Watt-IS mid-term report

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About OneNet

OneNet will provide a seamless integration of all the actors in the electricity network across Europe to create the conditions for a synergistic operation that optimizes the overall energy system while creating an open and fair market structure.

The project OneNet (One Network for Europe) is funded through the EU's eighth Framework Programme Horizon 2020. It is titled "TSO – DSO Consumer: Large-scale demonstrations of innovative grid services through demand response, storage and small-scale (RES) generation" and responds to the call "Building a low-carbon, climate resilient future (LC)".

While the electrical grid is moving from being a fully centralized to a highly decentralized system, grid operators have to adapt to this changing environment and adjust their current business model to accommodate faster reactions and adaptive flexibility. This is an unprecedented challenge requiring an unprecedented solution. For this reason, the two major associations of grid operators in Europe, ENTSO-E and EDSO, have activated their members to put together a unique consortium.

OneNet will see the participation of a consortium of over 70 partners. Key partners in the consortium include already mentioned ENTSO-E and EDSO, Elering, E-REDES, RWTH Aachen University, University of Comillas, VITO, European Dynamics, Ubitech, Engineering, and the EUI's Florence School of Regulation (Energy).

The key elements of the project are:

1. Definition of a common market design for Europe: this means standardized products and key parameters for grid services which aim at the coordination of all actors, from grid operators to customers;
2. Definition of a Common IT Architecture and Common IT Interfaces: this means not trying to create a single IT platform for all the products but enabling an open architecture of interactions among several platforms so that anybody can join any market across Europe; and
3. Large-scale demonstrators to implement and showcase the scalable solutions developed throughout the project. These demonstrators are organized in four clusters coming to include countries in every region of Europe and testing innovative use cases never validated before.

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List of Abbreviations and Acronyms

Acronym	Meaning
DEP	Data Exchange Platform
DSO	Distribution System Operator
FSP	Flexibility Service Provider
GUI	Graphical User Interface
RUC	Regional Use Case
SUC	System Use Case
TSO	Transmission System Operator
WIS	Watt-IS

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Executive Summary

The transition towards clean energy sources that are variable in nature and have a certain degree of unpredictability, along with the consumption dynamics from new technologies such as heat pumps or electric vehicles (EV's) creates new challenges to electricity network operators (DSOs & TSOs). As these challenges are deeply associated with the digitalization of the energy systems, where unprecedently high amounts of data are being generated and processed, there is an urgency to develop optimized data-sharing mechanisms between System Operators to increase network efficiency and resiliency while also aiming for a 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.

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 "forecasts" and "operational planning", 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. Within the scope of the OneNet project Watt-IS has been developing with project stakeholders (E-REDES and REN/NESTER) a set of System Use Cases that will allow optimized information exchange processes between the Portuguese DSO and TSO focused on grid "operational planning" and flexibility service requirements, namely: i) daily (next 72h) consumption and generation forecasts; ii) daily (next 24h) forecasted short-circuit information; iii) weekly, monthly and annual maintenance plans; iv) flexibility service providers prequalification and v) daily flexibility needs forecasts (next 24h).

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1 Introduction

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 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 for a 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.

Based on initial iterations with the project stakeholders (E-REDES & REN/NESTER) the scope of the work has been outlined and Watt-IS is set to build two Data Exchange Platforms (DEP), consisting of the necessary back-end (including the required APIs, where necessary) and front-end layers, that will allow for a more efficient information exchange process between the two system operators but also with others system operators within the Western Cluster (within the Regional Use Case and via the OneNet Connector), focused on grid "operational planning" and the provisioning of flexibility services. The data to be exchanged can be categorized as: i) daily (next 72h) consumption and generation forecasts; ii) daily (next 24h) forecasted short-circuit information; iii) weekly, monthly and annual maintenance plans, iv) flexibility service providers prequalification and v) daily flexibility needs forecasts (next 24h).

The current mid-term report is the 1st of 2 reporting deliverables that Watt-IS needs to deliver within the overall OneNet project and it describes the work developed up to now. In section 3.3, a detailed timeplan is presented highlighting the work already developed and what is still missing to be developed by Watt-IS.

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2 Impact of the project on OneNet and the general European Energy system

With the developments planned to be carried out by Watt-IS within the OneNet project, it is expected that an effective advance is made towards an improved coordination between the DSOs and TSOs through a more efficient information exchange process regarding grid “operational planning” and the provision of flexibility services. These developments are totally aligned with the objective of achieving a smarter and more flexible electricity grid that is critically necessary to guarantee a more efficiently managed and resilient grid, but also for System Operators to have a higher capacity to incorporate additional variable renewable energy resources along with supporting the ongoing cross-sector electrification (including, EVs, heat pumps, etc.), that jointly will bring us closer to the sustainability and climate goals that need to be achieved.

These developments will also contribute to the creation of more opportunities and revenue streams for Flexibility Service Providers (FSPs) that are allowed to provide these services for both DSOs and TSOs. Additionally, System Operators will have at their disposal, more solutions to better and more efficiently manage the network in a scenario with a vast expansion of variable renewables together with an expected increase in electricity demand arising from the cross-sectorial electrification of the energy systems.

Using the OneNet connector, the developments made by Watt-IS will allow the overall OneNet project objective of achieving the “Definition of a Common IT Architecture and Common IT Interfaces enabling an open architecture of interactions among several platforms so that anybody can join any market across Europe”, and this will be fully demonstrated in the Regional Use Case, by allowing other European system operators to validate if a given flexibility service provider may or may not enter in the flexibility market, and also in the SUC 02, by allowing European system operators to inform each other regarding their own flexibility needs. This will be a key feature to be able to demonstrate the capability for EU replicability of the proposed OneNet concept that effectively emphasizes the impact that the project may have throughout the EU.

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3 Project description

Within their overall participation in the OneNet project, the project mentors (E-REDES and REN/NESTER) have outlined and specified a set of "System Use Cases" (SUCs) to be implemented in the Portuguese demonstration, as a way to showcase the OneNet architecture and concept application, which are described in the project's public deliverables "D9.1 – Specifications and guidelines for Western Demos" and "D5.1 - OneNet Concept and Requirements". It's important to note that from the eight SUCs defined within that deliverable, five (plus the Regional Use Case, RUC) were selected for implementation and are included in Watt-IS's scope of work.

Based on different discussions held with the project mentors, the developments to be executed by Watt-IS in the implementation of the SUCs mentioned above, within the scope of the OneNet agreement, are two DEPs, one for each of the project mentors, in order to allow them to more efficiently manage the information exchange processes regarding grid "operational planning" and the provision of flexibility services.

For the development of the works foreseen in the OneNet project Watt-IS has adopted from the start an Agile approach seeking to achieve fast delivery iterations to stakeholders (E-REDES and REN/NESTER) that allow for a joint revision, analysis and incorporation of timely feedback, thus guaranteeing a strong alignment with existing expectations.

Below follows a summarized description of each one of the SUCs in which Watt-IS will contribute:

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). Watt-IS will be responsible for the implementation of a GUI that interacts with the REN/NESTER APIs.

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. Watt-IS will also support REN/NESTER with the integration of the OneNet Connector, besides implementing the GUI that interacts with the REN/NESTER APIs.

System Use Case 02 (REN/NESTER) – GUI & Integration with REN/NESTER APIs and OneNet Connector

This SUC supports the coordination between the DSO and TSO so that they can determine how much flexibility they will need to acquire, for a short-term timeframe. Watt-IS will also support REN/NESTER with

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the integration of the OneNet Connector, besides implementing the GUI that interacts with the REN/NESTER APIs.

System Use Case 06 (E-REDES & REN/NESTER)

The SUC 06 foresees the possibility for weekly, monthly and year ahead grid maintenance plans to be exchanged between the DSO (E-REDES) and the TSO (REN/NESTER). Watt-IS will implement the back-end (Implementation of E-REDES APIs + Database Management and Integration with REN/NESTER & E-REDES APIs) and frontend (GUIs for the DSO and TSO) layers for this SUC.

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). Watt-IS will implement the back-end (Implementation of E-REDES APIs + Database Management and Integration with REN/NESTER & E-REDES APIs) and frontend (GUIs for the DSO and TSO) layers for this SUC.

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). Watt-IS will implement the back-end (Implementation of E-REDES APIs + Database Management and Integration with REN/NESTER & E-REDES APIs) and frontend (GUIs for the DSO and TSO) layers for this SUC.

For REN/NESTER, the DEP developed by Watt-IS will support every SUC, including the RUC. For E-REDES, the DEP developed by Watt-IS will support SUCs 6 & 8. These 2 DEPs will be supported by a GUI (frontend-layer, that is responsible for allowing the visualization of the data exchanged) and a set of APIs (backend-layer, that is responsible for the exchange and management of the data). In order for the GUIs to be fed with the needed data, Watt-IS will also implement two APIs for each DEP GUI, namely i) an API made for the REN/NESTER DEP GUI, that will interact with the API developed by R&D Nester, and ii) one made for the E-REDES DEP GUI, that will communicate with an API developed by Watt-IS (E-REDES API). This last API, will be responsible for handling and managing the data exchange processes related to the SUCs 6 to 8 between the DSO and the TSO.

In parallel, Watt-IS will also support R&D Nester, with the integration of the OneNet Connector for the SUC 02 and the RUC. All of these developments will allow an optimal coordination between these two system operators but also with others system operators within the western cluster (via the OneNet Connector), when it comes to information more focused on grid “operational planning” (SUC 6 to 8) and flexibility services requirements (SUC 1, 2 and the RUC).

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3.1 Backend development

3.1.1 Backend development (E-REDES)

Watt-IS implements the Operational Module regarding use cases SUC 06, SUC 07, SUC 08 and the associated Data Storage using a stack of Ruby on Rails web framework, ReactJS and a PostgreSQL database. This solution allows us to reuse components for both DSO and TSO implementations.

Given the asynchronous nature of the system use cases and the associated processes transactions, a "Business Process Runner" component is designed so that it accepts a task descriptor and schedules its execution in a separated multithreaded background worker process, backed by a SQL database. The execution operation is itself idempotent if no external changes happen regarding the last run, in practice the process state machine (context) is restored, and any progress conditions are re-evaluated. We rely on an existing queuing library implementation for the Ruby on Rails framework Active Job backend that guarantees reliability and integrity regarding job execution and information persistence.

All the software will be running via Docker containers hosted inside a virtual machine (Standard D1 v2 with 1 vCPU and 3.5 GB RAM) provisioned by E-REDES on their own cloud infrastructure (Azure). Additionally, at least 2 Standard SSD 32 GiB shall be also provisioned in order to support the file storage requirements of the solution.

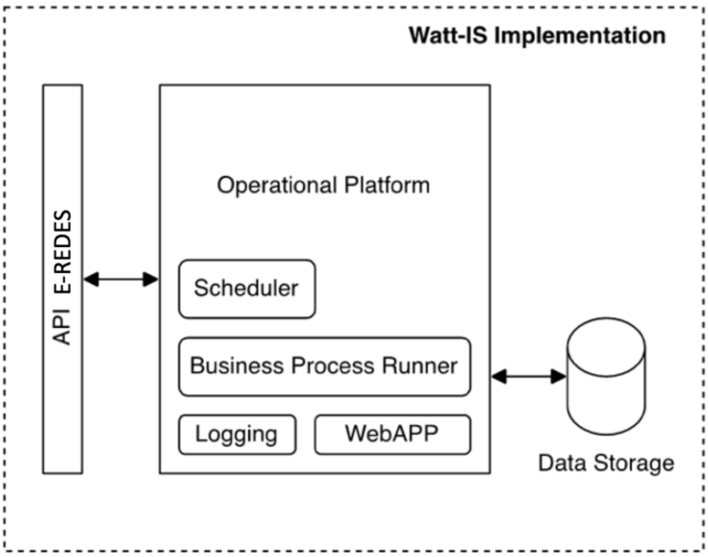

Figure 3.1 – E-REDES proposed back-end architecture

3.1.2 Backend developments (REN/NESTER)

Watt-IS will implement a User Interface Platform delivering a Web Application using a stack of Ruby on Rails web framework and ReactJS. Since it is used the same stack for the DSO implementation some of the components developed for the DSO user interface can be reused.

For REN/NESTER to be able to exchange information with DSOs within the Western Cluster, Watt-IS will also support the integration and testing of the OneNet Connector with the REN/NESTER API (for the RUC and SUC 02 use cases).

Similarly to the E-REDES side, all the software will be running inside Docker containers hosted in a virtual machine or as a service, provisioned by REN/NESTER on their own cloud infrastructure (AWS).

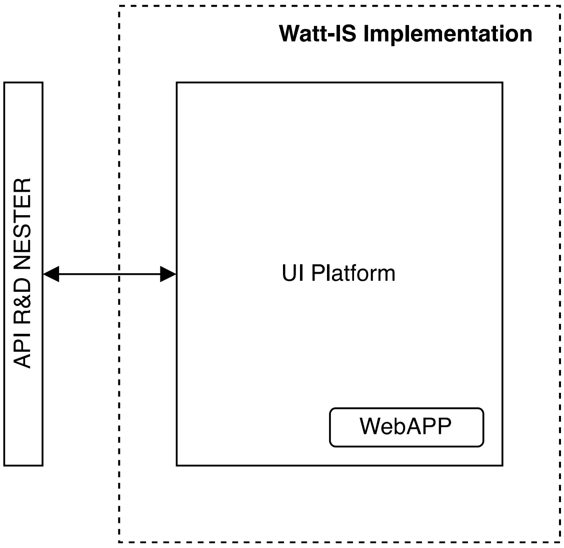

Figure 3.2 – REN/NESTER proposed back-end architecture

3.2 Frontend developments

During the first months of iteration with the DSO & TSO Watt-IS managed to clarify existing doubts and incoherencies identified in the initial proposed SUC layouts and developed mockups that have been discussed and agreed with both parties.

3.2.1 SUC 01 / RUC (REN/NESTER)

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Within the SUC 01 and RUC, Watt-IS has defined the layouts to be implemented and that will allow the grid and product pre-qualification of FSPs.

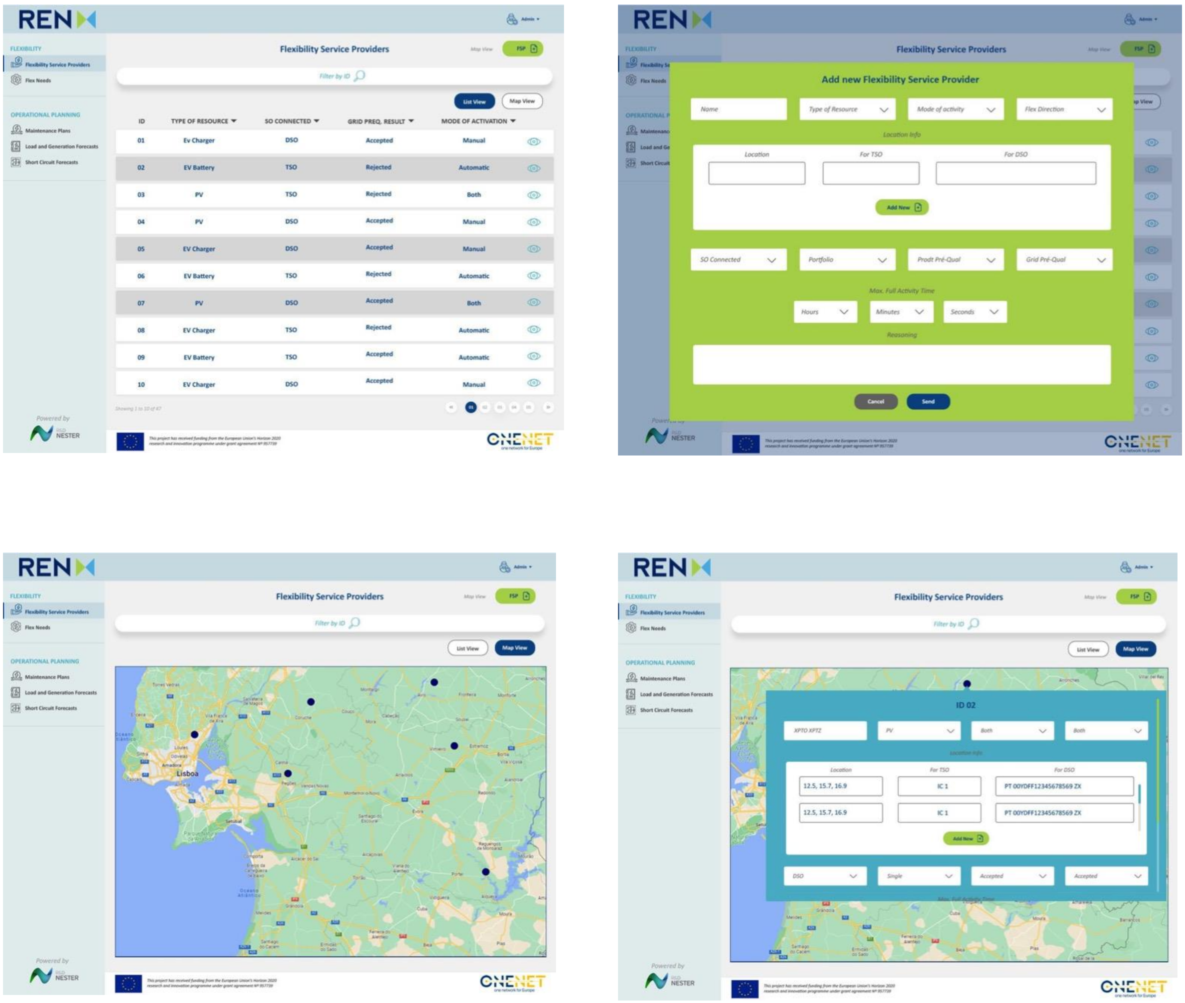

Figure 3.3 – SUC 01 proposed layouts (REN/NESTER)

3.2.2 SUC 02 (REN/NESTER)

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Within SUC 02, Watt-IS has defined the layouts to be implemented and that will support the coordination between the DSO and TSO so that they can determine how much flexibility they will need to acquire, for a short-term timeframe.

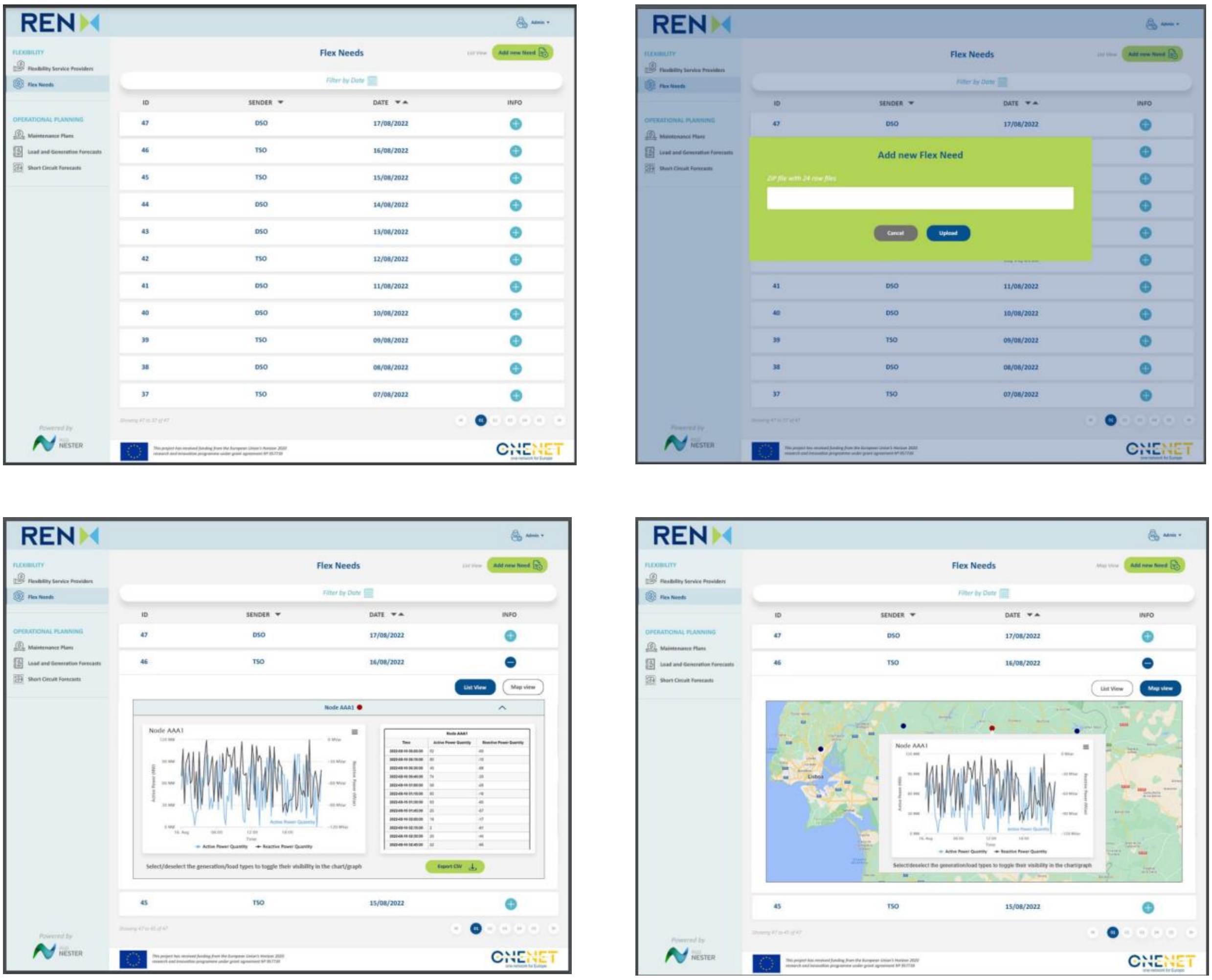

Figure 3.4 – SUC 02 proposed layouts (REN/NESTER)

3.2.3 SUC 06 (E-REDES & REN/NESTER)

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Within SUC 06, Watt-IS has defined the layouts to be implemented and that will allow the exchange of maintenance plans between E-REDES and REN/NESTER.

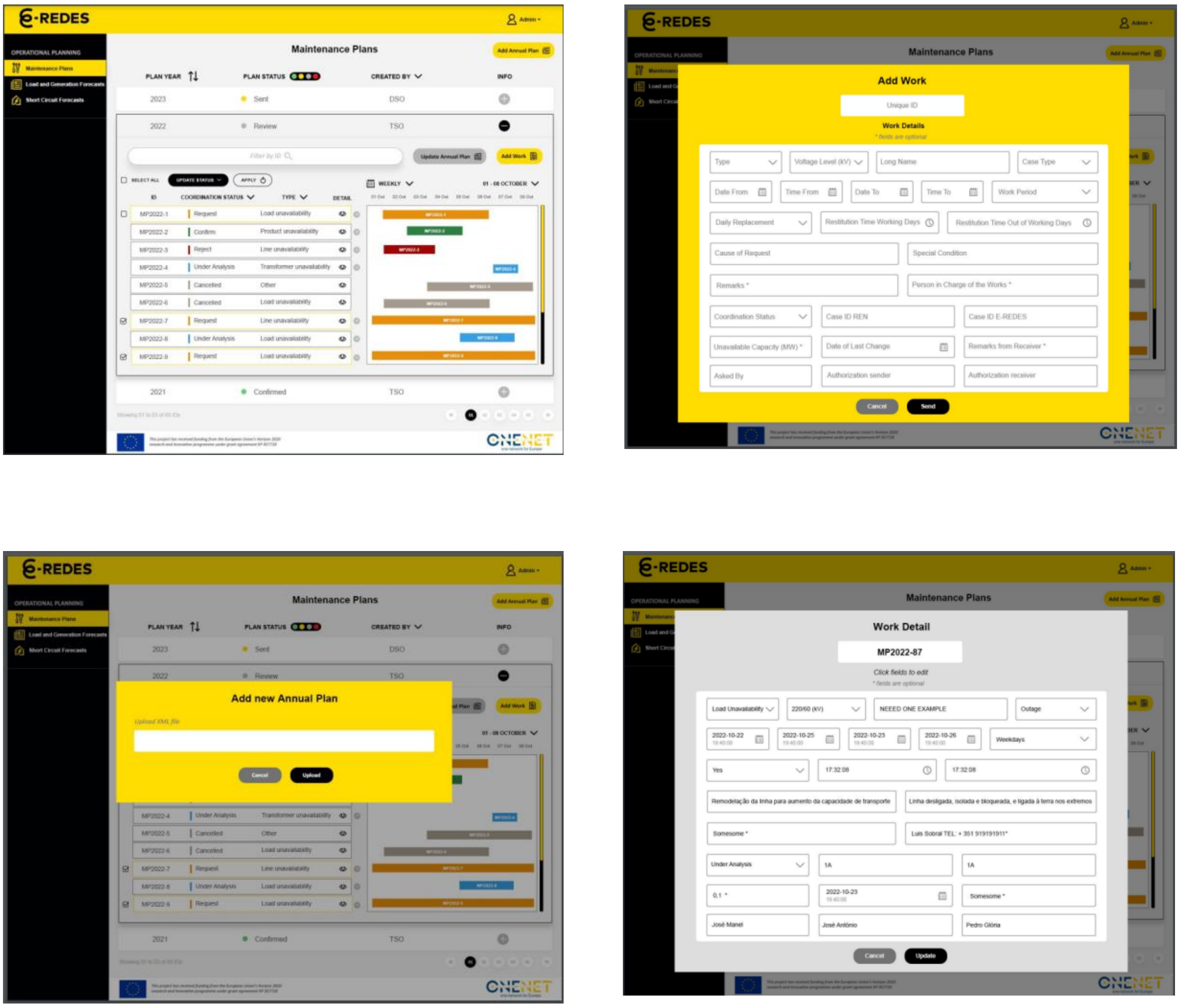

Figure 3.5 – SUC 06 proposed layouts (E-REDES)

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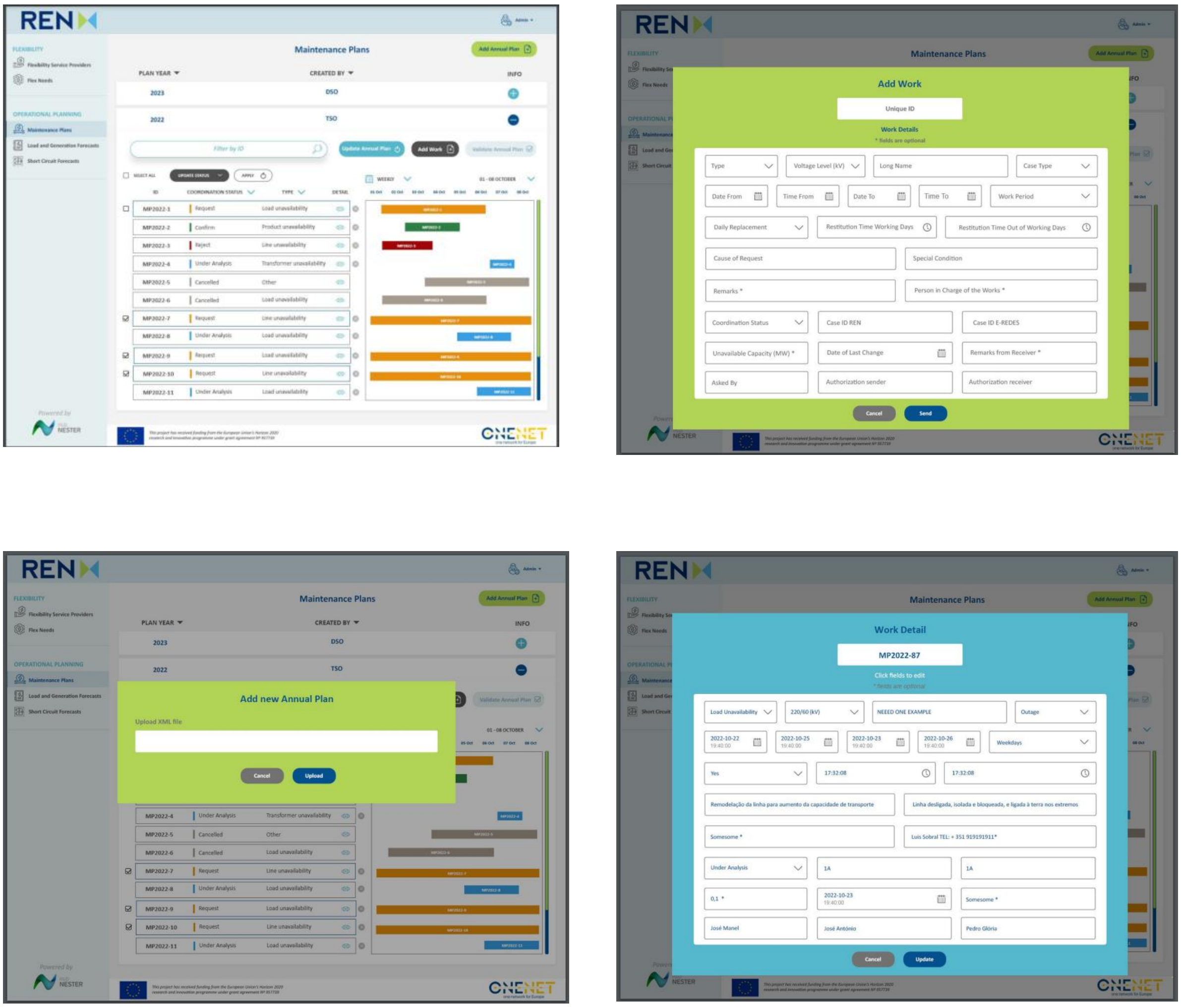

Figure 3.6 – SUC 06 proposed layouts (REN/NESTER)

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3.2.4 SUC 07 (E-REDES & REN/NESTER)

Within SUC 07, Watt-IS has defined the layouts to be implemented and that will allow the exchange of load and generation forecast information between E-REDES and REN/NESTER.

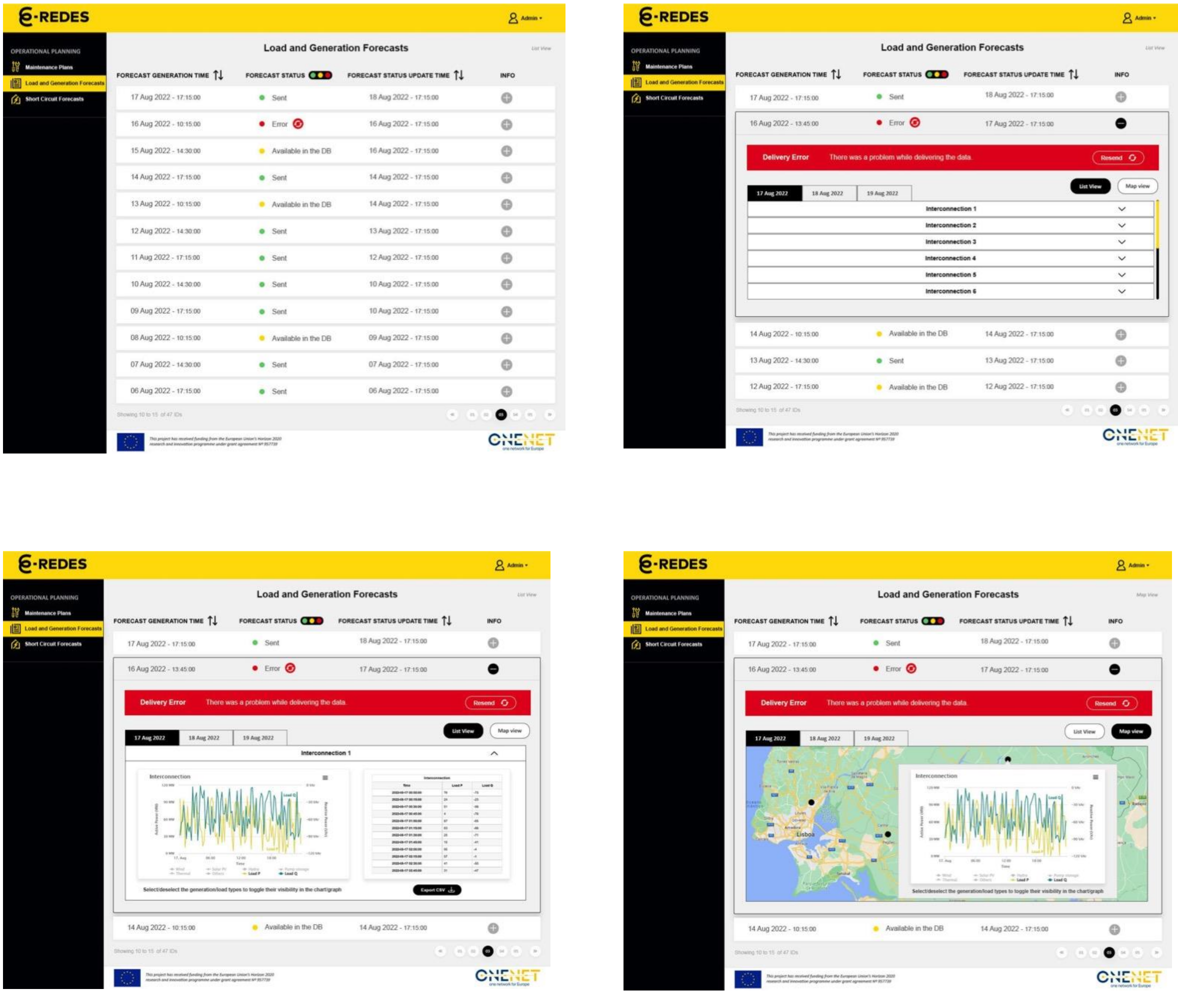

Figure 3.7 – SUC 07 proposed layouts (E-REDES)

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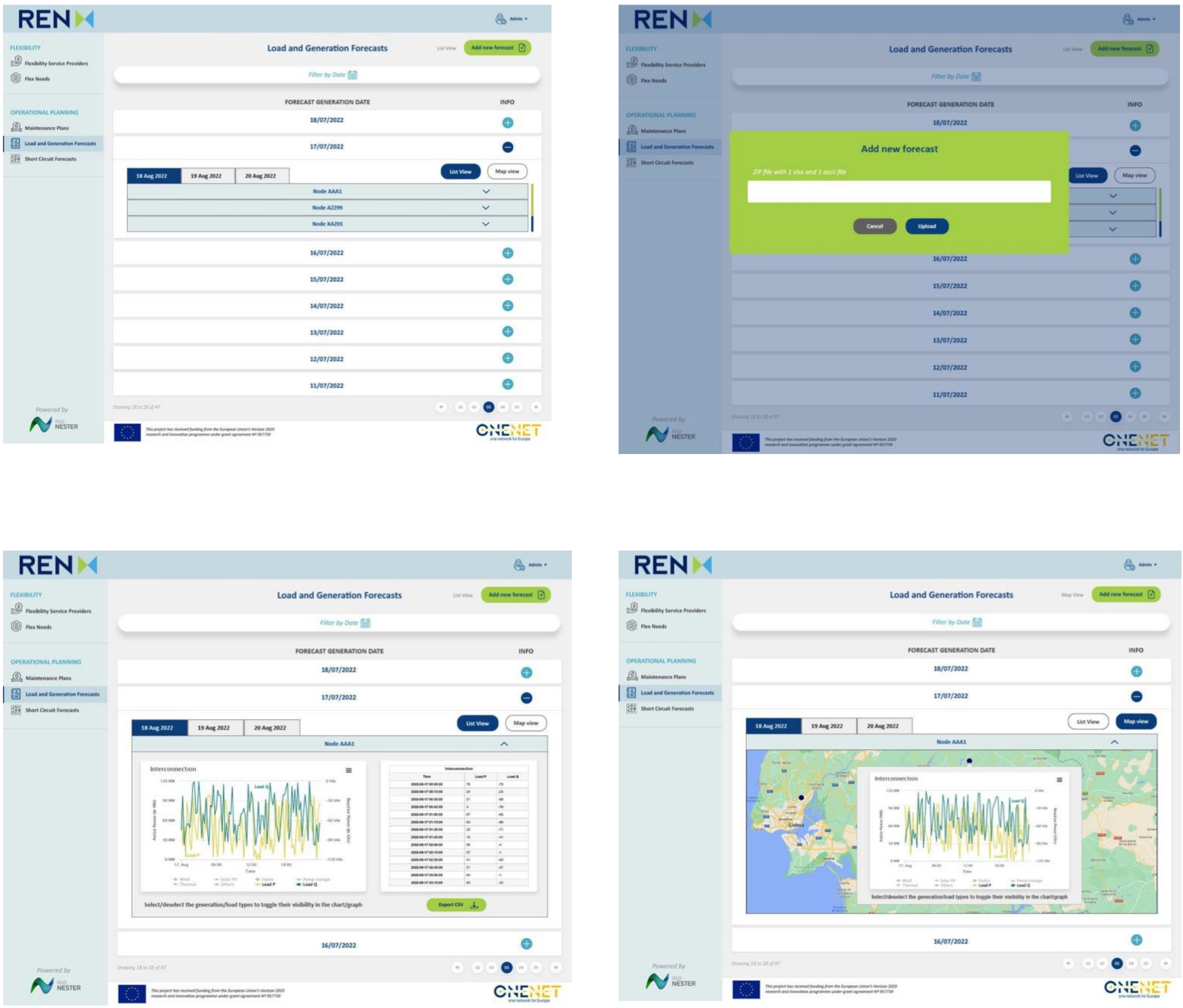

Figure 3.8 – SUC 07 proposed layouts (REN/NESTER)

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3.2.5 SUC 08 (E-REDES & REN/NESTER)

Within SUC 08, Watt-IS has defined the layouts to be implemented and that will allow the exchange of short-circuit forecasting information between E-REDES and REN/NESTER.

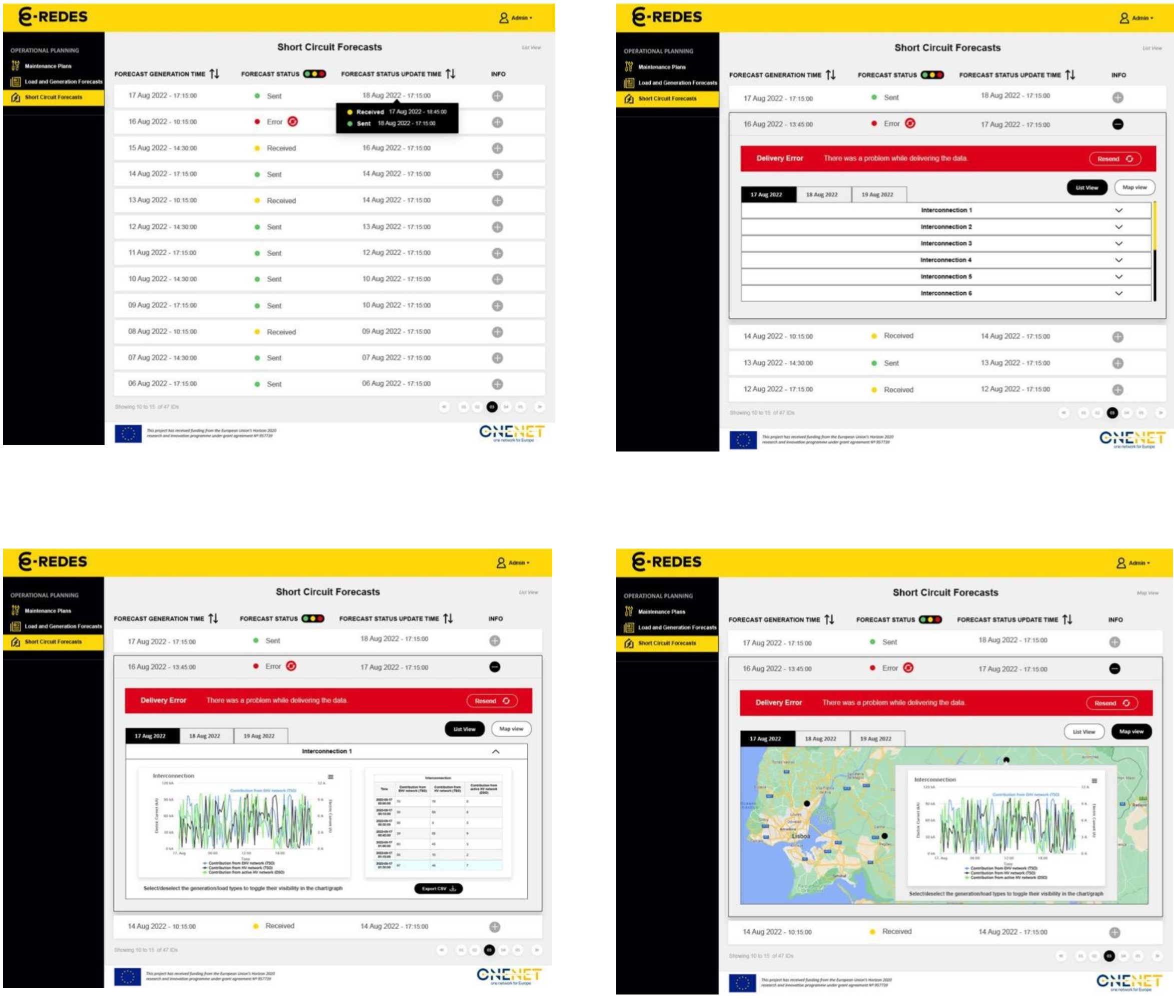

Figure 3.9 – SUC 08 proposed layouts (E-REDES)

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Figure 3.10 – SUC 08 proposed layouts (REN/NESTER)

3.3 Project Timeplan

Within the scope of Watt-IS participation in the OneNet project (Watt-IS contract agreement with OneNet was signed on July 10th 2021) an "Overall requisite analysis" was developed jointly with the project mentors (E-REDES and REN/NESTER) where several improvement opportunities were identified (both at the front-end and back-end layers, from what was initially defined as requirements by the DSO and TSO). That gave rise to the need for internal evaluations and discussions regarding the proposed layouts and required functionalities, and sometimes requiring additional alignments between the DSO and TSO.

This extended requisite analysis that also included a more prolonged review and preparation of the individual SUCs gave rise to the need of the extension request that has been formally presented, proposing a new project termination date of March, 31st, 2023. It is important to emphasize that this new proposed termination date does not generate any impact to the Portuguese demonstration, nor to any of the resulting deliverables and contributions to the several Work Packages of OneNet, and indeed will allow for different improvements to be implemented that will allow both i) an increased usability for the specified use cases and ii) a technically more robust implementation for the Portuguese demonstration.

It is also worthwhile to mention that, based on the contract signature date from Watt-IS (July 10th 2021) and the current expected date for the release of the final version of the OneNet Connector API (that to our knowledge is expected to occur in the end of January 2023) the project end date would already make necessary a project extension request, since all the integration effort and testing would still be needed and that would clearly surpass January 2023.

In Annex A you will find a revised project timeplan where the "Executed" tasks and the "still to be executed" tasks are identified, based on the new proposed project execution timeline of March, 31st, 2023.

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4 Conclusions

Within the scope of the OneNet project Watt-IS has been developing with project stakeholders (E-REDES and REN/NESTER) a set of System Use Cases that will allow optimized information exchange processes between the Portuguese DSO and TSO. The processes are focused on grid "operational planning" and flexibility service requirements, namely: i) daily (next 72h) consumption and generation forecasts; ii) daily (next 24h) forecasted short-circuit information iii) weekly, monthly and annual maintenance plans; iv) flexibility service providers prequalification and v) daily flexibility needs forecasts (next 24h).

From the start of the project Watt-IS has thoroughly analyzed all available specification both at the DSO and TSO level, regarding the SUCs to be implemented and has proposed to project stakeholders several adjustments and improvements both at the frontend and backend layers that have been discussed and will be adopted in the development phase.

Adopting an agile approach Watt-IS is currently implementing the agreed upon SUCs and will seek to iteratively make them available to project stakeholders (E-REDES and REN/NESTER) as a way to gather fast and timely feedback so that they may be incorporated into the development phases as a way to guarantee a strong alignment in terms of functional and operational expectations.

With the successful implementation of all of the foreseen SUCs within the Portuguese demonstration, the DSO and TSO will be empowered to have more efficient and streamlined data exchange mechanisms focused on:

i) "operational planning" - being possible to exchange and update between them weekly, monthly and annual grid maintenance plans;

ii) "forecasts" – allowing for a more efficient exchange of daily 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 flexibility needs forecasts.

With these foreseen developments Watt-IS has the objective to contribute towards the achievement of a more efficient information exchange process and cooperation between Portuguese System Operators and to facilitate the creation and development of a new layer of flexibility services. Additionally, 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 Operators within the EU in the field.

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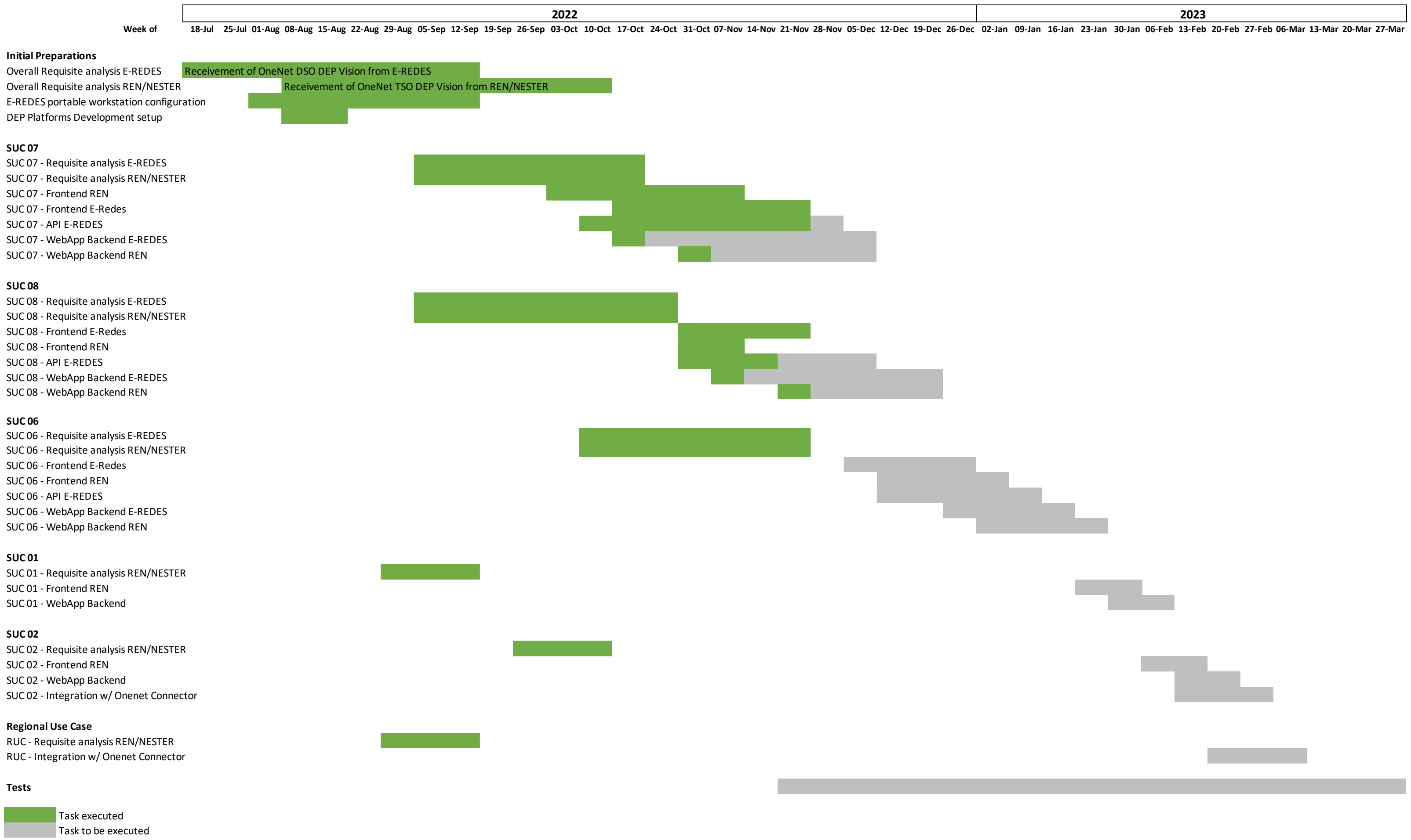
5 ANNEX A – Project Execution Timeplan



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