	partial_days	0.00170
AggregatedGenerationPerType_NUCLEAR	single_days	0.00242
AggregatedGenerationPerType_NUCLEAR	single_hours	0.00048
AggregatedGenerationPerType_SOLAR	five_days	0.04497
AggregatedGenerationPerType_SOLAR	partial_days	0.01425
AggregatedGenerationPerType_SOLAR	single_days	0.02627
AggregatedGenerationPerType_SOLAR	single_hours	0.00677
ForecastedDayAheadTransferCapacities	five_days	0.00422
ForecastedDayAheadTransferCapacities	partial_days	0.00036
ForecastedDayAheadTransferCapacities	single_days	0.00094
ForecastedDayAheadTransferCapacities	single_hours	0.00000
TotalCapacityNominated	five_days	0.06122
TotalCapacityNominated	partial_days	0.02585
TotalCapacityNominated	single_days	0.03851
TotalCapacityNominated	single_hours	0.00855

Conclusions regarding outlier detection:

- Manual curation of positives is required in order to calculate precision so F1-score
- Accuracy is highly related to the properties of the time series. As it was expected, high stochastic time series have worse results.
- Accuracy in global spike and plateau outliers is quite good in all methods
- Detection in contextual and collective outliers is only done by the pattern based algorithm. LOF could work under some specific time series properties
- Pattern based algorithms detects potential (false/true) positives which should be manually reviewed
- Automatic hyperparameter tuning must be used to improve the results once labeled data is available
- Hyperparameter tuning can be used to generate different kinds of outlier signals. Soft and strict hyperparameter tuning can be used to create warning and severe outliers
- Additional extra-information like holidays or special days could be added to pattern based method in order to improve clustering quality

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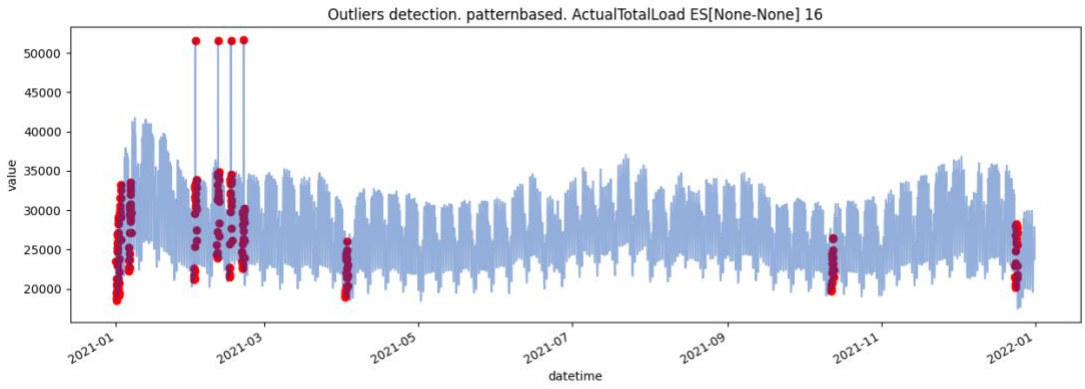
Conclusions regarding imputation:

- Deviation is highly related to the properties of the time series. Best results are obtained in low stochastic time series and worse results are obtained in high stochastic time series
- Partial day gaps and single hour gaps are best predicted as they provide daily pattern contextual information to the imputation method
- Automatic hyperparameter tuning must be used to improve the results once outlier labeled data or extra information on gaps is available
- Additional extra-information like holiday, specials days or specific domain specific data (weather, market info, time serie correlation, …) could be added to improve prediction

The results per each kind of time series introduced in the evaluation description are displayed below. The red dots are the predicted outliers detected in the time series by the outlier detection.

ActualTotalLoad.global_spike_plateau

Daily-pattern based



AggregatedGenerationPerType_NUCLEAR.contextual

Daily-pattern based

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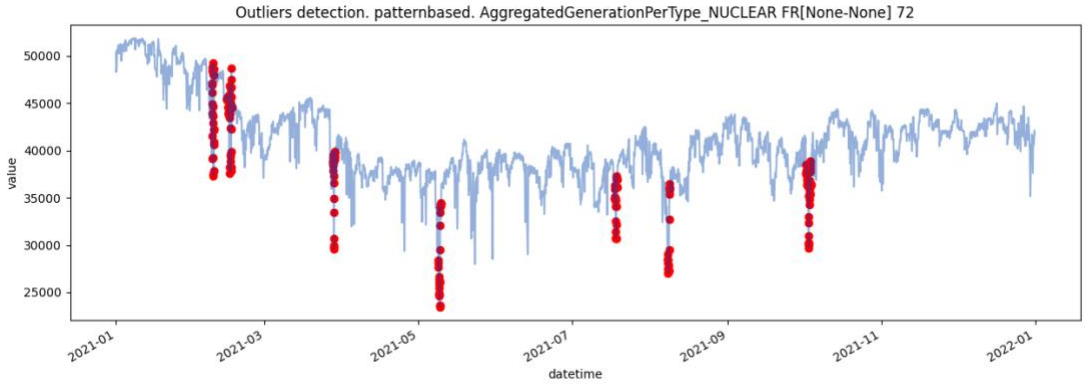
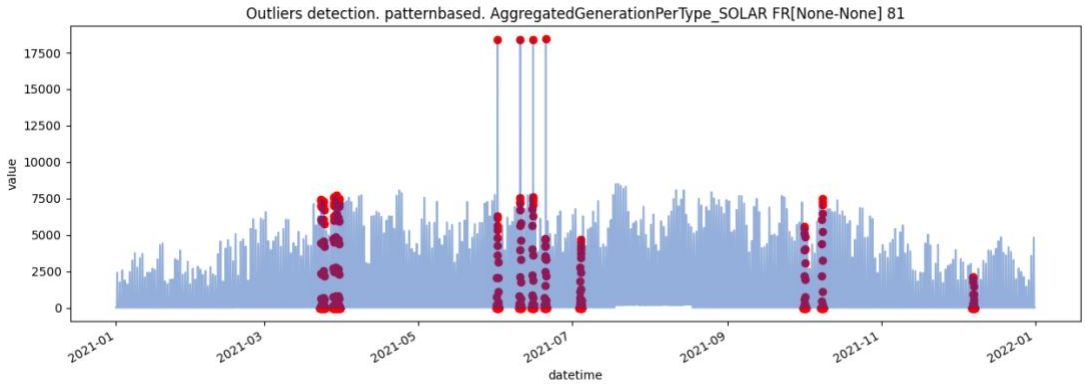


AggregatedGenerationPerType_SOLAR.global_spike_plateau

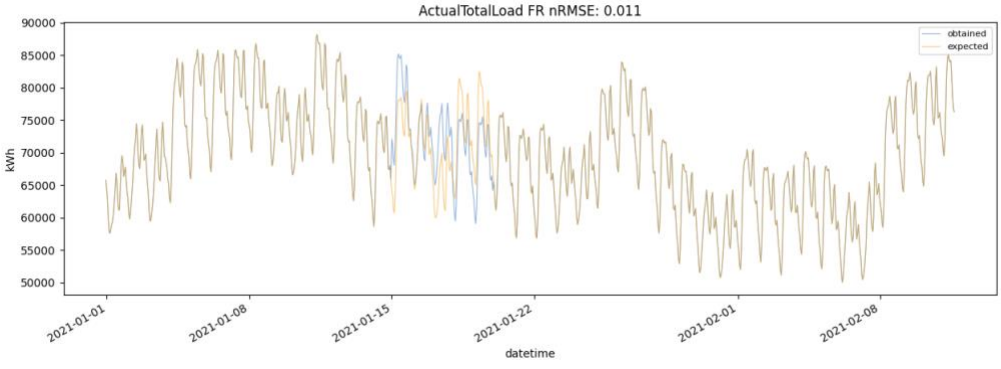
Daily-pattern based



Imputation evaluation results

The results per each kind of time series introduced in the evaluation description are displayed below. The blue time series corresponds to obtained imputation results and the orange time series corresponds to expected imputation results, so the original time series.

ActualTotalLoad.five_days



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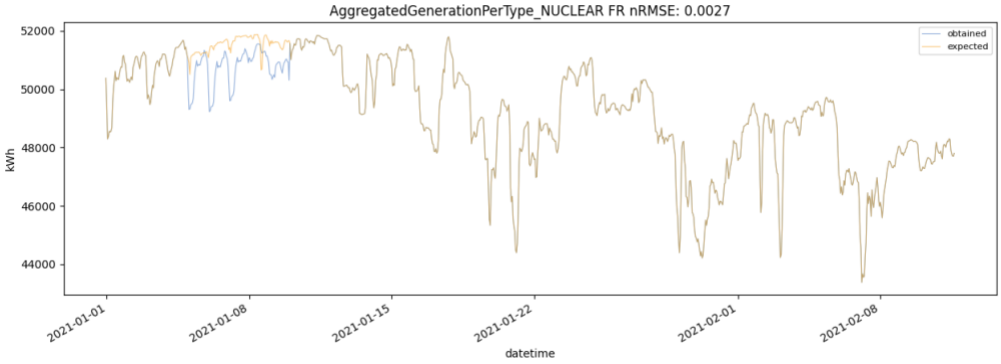
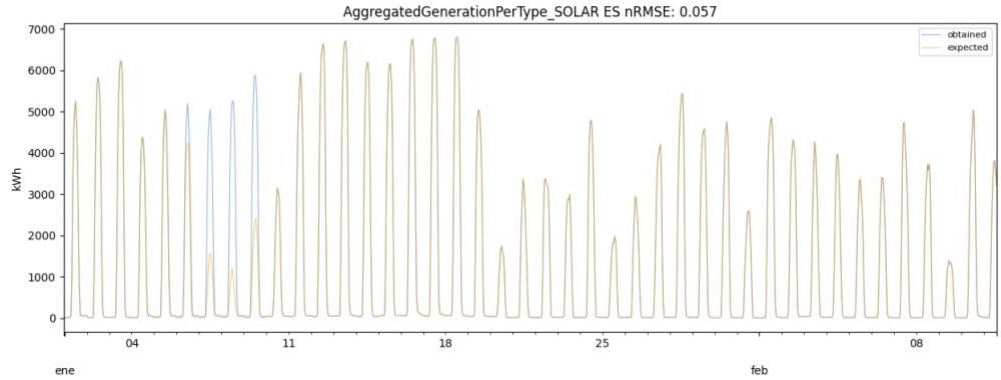
AggregatedGenerationPerType_NUCLEAR.five_days



AggregatedGenerationPerType_SOLAR.five_days



1.7.2 Company Description

Beedata Analytics translates smart meters data, customers data, weather and other sources into actionable intelligence for customer engagement. Beedata is doing Home and business Energy Report (BERs) programs powered by AI (artificial intelligence) to help Energy companies providing a more cost-effective way to greater customer engagement, increase program conversions and lasting customer satisfaction.

1.8 ADREE by Artelys

1.8.1 Project Description

1.8.1.1 Challenge

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The study of energy systems involves a considerable amount of data intensive tasks, requiring an increasing need for detailed temporal and spatial granularities. European data exchange platforms, such as the Transparency Platform powered by the ENTSO-E, are a key component in giving access to a wide range of power system data to all actors of the energy system. In addition to facilitating data exchange between actors, those transparency platforms work for the creation of efficient, liquid and competitive wholesale markets. It thus levels the playing field between small and large actors. Intensive data exchanges are meant to increase through various new and innovative data services between actors of the European energy system such as TSOs, DSOs, aggregators, suppliers, consumers, etc… For instance, in France, with the ambition to engage more strongly consumers as a proactive actor on electricity markets, Enedis has designed and deployed the Linky smart meter, enabling consumers to monitor their electricity usage and Enedis to gather a large amount of consumption data at a very detailed level which can then be made available to conduct relevant analysis on electricity consumption. Such an extensive database is unprecedented and can then be aggregated at many different levels to be exchanged with other stakeholders.

However, frequent reviews of the Transparency Platform, for instance commissioned by the European Commission[1] or under the initiative of European researchers[2] and frequent users of the platform, have hinted at various shortcomings and problems in terms of data quality. The ADREE tool addresses these issues and proposes an innovative solution to leverage the progress of AI into a transparent and easy-to-use web application.

1.8.1.2 Proposed Solution

The ADREE tool has the ambition to significantly improve the accuracy and the quality of the exchanged data between TSO-DSO-consumers, by providing:

- An **efficient** and **robust** solution to get an overview of the quality of the “raw” exchanged data, for many different data sources, leveraging state-of-the art machine learning techniques;
- An “**easy-to-use**” solution to conduct data analysis;
- A **quick** solution to **fix and clean** the “raw” data based on the provided quality diagnoses.
- The overall concept and approach are twofold:
- To implement **state-of-the art** algorithms for **data quality diagnosis** and **data sanitization**, powered by Machine Learning and Artificial Intelligence.
- To embed theses algorithms inside an **innovative and user-friendly web application** composed of:

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- A **workflow engine** to power data pipelines and provide a set of functionalities to follow the treatments (progress, logs, gantt, etc);
- A **web frontend** to easily access results and KPIs

The ADREE project ambitions to deliver a tool that will provide more transparency and trustworthiness to energy systems studies.

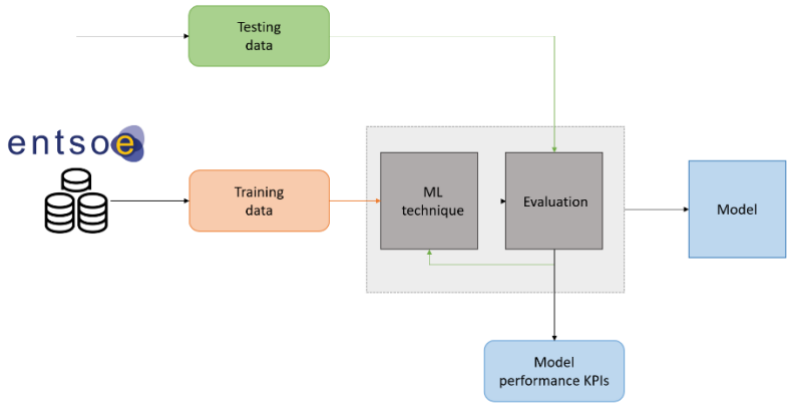

*Figure **Error! No text of specified style in document.**.8.1 – Model training workflow scheme*

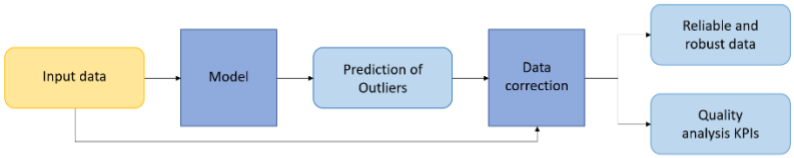

*Figure **Error! No text of specified style in document.**.8.2 - Model application workflow*

1.8.2 Company Description

Artelys is an independent consulting company of 80 people, specialized in optimization, data science, decision support and modelling thanks to a high-level expertise in advanced quantitative techniques such as statistics, Artificial Intelligence and solutions in optimization. Artelys operates in diversified sectors but is particularly active in the energy sector, acknowledged as a leading performer of energy system modellings. Thus,

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Artelys often collaborates with major companies and authorities in the energy sector, on a French, European, or international scale.

Artelys offers a comprehensive and modular range of services which relies on its consultants' expertise in:

- Artificial Intelligence, optimization and prediction techniques,
- The modelling and strong understanding of energy systems,
- Project Management.

By combining its understanding of the energy systems with the use of advanced quantitative methods, Artelys delivers high-quality consultancy services with actionable recommendations for its clients. An overview of key projects already undertaken by Artelys, relevant for the given call follows:

- H2020 project REWARDHeat (2019-2023)
- H2020 project ECEMF (2021-2025)
- RTE Projects L2RPN and Chronix2grid (2019)
  https://github.com/rte-france/grid2viz
- European Commission METIS 3 (2020- 2023)
  https://energy.ec.europa.eu/publications-new/metis-scripts-and-data_en
- TenneT Power Flow Simulator (2019)
  https://www.entsoe.eu/data/powerflow-tool/

1.9 RYNADMTS by Presify Analytic Software Inc.

1.9.1 Project Description

1.9.1.1 Challenge

The scenario aims to encourage the development of tools and services for data quality checks from a general perspective that will be flexible enough to adapt to the different needs of data exchanges among TSOs, DSOs and consumers. More specifically, the developed service will also serve for the Transparency Platform to enhance the quality of the data by highlighting the abnormalities. In particular, the service should be able to detect outliers from timeseries where standard methodologies are not sufficient.

1.9.1.2 Proposed Solution:

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The proposed algorithm is a novel method which is based on deep recurrent autoencoder ensembles which Presify expect to generate scientific impact. Deep ensembles are proven to be robust predictors and approximates predictive uncertainty effectively using deep networks as base learners. The algorithm proposed uses the recurrent autoencoder model as the base learner and reconstructs the sequence and hence detects anomaly. Recurrent neural networks are subclass of deep learning models that performing superior in sequential learning problems gained popularity among scholars in anomaly detection. It could capture both long term and short-term dependencies in sequential data and therefore predicts it accurately. Recurrent autoencoders models are models that constructs time series and its embeddings via encoder and decoder structure, where encoder generates embeddings and decoder reconstructs series via encoded embeddings. Thereby, natural behavior of time series could be detected via this autoencoder, and anomalies could be detected as divergence from expected behavior of time series represented by recurrent autoencoder. However, a single autoencoder might not sufficiently capture the nature of time series due to noisiness of time series data. In order to tackle this problem deep ensembles emerges. Power of ensembling methods is due to diversity by initializing randomly parameters of each neural network in the ensemble or bootstrapping the dataset. Deep ensembles combine N models, which are called base models, generally by simple averaging it exploits the correlations between those models and generate more robust predictor. Moreover, deep ensemble models are capable of approximating distribution of predictions by which anomaly detection could be performed. Using these predictive intervals, anomaly could be detected easily just by calculating the distance of potential anomaly point from upper and lower intervals. Regarding above approach, Presify ‘s solution for Advanced Data Quality Analysis of Data Exchange Platforms could be summarized in flow below (Figure 8.9):

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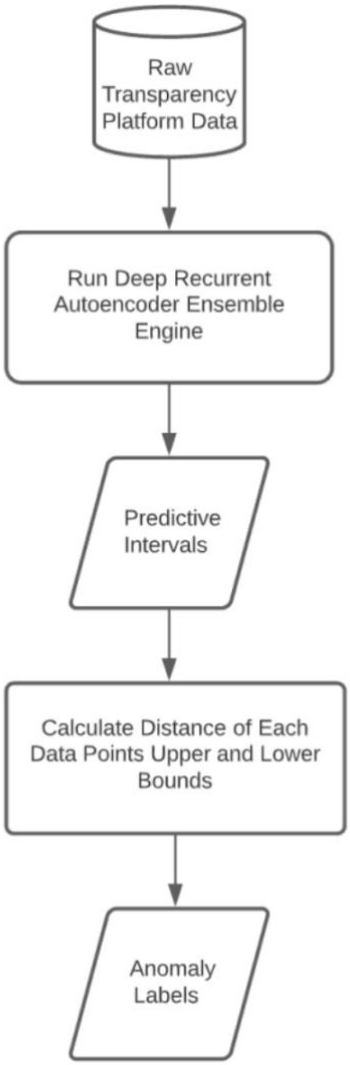

Figure ***Error! No text of specified style in document.****..9* – Proposed Model Flowchart

1.9.1.3 Expected Results:

Anomaly detection is important for several reasons for several market participants such as TSOs, generators, energy distribution, and generation companies, and consumers. Day-ahead operations and planning activities require accurate forecasts for market participants to operate efficiently. Thus, data quality is a vital issue. Other than day-ahead planning, market participants should monitor system data in real-time to operate functionally and profitably on their mission critical operations such as dispatching or balancing operations, energy trading, outage repairing. Regarding these economic impacts could be listed as follows: (i) For TSOs, inaccurate forecasts

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could damage day-ahead planning and intraday operations and because of these poor planning activities outages would happen which directly affect economic actors such as factories, households, etc. (ii) Distribution companies would end up high imbalance costs. Moreover, since distribution companies are required to meet energy demand, they need to buy energy from the intraday market which could be costly. In addition to this, distribution companies could end up losing favorable trading opportunities as well. As distribution companies responsible for outages in their assigned territory, anomaly in outages could affect their operations and could cause damage to their operations. (iii) Energy production and trading companies could miss favorable trading opportunities as well since their trading optimization will rely on accurate demand and production forecast which require data quality. (iv) Smart grids are sensor- rich environments and are expected to grow further. In long term, smart grid data could assist end- users, energy producers, and utility companies in detecting anomalous power consumption and understanding the causes of each anomaly. Moreover, it will aid in better decision-making to reduce wasted energy and promote sustainable and energy-efficient behavior[2]. Avoiding the above problems due to poorly planned day-ahead activities and avoiding missing opportunities in intraday markets would create economic lift and revenues. Presify expect this model to be a robust anomaly detector and publish their findings in scientific journals. Moreover, this research will enhance their knowledge of usefulness of deep neural networks for anomaly detection and could trigger further research.

The expected results could be summarized with two objectives:

Objective1: Minimizing reconstruction error of time series data of transparency platform which will be the base for labeling anomaly.

- KPI: MAPE of test dataset < 5%

Objective2: Detecting anomalies in time series data of transparency platform.

- KPI: F1 score > 80%

1.9.2 Company Description

Presify provides machine learning based predictive analytics tools for demand forecasting, renewable energy generation forecasting, electricity price forecasting; predictive maintenance and anomaly detection tools for wind and solar generation; decision support tool for energy management system and energy trading and plans to develop a complete system for peer-to-peer trading or community grids. Presify provides these solutions in its All-in-One Expert Systems Platform. This platform combines the following sub-products, each of them can be positioned as a separate product:1) Electricity demand forecasting, 2) Renewable energy analytics (forecasting, anomaly detection), 3) Auto AI for Energy Analytics, 4) Energy Management System, 5) Energy Trading System.

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