



POCITYF

D6.7
WP6, T6.4

Authors: Rui Amaral Lopes (UNINOVA) and João Martins (UNINOVA)



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 864400.

Technical references

Project Acronym
Project Title
Project Coordinator
Project Duration

POCITYF

A POsitive Energy CITY Transformation Framework

João Gonalo Maciel
EDPL
JoaoGoncalo.Maciel@edp.com

60 months (from October 2019 - to September 2024)

Deliverable No.
Dissemination level*
Work Package
Task
Lead beneficiary
Contributing beneficiary/ies
Due date of deliverable
Actual submission date

D6.7

PU

WP 6 - Évora Lighthouse City demonstration activities

T6.4 - Demonstrating ETT #2: P2P Energy Management and Storage Solutions for Grid Flexibility

03 (UNINOVA)

EDPL; CME; UEVORA; DECSIS; SONAE; Batteries; Kimatica

31 December 2022

9 November 2023

* PU = Public

PP = Restricted to other programme participants (including the Commission Services)

RE = Restricted to a group specified by the consortium (including the Commission Services)

CO = Confidential, only for members of the consortium (including the Commission Services)



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 864400.



v	Date	Beneficiary	Brief Description	Author
0.1	13/10/2022	UNINOVA	ToC	Rui Amaral Lopes
0.2	19/10/2022	UNINOVA	Deliverable drafting	Rui Amaral Lopes
0.3.1	18/11/2022	Betteries	Section 4.1.1	Joscha Winzer
0.3.2	18/11/2022	SONAE	Section 4.2.1	Amândio Ferreira
0.3.3	18/11/2022	UNINOVA	Section 4.1.3	Rui Amaral Lopes
0.3.4	23/11/2022	Kimatica	Section 2.1.4	Natasha Karatza
0.3.5	27/11/2022	EDPL	Sections 4.1.2 and 4.2.2	Júlia Pereira, João Cravinho, Claire Harvey
0.4	30/11/2022	UNINOVA	Integration of partners inputs	Rui Amaral Lopes
0.5	30/11/2022	UNINOVA	Deliverable sent for internal review	Rui Amaral Lopes and João Martins
0.6	07/12/2022	TNO and InVesta	Internal review	Alexandre Zandbergen (InVesta) and Ellen Hofbauer (TNO)
0.7	14/12/2022	UNINOVA	Revision and deliverable sent for project coordination.	Rui Amaral Lopes
0.8	26/12/2022	EDPL	Comprehensive review	Júlia Pereira
1.0	16/01/2023	UNINOVA	Deliverable ready for submission.	Rui Amaral Lopes and João Martins



Disclaimer

This document reflects only the author's view. Responsibility for the information and views expressed therein lies entirely with the authors. The Innovation and Networks Executive Agency (INEA) and the European Commission are not responsible for any use that may be made of the information it contains.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 864400.



Executive Summary

Under the scope of WP6 (Évora Lighthouse City demonstration activities), this deliverable represents the first main output of task T6.4 (Demonstrating ETT#2: P2P Energy Management and Storage Solutions for Grid Flexibility) considering the work carried out from M13 to M38. The document provides a detailed analysis of the status and next steps for the demonstration of each Innovative Element (IE) associated with Integrated Solutions 2.1 (Flexible and Sustainable Electricity Grid Networks with Innovative Storage Solutions) and 2.2 (Flexible and Sustainable District Heating/Cooling with Innovative Heat Storage Solutions), including information on additional related aspects, such as faced barriers and lessons learned.

The City Vision and Master Plan for ETT#2 Solutions reported in deliverable D1.8, which represents the main output of task T1.4, guided the development of ETT#2 related Innovative Elements to be demonstrated until M60. Additionally, the methodology put in place during the development of task T1.4 to ensure the required cooperation between POCITYF partners was used as a basis for the one developed for task T6.4, which considers interactions with other entities, such as external suppliers. This cooperation allows the improvement of POCITYF solutions, not only in terms of individual pilots, but also in terms of enhanced aggregated solutions using multiple Innovative Elements from different ETTs.

From the six Innovative Elements belonging to ETT#2, whose operation will be demonstrated in Évora LH, two are already in operation in some of the defined locations, namely IE 2.1.1 (2nd Life Batteries) and IE 2.1.3 (Flexibility Control Algorithms), and the remaining are expected to be delivered during 2023. The main barriers found during the development phase (from M13 to M36) refer to regulatory issues related to state-of-the-art concepts and COVID-19 restrictions. The second version of the deliverable (D6.8) will report the main findings and lessons learnt during demonstration activities, which will be conducted until M60, and detail all the Innovative Elements operations.



Table of contents

Executive Summary	5
Table of contents	6
Introduction	10
1.1 Scope, objectives and expected impact	10
1.2 Relation to other POCITYF activities	11
1.3 Structure of the deliverable	11
Methodological approach	12
ETT #2 Demonstration Activities in Évora	13
1.4 POCITYF Solution IS 2.1 in Évora	13
1.4.1 Demonstrating IE 2.1.1 (2 nd Life Batteries)	14
1.4.2 Demonstrating IE 2.1.2 (Renewable Energy Communities Management Platform)	20
1.4.3 Demonstrating IE 2.1.3 (Flexibility Control Algorithms).....	25
1.4.4 Demonstrating IE 2.1.4 (P2P energy trading platform)	36
1.5 POCITYF Solution IS 2.2 in Évora	42
1.5.1 Demonstrating IE 2.2.1 (Freezing storage in store)	43
1.5.2 Demonstrating IE 2.2.2 (Extended market-oriented building flexibility services)	45
Conclusions.....	49
Annex A: Template for data collection	50
References	51



List of Tables

Table 1 ETT#2 Integrated Solutions	10
Table 2 ETT#2: IS 2.1 Innovative Elements in Évora LH	13
Table 3 IE 2.1.1 (2 nd Life Batteries) at PEB 2.1	15
Table 4 IE 2.1.1 (2 nd Life Batteries) at PEB 2.2	17
Table 5 IE 2.1.2 (Renewable Energy Communities Management Platform)	20
Table 6 IE 2.1.3 (Flexibility Control Algorithms) at PEB 1.9 and PEB 2.2	25
Table 7 IE 2.1.3 (Flexibility Control Algorithms) at PED1 Municipal Buildings	29
Table 8 IE 2.1.3 (Flexibility Control Algorithms) at PEB 2.1	31
Table 9 IE 2.1.3 (Flexibility Control Algorithms) at PED3	33
Table 10 IE 2.1.4 (P2P Energy Trading Platform).....	36
Table 11 ETT#2: IS 2.2 Innovative Elements in Évora LH.....	42
Table 12 IE 2.2.1 (Freezing storage in store)	43
Table 13 IE 2.2.2 (Extended market-oriented building flexibility services)	45

List of Figures

Figure 1 Methodology loop followed by POCITYF partners under task T6.4	12
Figure 2 2 nd Life Batteries life cycle	14
Figure 3 Demonstration of 2 nd Life Batteries in an emergency scenario	15
Figure 4 Example of 2 nd Life Batteries to be installed during POCITYF	16
Figure 5 2 nd Life Batteries betterUI interface module	16
Figure 6 2 nd Life Batteries betterLink-EM DC Connectivity Module	16
Figure 7 “betterGen” with betterPacks	17
Figure 8 Demonstration of modular 2 nd Life Batteries system in real operation at a fair	18
Figure 9 Example of characterization results collected until M38 (inverter discharge efficiency as function of the tested power level)	18
Figure 10 Demonstration of modular 2 nd Life Batteries system in real operation to power portable tools .	19
Figure 11 Renewable Energy Communities Management Platform homepage mockup	21
Figure 12 EC management dashboard mockup 1	21
Figure 13 EC management dashboard mockup 2	22
Figure 14 Billing section mockup	22
Figure 15 Sharing coefficients.....	23
Figure 16 Parameters that will influence the sharing coefficients in the EC.....	23
Figure 17 PEB 1.9 Residential Building’s 6.5 kWh storage system	25
Figure 18 PEB 1.9 Residential Building’s 1.4 kWp PV installation.....	25



Figure 19 Results from PEB 1.9 Residential Building illustrating the operation of the Flexibility Control Algorithms (real data collected during November 2022)	26
Figure 20 Solutions involved in the demonstration of Flexibility Control Algorithms in PEB 1.9	27
Figure 21 Building Ário Lobo de Azevedo at PED2 University Campus	27
Figure 22 Different solutions involved in the demonstration of Flexibility Control Algorithms in PED1 Municipal Buildings	29
Figure 23 Different solutions involved in the demonstration of Flexibility Control Algorithms in PEB 2.1 ..	31
Figure 24 Different solutions in the demonstration of Flexibility Control Algorithms in PED3 SONAE	33
Figure 25 PEB 3.2 space whose temperature will be controlled by Flexibility Control Algorithms	34
Figure 26 Become an ambassador	36
Figure 27 Smart giving	36
Figure 28 Smart energy for free	37
Figure 29 Examples of energy donation campaigns	37
Figure 30 Landing page	38
Figure 31 Energy Wallet page, where users have access to data of their Consumed Energy, Produced Energy, Smart Savings, Balance, and Tokens.....	39
Figure 32 Transactions, where users have access to the history of the transactions performed so far	39
Figure 33 Marketplace page, where users can trade energy with the other users of the community	39
Figure 34 Tokens page, where users have access to coupon/token history and are able to generate and redeem coupons	40
Figure 35 Settings, where users can edit their profiles (i.e., username, password, name, surname, smart meter, solar panel, PayPal information) as well as find the feature Invite a friend	40
Figure 36 Building Oriented Market Flexibility Services homepage mockup.....	46
Figure 37 MOBFS dashboard mockup number 2	46
Figure 38 MOBFS dashboard mockup number 3	47
Figure 39 MOBFS dashboard mockup number 4	47



Abbreviations and acronyms

Abbreviation	Definition
BEMS/HEMS/CEMS	Building/Home/City Energy Management System
BMS	Building Management System
DSO	Distribution System Operator
ETT	Energy Transition Track
EV	Electric Vehicle
IE	Innovative Element
IS	Integrated Solution
KPI	Key Performance Indicator
LH	LightHouse
P2P	Peer-to-Peer
PEB	Positive Energy Building
PED	Positive Energy District
PRC	Portuguese Red Cross
PV	PhotoVoltaic
RES	Renewable Energy Source
V2G	Vehicle to Grid
VPP	Virtual Power Plant
WP	Work Package



Introduction

1.1 Scope, objectives and expected impact

POCITYF follows a strategy built around four multidisciplinary and complementary Energy Transition Tracks (ETTs) to achieve its objectives by demonstrating ten Integrated Solutions and dozens of Innovative Elements. The present deliverable focuses on the demonstration of ETT#2 (P2P Energy Management and Storage Solutions for Grid Flexibility) related solutions in Évora LH city, whose Integrated Solutions and Innovative Elements aim to i) maximise self-consumption of renewable energy sources; ii) reduce grid stress, avoiding load and generation curtailment; and iii) increase the financial value of existing resources through flexibility services to the grid. The referred Integrated Solutions are presented in Table 1.

ETT#2 is also important to support both ETT#1 (Innovative Solutions for Positive Energy (CH) Buildings and Districts) and ETT#3 (e-Mobility Integration into the Smart Grid & City Planning) in achieving their objectives while maximising the benefits introduced to consumers and other stakeholders, including grid operators. This is accomplished by exploring the energy flexibility provided by several Innovative Elements to modify energy consumption and generation profiles according to the existing needs while respecting users' comfort preferences. Examples of such needs refer to the reduction of electricity costs through the improvement of matching between buildings' demand and on-site generation (increasing the benefits of ETT#1 related solutions) or the reduction of electric vehicles' charging peak loads (mitigating impacts associated with the electrification of energy demand under ETT#3).

Taking this into consideration, deliverable D6.7 represents the first main output of task T6.4 (Demonstrating ETT #2: P2P Energy Management and Storage Solutions for Grid Flexibility) and aims to describe ETT#2 implementation activities conducted from M13 to M38, detailing the status and next steps for the demonstration of each Innovative Element in Évora LH city, as well as faced barriers and lessons learned during this period. The methodology followed during the development of the reported work is addressed in Chapter 2, while Chapter 3 describes the demonstration activities to be carried out in Évora LH city. Conclusions and remarks on future work are presented in Chapter 4.

Table 1 ETT#2 Integrated Solutions

 ETT#2: P2P Energy Management and Storage Solutions for Grid Flexibility		
Integrated Solutions	 IS 2.1	Flexible and Sustainable Electricity Grid Networks with Innovative Storage Solutions
	 IS 2.2	Flexible and Sustainable District Heating/Cooling with Innovative Heat Storage Solutions



1.2 Relation to other POCITYF activities

The implementation and demonstration activities reported in this deliverable received important inputs from task T1.4 (City Vision and Master Plan for ETT#2: P2P Energy Management and Storage Solutions for Grid Flexibility) and task T6.1 (Updating Evora's Vision and Master Planning) and were conducted in close collaboration with other WP6 partners under the scope of task T6.2 (Coordination of Evora integration and demonstration activities). WP6 task T6.4, whose present deliverable belongs to, will provide inputs to all WPs reporting on the findings and assessment of the POCITYF project, including WP2 (Setting Up, Planning and Execution of Performance Monitoring Activities) and WP3 (Evaluation Activities, Socio-economic Impact Assessment and Recommendation), in addition to contributions for replication activities to be conducted under WP8 (Replication strategy, activities planning and roadmap creation) and for the development of business models under the scope of WP5 (Business Models across Circular & Sharing Economy Pathways).

1.3 Structure of the deliverable

Chapter 1 - Introduction

The present chapter describes the scope, objectives and expected impacts of deliverable D6.7, as well as the relation to other POCITYF activities.

Chapter 2 - Methodological Approach

This chapter describes the methodology followed during the development of the work reported in this deliverable.

Chapter 3 - ETT #2 Demonstration Activities in Évora

This chapter describes ETT#2 demonstration activities that are already being carried out in Évora or that will be conducted in the following months.

Chapter 4 - Conclusions

This chapter concludes deliverable D6.7 referring the main results achieved so far and the future works to be conducted until M60.



Methodological approach

The methodology followed by UNINOVA to achieve the goals of task T6.4 (Demonstrating ETT #2: P2P Energy Management and Storage Solutions for Grid Flexibility in Évora LH city) ensures that the cooperation structure designed under task T1.4 (City Vision and Master Plan for ETT#2: P2P Energy Management and Storage Solutions for Grid Flexibility) continued to be used from M13 to M38 (with the required adaptations), under the scope of task T6.2 (Coordination of Evora integration and demonstration activities). This approach allowed to achieve a smooth transition from the preparatory phase developed from M03 to M12, and from M28 to M30, under task T1.4, to the implementation phase from M13 to M38 under task T6.4. Please refer to deliverable D1.8 (City Vision and Master Plan for ETT#2 Solutions - Version 2), which represents the main output of task T1.4, for more details about task T1.4 methodology.

Taking this into consideration, under the supervision of WP6 and T6.2 leaders (CMÉ and EDPL), task T6.4 leader (UNINOVA) interacts with POCITYF IE providers (Betteries, EDPL, UNINOVA, Kimatica and SONAE), often together with EDPL, to i) follow the current development status of each Innovative Element; and ii) ensure that the agreed city vision and master plan for ETT#2 in Évora LH, developed under task T1.4, is respected. POCITYF IE providers interact with the respective suppliers, which ensure the required equipment and other hardware/software components, while updating on the status of supply. This includes interactions inside the same organisation, as in the case of SONAE, where the group's company responsible for cyber-security must be involved during the demonstration of IE 2.2.1 (Freezing storage in store). The developed Innovative Elements are then installed at buildings belonging to three Positive Energy Districts (see Chapter 3), whose users are engaged in POCITYF project demonstration activities by the WP6 and T6.2 leaders, supported by POCITYF IE providers. Figure 1 presents the described methodology loop.

The results of the referred interactions between POCITYF partners, suppliers and users are shared among all involved entities using the main WP6 communication channel, which refers to the weekly 1.5-2.0 hours meetings. When more specific topics/problems should be addressed, dedicated meetings and/or working sessions are put in place to ensure coordinated efforts and alignment between involved POCITYF partners. This is the case, for instance, of efforts carried out between UNINOVA and Betteries to ensure the required remote control of 2nd Life Batteries in preparation for the Innovative Element 2.1.1 demonstration (see Chapter 4). Additionally, technical visits are carried out to speed up the process when needed in terms of technology development and installation and user engagement.

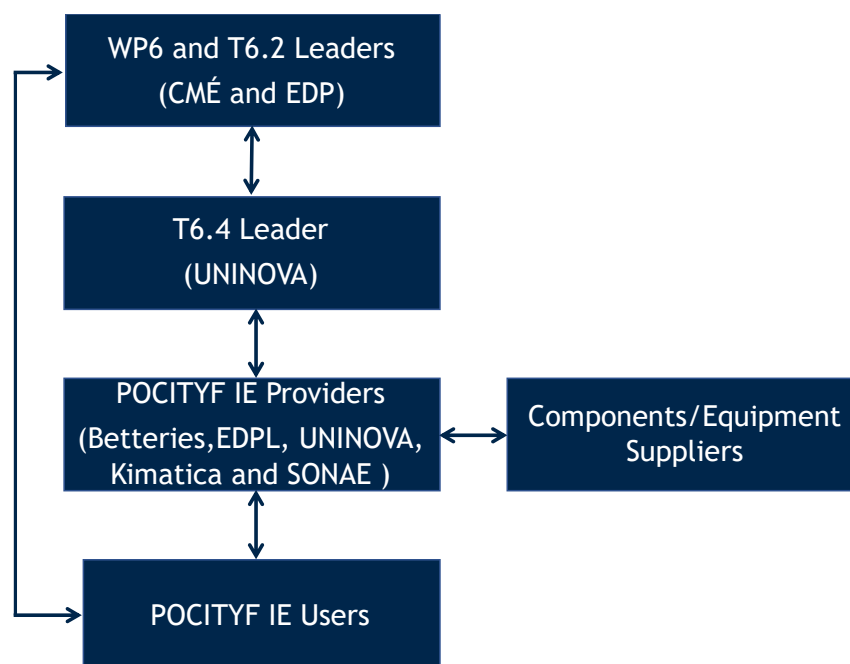


Figure 1 Methodology loop followed by POCITYF partners under task T6.4



ETT #2 Demonstration Activities in Évora

This chapter describes ETT#2 related solutions to be demonstrated during POCITYF in Évora, clustering the provided information by i) goal and description of each Innovative Element at a specific PED/PEB; ii) role of the POCITYF partners involved; iii) progress achieved until M38; iv) faced barriers and lessons learned; v) next steps; vi) and connection to other Innovative Elements. Innovative Elements from IS2.1 are addressed in Section 3.1, while Innovative Elements from IS2.2 are considered under Section 3.2.

1.4 POCITYF Solution IS 2.1 in Évora

Innovative Elements belonging to Integrated Solution 2.1 (Flexible and Sustainable Electricity Grid Networks with Innovative Storage Solutions) will be demonstrated in all Évora Positive Energy Districts (PEDs) using resources available at, both, building and community levels, as described in Table 2. Detailed information about these demonstration areas has been provided in deliverable D1.6, which represents one of the outputs of the preparatory work developed under WP1 from M03 to M12 and from M28 to M30.

Table 2 ETT#2: IS 2.1 Innovative Elements in Évora LH



Innovative Element	Responsible Partner	Évora Demonstration Area
IE 2.1.1 (2 nd Life Batteries)	Betteries	<u>PED2 - Valverde</u> PEB2.1 - Residential and commercial clients PEB2.2 - Polo da Mitra
IE 2.1.2 (Renewable Energy Communities Management Platform)	EDPL	All PEDs
IE 2.1.3 (Flexibility Control Algorithms)	UNINOVA	<u>PED1 - Évora city centre</u> PEB1.1 - May 1 st Municipal Market PEB1.4 - EB1 S. Mamede school PEB1.5 - Town hall PEB1.7 - Rossio School PEB1.8 - Interpretative Centre (LVpDE) PEB1.9 - Residential and commercial clients <u>PED2 - Valverde</u> PEB2.1 - Residential and commercial clients PEB2.2 - Polo da Mitra <u>PED3 - Industrial and Science Park</u> PEB3.1 - SONAE commercial building PEB3.2 - PACT building PEB3.3 - DECSIS Campus
IE 2.1.4 (P2P energy trading platform)	Kimatica	All PEDs



The information presented in this section was provided by the partners responsible for the respective Innovative Elements through the fulfilment of the form that can be found in Annex A.

1.4.1 Demonstrating IE 2.1.1 (2nd Life Batteries)

POCITYF partner betteries has optimized each upcycling step to maximize productive battery life and close the material cycle, as illustrated in Figure 2.

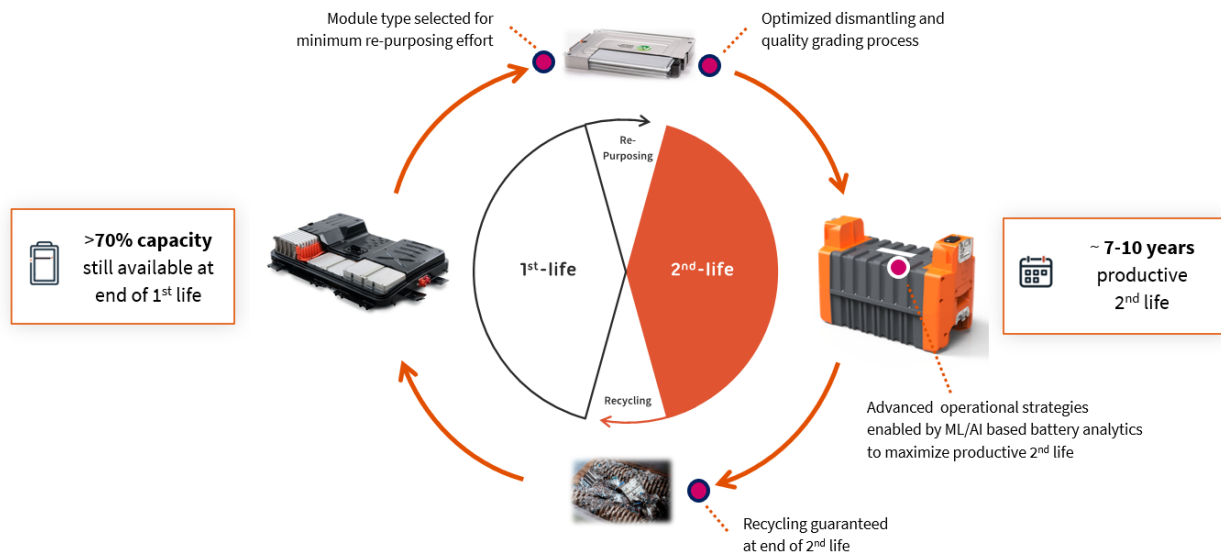


Figure 2 2nd Life Batteries life cycle

Betteries' system is a true system solution, with the following characteristics:

- Mobile ("click and go" solution with no cabling);
- Modular (stacking of up to 3 battery modules for 7 kWh energy);
- Multi-purpose (standardized battery pack combined with customized application module);
- Optimized Battery life (innovative BMS optimized for 2nd life cells);
- Robust & Waterproof (marinized (IP65) casing);
- Connected to the cloud (GSM plus WiFi to the betteries proprietary cloud).

The demonstration of 2nd Life Batteries during POCITYF considers two scenarios. In the first one, 2nd Life Batteries are used in residential buildings located in PEB 2.1 to increase PV self-consumption and reduce electricity costs, being remotely controlled by IE 2.1.3 (Flexibility Control Algorithms), as described in Table 3. In the second scenario, 2nd Life Batteries are used to supply mobile and/or off-grid consumers in replacement of carbon intensive energy conversion systems, such as diesel/gasoline generators, in PEB 2.2 and other locations. For instance, the University of Évora, the Portuguese Red Cross (PRC) and Betteries successfully demonstrated on 27 October 2022 the operation of 2nd Life Batteries in an emergency scenario, at the Foz do Tejo Delegation (PRC), to promote the energy transition and increased resilience of the equipment used at disaster scenarios¹ (see Figure 3). Additionally, in an activity related to this second scenario, POCITYF partners Betteries and the University of Évora have been developing models and experiments to characterise 2nd Life Batteries in different operation ranges.

¹ <https://betteries.com/2nd-life-batteries-for-disaster-relief/>



Figure 3 Demonstration of 2nd Life Batteries in an emergency scenarioTable 3 IE 2.1.1 (2nd Life Batteries) at PEB 2.1

IE 2.1.1 - 2 nd Life Batteries (PEB2.1 Valverde)
Goal and description of the IE at the PEB
2nd Life Batteries (see Figure 4 - Figure 6) refer to a modular and mobile battery system that re-uses Li-Ion battery modules coming from electric vehicles (EVs), extending the productive life of EV battery modules through the residential application by another 5-7 years. The battery system is made up of two core elements, namely: i) standardized “betterPack”, a 2nd Life battery pack and “betterUI”, a monitoring device, user-interface, and battery management unit; and ii) “Victron Multiplus 2” bidirectional inverter. Product specifications include: - 14pcs, BetterPack, batteries AMPS GmbH, Nom. Energy: 2346 Wh, Dimensions: 365 x 546 x 277mm, 38.8 kg; - 10pcs, Multiplus 2, Victron inverter, 3kVA-230VAC-48V; - 3pcs, battery home storage prototypes, batteries AMPS GmbH, Nom. Energy: 4692Wh, with 3 different cooling concepts; - 7pcs, betterUI, batteries AMPS GmbH, Dimensions: 42 x 89 x 99 mm; During POCITYF, ten consumers/clients of PEB2.1 (Valverde), all of them with a 1.5 kWp PV system, will receive a 2nd life-based battery, with 5.0/4.6 kW/kWh, and, also, an inverter of 3 kVA nominal power, aiming to reach average savings of 788.4 kWh/year, 29% increase in self-consumption rate, and 23% energy savings share on annual consumption per dwelling.





Figure 4 Example of 2nd Life Batteries to be installed during POCITYF



Figure 5 2nd Life Batteries betterUI interface module



Figure 6 2nd Life Batteries betterLink-EM DC Connectivity Module

Role of POCITYF partners involved

- EDPL: finding, engaging, and selecting the test customers/clients, perform technical visits, pre-system laboratory tests, support the installations, and pre-monitoring data;
- Municipality of Évora: support in finding test customers and facilitating the clients/customers engagement;
- University of Évora: local contact point, support in logistics, technical visits and customers/clients engagement;
- UNINOVA: development of Flexibility Control Algorithms (IE 2.1.3).

Progress achieved to M38 (provide progress and timeline on preparation, delivery, installation, operationalization, and monitoring)

The systems are ready for shipment. Pre-tests at EDPL have been executed. Batteries AMPS GmbH are only waiting for the confirmation, by EDPL, that all test customers can receive the systems, to start shipment and installations.

The following phases are considered under the scope of POCITYF:

- Preparation phase (research, design);
- System requirement and architecture definition: 02/2020 to 03/2021;
- System design phase: 01/2021 to 07/2021;
- System manufacturing first iteration: 07/2021 to 11/2021;
- New system production (to be able to test the latest product): 08/2022 to 10/2022;
- System tests at EDPL in Portugal: 06/2022 - 10/2022;
- Installation site investigation: from 02/2020 to 06/2021;
- Delivery of the materials, equipment, and technology: see next steps;



- Installation/implementation of the innovative element: see next steps; - Operationalization phase: see next steps; - Monitoring phase: EDPL is working on monitoring by using existing data points of the project.
Faced barriers and lessons learned
- Partners test capabilities have been reduced/slowed down due to their moving of location. - The acquisition of test customers by our partners took much longer than expected.
Next steps
- Finalizing the definition of test users, installing the innovative element, getting the innovative element operational until July 2023 (first installation already in Q1 2023), and monitoring the performance until the end of the project.
Connection to other IEs within ETTs
- The Flexibility Control Algorithms (IE 2.1.3) developed by UNINOVA will optimize the energy consumption and production by the test households.

Table 4 IE 2.1.1 (2nd Life Batteries) at PEB 2.2

IE 2.1.1 - 2nd Life Batteries (PEB 2.2 Polo da Mitra)
Goal and description of the IE at the PEB
POCITYF aims to demonstrate and replicate success stories for waste stream (material) utilization, originating from different sources, as an alternative highly efficient pathway for satisfying energy needs and reducing waste, in line with EU policies regarding the promotion of industrial symbiosis and circular economy. This solution acts supportively to the ones presented in IS-1.1 and IS-1.2 strengthening the potential success of PEDs deployment. In PEB 2.2 (Polo da Mitra), the battery system is made up of two core elements - the standardized “betterPack”, a 2nd Life battery pack, and “betterGen”, a mobile green generator for up to 3 stacked betterPacks (see Figure 7). The development of technical documentation characterizing the 2nd Life batteries operation is also an objective for the demonstration of this IE at PEB 2.2 (Polo da Mitra). The standardized “betterPacks” are of the same type as in PEB 2.1. However, the power interface unit (“betterGen” and “betterLink”) differ. In PEB 2.2 the mobile feature of the batteries’ system is being utilized as well. This shows the modular approach of the batteries system which makes it possible to use the 2nd Life Batteries in many different applications to ensure reliable power supply.

Figure 7 “betterGen” with betterPacks
Role of POCITYF partners involved
- University of Evora (planning, organizing, executing, analysis of technical tests, documentation, and publications).



Progress achieved to M38 (provide progress and timeline on preparation, delivery, installation, operationalization, and monitoring)

- Classification characterization tests have been run and reports have been written. The first report included the prototypes (05/05/2021). The second batch of tests with the most recent (but not yet certified product) were treated, and a report was written in July 2022. Results collected during these activities have been reported in (Foles, 2022).
- Presentations on fairs have been conducted. The first presentation was done on 23/11/2021 at a fair called "Open Day of PACT - Parque do Alentejo de Ciência e Tecnologia" in Évora. The second presentation at a fair was given on 20/09/2022 at an event called "Tech@Weeks: Dia aberto to UÉvora" at the University of Évora. On 27 October 2022, the operation of 2nd Life Batteries in an emergency scenario to supply off-grid loads was successfully demonstrated in cooperation with the PRC (see Figure 3). This activity took place at the Delegation of Foz do Tejo, Seixal (Portugal), and included a Triage Post, Mobile Clinic, two Ambulances, Campaign Canteen and Command and Communication Post. In this scenario, a 2nd life battery system was tested, supplying the entire installed infrastructure with electricity. During the tests, it was possible to rehearse all aspects from inflating field tents to the usage of emergency medical equipment by the PRC team, replacing the usual use of gasoline generators with 2nd life batteries. This new equipment allows the use of electricity from a renewable source, e.g., solar energy, and eliminates logistical difficulties associated with supplying fuel to generators in emergency or catastrophe scenarios.



Figure 8 Demonstration of modular 2nd Life Batteries system in real operation at a fair

- A research paper is under review. An oral presentation was given at WCPEC-8 Conference in September 2022 in Milan, Italy, and a proceedings conference paper is in review to be published.

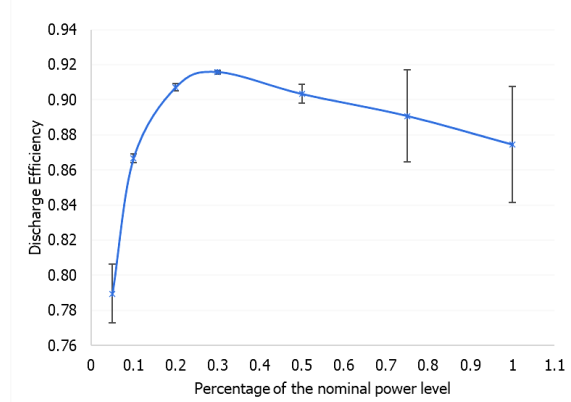


Figure 9 Example of characterization results collected until M38 (inverter discharge efficiency as function of the tested power level)



- Dedicated use-case tests have been conducted with the prototypes to portable power tools in PEB 2.2 (see Figure 10).



Figure 10 Demonstration of modular 2nd Life Batteries system in real operation to power portable tools

The following phases are also considered under the scope of POCITYF:

- Preparation phase (research, design)
 - o 10/2019 - 05/2020: site visit, requirements and prototyping design have been done
- Delivery of the materials, equipment, and technology
 - o 07-09/2020: delivery of first equipment
 - o 01/2021: delivery of the second set of systems
 - o 10/2022: delivery of the third set of systems
- Installation/implementation of the innovative element
 - o 07-09/2020: installation of the first equipment
 - o 02-06/2021: remote installation of 2nd set of equipments
 - o 10/2022: installation of 3rd set of systems
- Operationalization and monitoring phase
 - o 10/2020 - today: several laboratory and real-life use-case tests run, monitored and documented by the University of Evora.

Faced barriers and lessons learned

Transportation of batteries during the COVID-19 period had long lead times and equipment was partially destroyed on the way (and needed to be recycled). In the future, packaging and logistics planning needs to be done carefully and in detail.

Next steps

- Characterization tests with the CE product from December 2023;
- Further test scenarios and monitoring 03-12/2023;
- Evaluation while and after these periods.

Connection to other IEs within ETs

- N/A



1.4.2 Demonstrating IE 2.1.2 (Renewable Energy Communities Management Platform)

The Renewable Energy Communities Management Platform aims to facilitate the interaction between all parties involved in energy communities, understanding the members' needs and local regulation, paving the way to easier implementation of energy communities throughout Europe. The platform is currently being coded after an ideation process involving the description of scenarios and use cases. The platform models were based on prototypes prepared before the start of the coding development. The platform will be tested in Évora lighthouse city, linked to the IE 1.2.5 Community Solar Farm. It will use energy sharing coefficients of the Community Solar Farm and maximise the benefit to all its members, keeping track of energy consumption and production of each member for the billing process, and displaying all data in a user interface. Table 5 describes these demonstration activities in detail.

Table 5 IE 2.1.2 (Renewable Energy Communities Management Platform)

IE 2.1.2 - Renewable Energy Communities Management Platform	
Goal and description of the IE at the PEB	
EDPL is developing a Renewable Energy Communities Management Platform to enhance the communication and interaction between any Energy Communities' management entity (EDPL in POCITYF) and its members. The platform will communicate with other project solutions (e.g., P2P market platform, City Information Platform, and building-level energy management systems) to receive inputs regarding the energy transactions between POCITYF participants and their energy consumption and production. The platform will provide two main functionalities from the perspective of a member: ○ Visualization - dashboards are showing the energy and financial flows of the Energy Community (EC) and its members. - Reward mechanisms and social space - rewarding mechanisms to incentivize community members to apply certain behaviors that will benefit the community. The social space is meant for users to interact between themselves, with the community manager, and with other energy communities. Two additional functionalities will be provided from the perspective of a community manager: ○ Energy sharing coefficient customization - definition of the distribution of energy generated by the community according to customizable parameters. ○ Automatic billing - considering the sharing coefficients defined, the system will automatically calculate the bill for each member. ○ The current strategy being considered for the PEBs, where the innovative solution is to be operational (i.e., PED1 and PED2 demo-sites in the Lighthouse city of Évora), is to consider each PED as one Energy Community. According to the Portuguese national legislation, this strategy will facilitate the IE implementation due to the (legal) geographical limitation of an Energy Community.	
Role of POCITYF partners involved	
- EDPL: responsible for the development of the Renewable Energy Communities Management Platform; - CMÉ: pilot site (PEBs) owner and responsible POCITYF partner.	
Progress achieved to M38 (provide a progress and timeline on preparation, delivery, installation, operationalization, and monitoring)	
The Energy Community Management platform's vision and definition were followed by the definition of the platform's requirements and functionalities via a specification-by-example approach where the functionality requirements for the platform were illustrated with the development of functional prototypes. The prototypes, illustrated below, served as a basis to further develop the platform's requirements and functionalities iteratively alongside relevant stakeholders (EDP group commercial business units and POCITYF partners). Mockups are used to illustrate the functionalities of the platform (see Figure 11). The homepage will display comprehensive information regarding the selected Energy Community.	



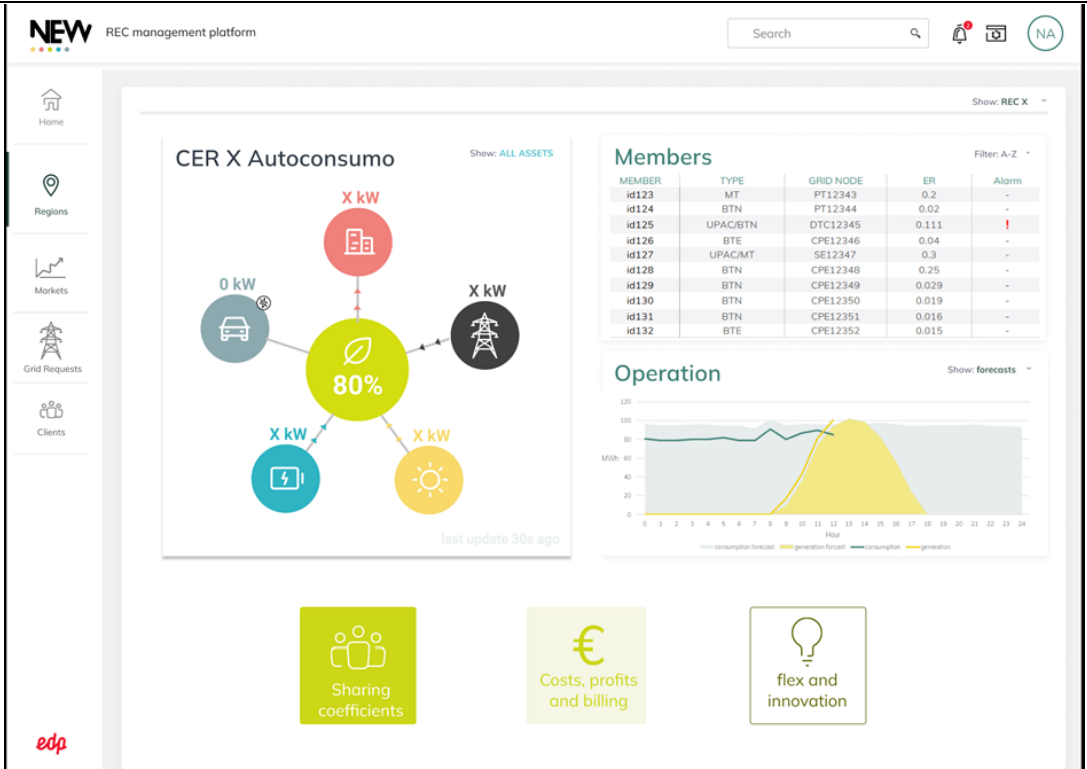


Figure 11 Renewable Energy Communities Management Platform homepage mockup

The EC management entity (EDPL in POCITYF) will be able to visualize the main energy and financial flows of the EC and its members, including a tree-type graph and overall consumption and production that allows overseeing all operations of the EC in a glimpse and in detail (see Figure 12 and Figure 13). Also, a detailed table is shown as a method of seeing individual value for EC members and as a method for quick troubleshooting with individual alerts.

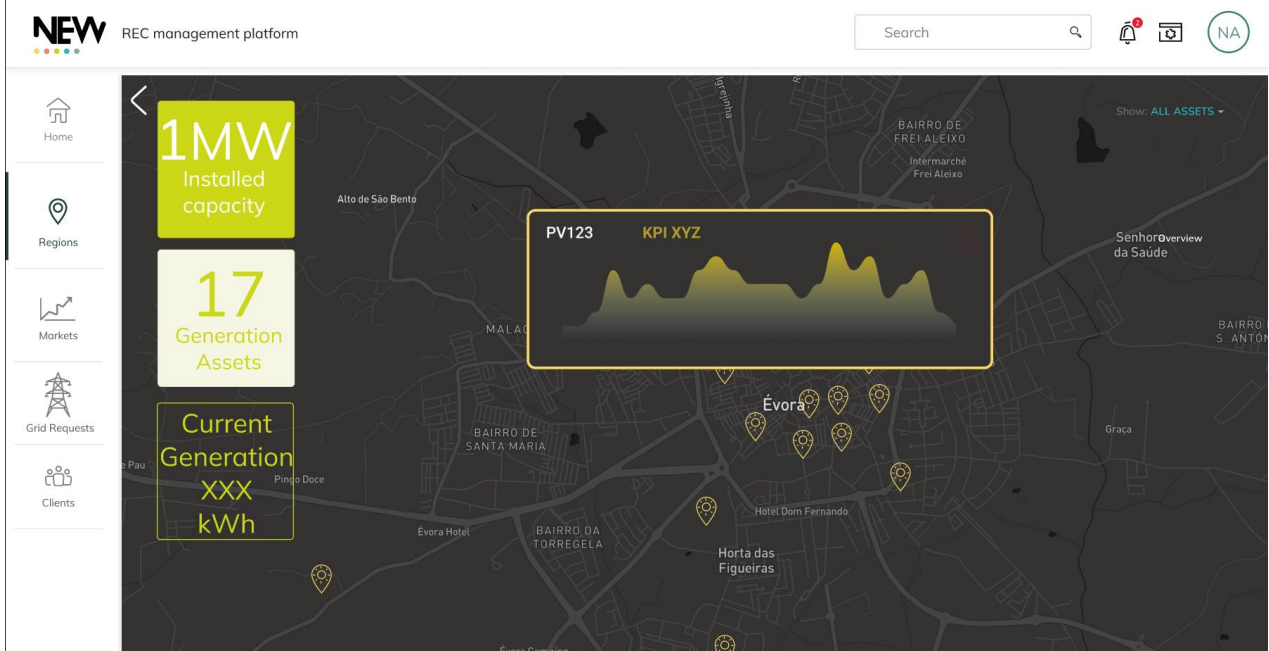


Figure 12 EC management dashboard mockup 1



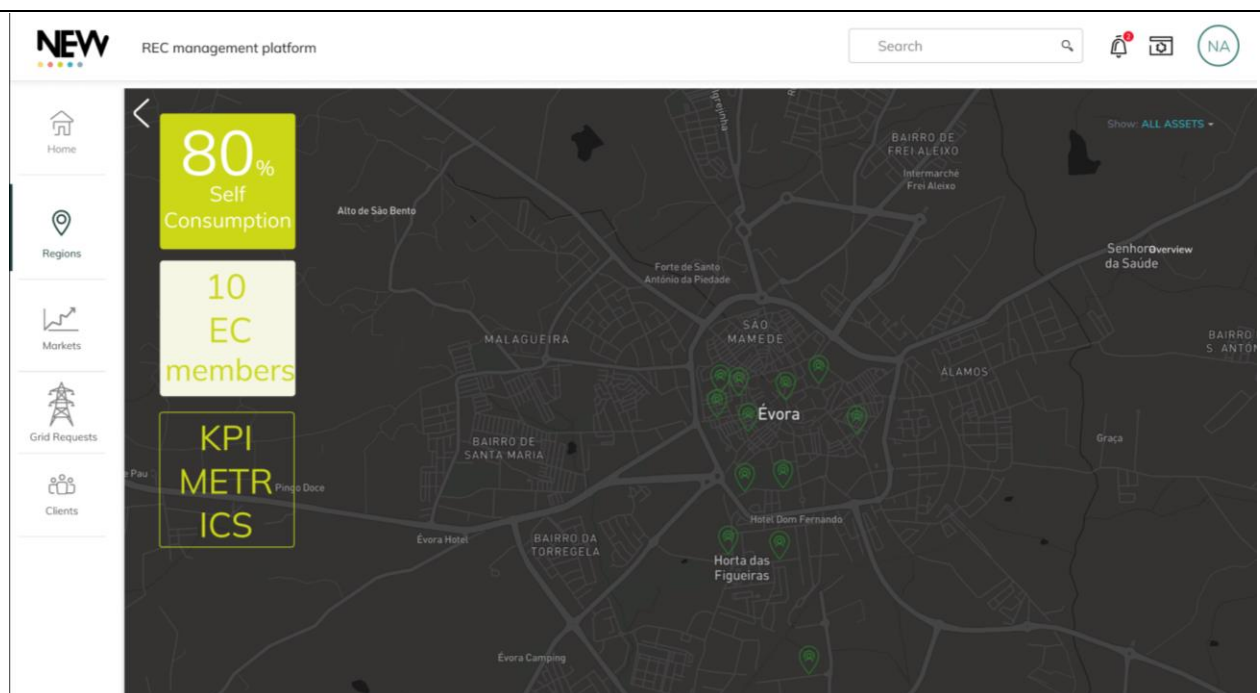


Figure 13 EC management dashboard mockup 2

The mapping of assets is essential for the EC manager to manage the community and find details beyond what is shown on the homepage. The map display enables to evaluate each asset based on its physical location, in a comprehensive approach. The EC manager and the EC members will also be able to access the billing section, as exemplified in Figure 14.

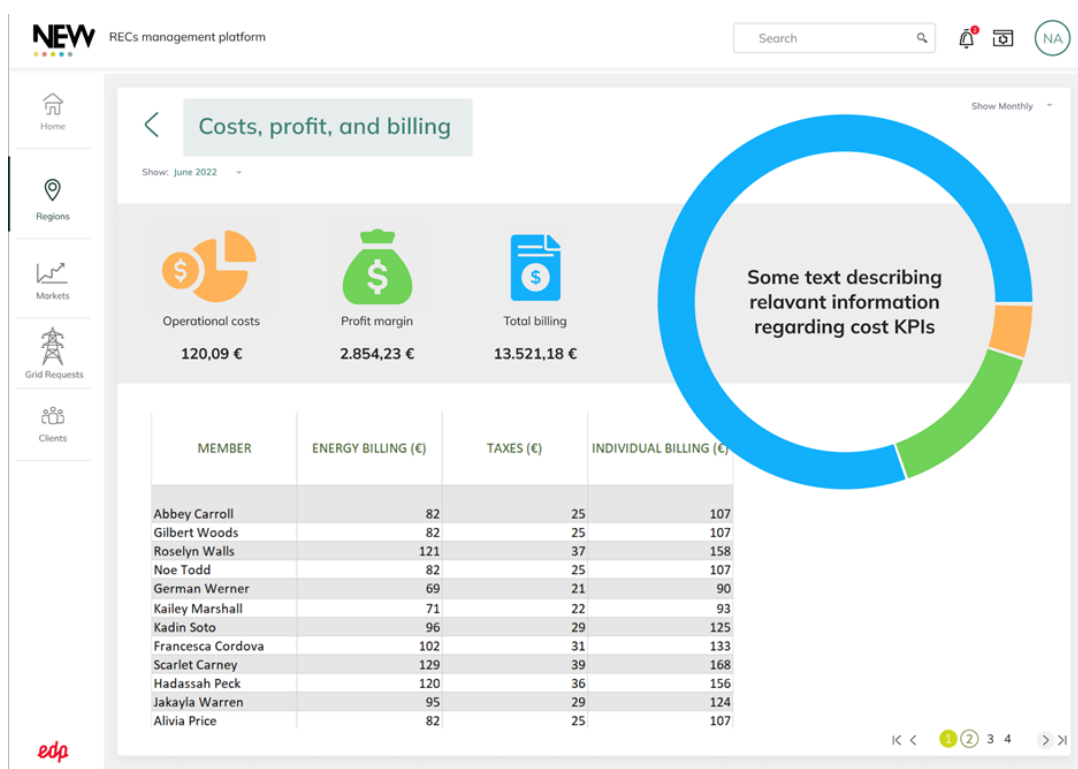


Figure 14 Billing section mockup

The billing component intends to display the updated billing to reflect the sharing coefficients applied for every EC member. The sharing coefficients section, illustrated in Figure 15, will offer the possibility to



adapt and change the sharing coefficients of the EC according to different parameters (e.g., the share of ownership). The table shows the parameters that can influence the sharing coefficients and the updated sharing coefficients. A window can be opened to change the parameterization of the sharing coefficients, enabling to change the calculation formula and the parameters in use.

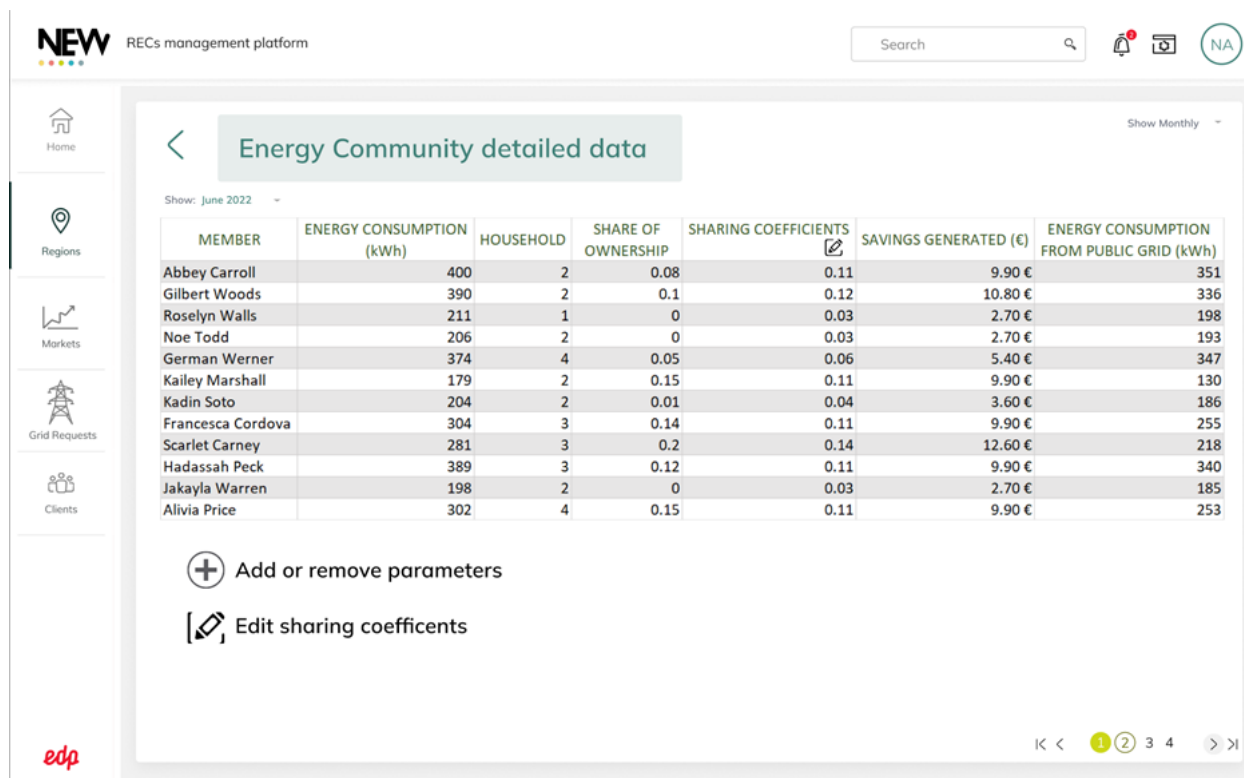


Figure 15 Sharing coefficients

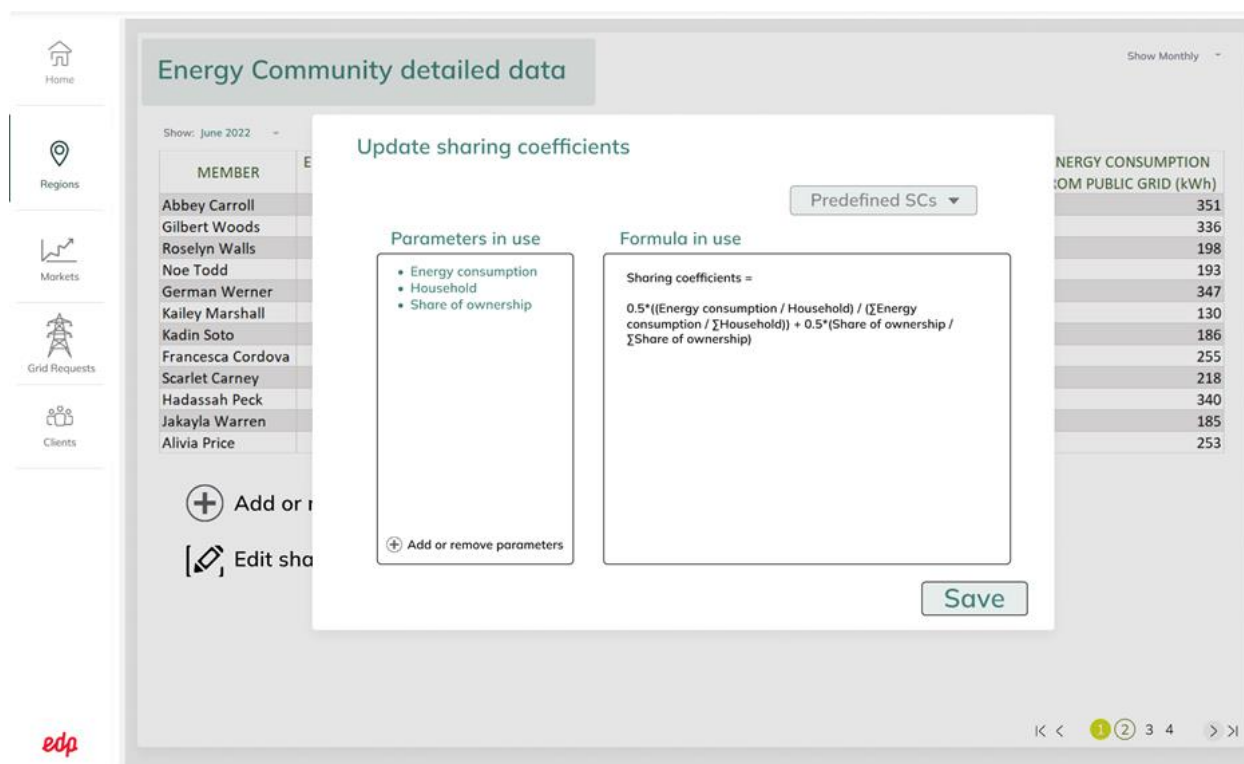


Figure 16 Parameters that will influence the sharing coefficients in the EC



The platform is currently under development and is expected to be finalized and delivered by July 2023. Following its implementation stage (August 2023), the innovative solution is operationalized in the Lighthouse city of Évora. From the implementation, and until the end of POCITYF demonstration activities, the EC management platform's operation will be monitored.

Faced barriers and lessons learned

The main barriers that EDPL faces when it comes to IE 2.1.2 are related to regulatory uncertainties within the EC topic/space.

Since January 2022, it has been possible to adopt dynamic sharing coefficients, adapted for every 15 minutes (decree law n.º 15/2022 of January 2022), allowing for a better optimization of energy sharing between REC members. Previously to this very recent decree law, the sharing coefficients had to be provided 12 months in advance, meaning forecasting needed to cover more extended periods (which, in turn, come with forecasting uncertainties). Alongside the regulatory changes, potential solutions concept changes were identified to accommodate the new regulatory contexts possible for energy sharing within the EC (sharing coefficients). A possibility for submitting sharing coefficients up to a month after the consumption of the grid and self-generated energy is also under evaluation; this could maximize the benefits for the EC members and, at the same time, simplify management processes by eliminating the need for consumption and generation forecasts.

Lessons learned:

- EDP group has been developing its business model to push energy communities for its customers. The concept is called Solar Neighbours and has provided some insights into the needs of EC managers and opportunities for citizens engaging in ECs. It has been clear that typical utilities need more time to be ready to incorporate models of distributed self-consumption into their billing process, which has been a barrier to the implementation and has been a hot topic with the national legislators and DSOs. The RECs Management platform already tries to facilitate the resolution of this issue by providing an automated calculation for billing that could be shared with the DSO to validate grid usage. Additionally, from the citizens' side, it has been evident that the lack of knowledge on the topic has been an implementation barrier.
- With the visualization and social spaces of the RECs Management platform, EDPL aims to increase awareness of the potential of these solutions to reduce grid energy consumption and generate a sense of community locally.

Next steps

The most pressing next steps concern the platform development. The platform front-end, and its visualizations, are to be adapted to the mockups while the back-end connection and link to other IEs, within the ETTs (e.g., IE 4.3.3, Data Lake intelligence for positive communities) is under development. After its preparation, the IE deployment is expected to be concluded in July 2023. During the project's demonstration activities in the Lighthouse city of Évora, the monitoring phase of the innovative element will take place, where its operation will be assessed and monitored. From August 2023 forward, the monitoring stage of the innovative solution will undergo the remaining demonstration activities.

After an initial implementation in Évora, the replication of the solution to other environments is already idealized for an energy community pilot in Spain, managed by EDP's group.

Connection to other IEs within ETTs

The platform, managed by the Energy Community manager (EDPL, in POCITYF), will communicate directly with other project solutions (e.g., IE 1.2.4, P2P market platform; IE 4.3.5, City Information Platform and building-level energy management systems) to receive inputs regarding the energy transactions between POCITYF participants and the energy consumption (e.g., IE 4.3.3, Data Lake intelligence for positive energy communities) and generation (IE 1.2.5, Community Solar Farm) of the EC members. The Community Solar Farm must be in place to demonstrate the Renewable Energy Community Management Platform in Évora's PEBs. Additionally, the IE 4.2.2, Market-Oriented Building Flexibility Services, is directly connected to the EC management platform as they share the same platform interface.



1.4.3 Demonstrating IE 2.1.3 (Flexibility Control Algorithms)

Flexibility Control Algorithms use the energy flexibility provided by new or existing controllable devices through APIs (or other interface means) made available by the devices operators or other entities which enable the required monitoring and control activities. Flexibility Control Algorithms allow the characterisation and use of the available energy flexibility to achieve different objectives defined by a specific Demand Response measure. This is achieved by modifying the controllable devices' energy consumption profiles while respecting the comfort needs and preferences of the involved consumers. During POCITYF, Flexibility Control Algorithms will be used in all PEDs to explore the available energy flexibility. The following tables describe these demonstration activities, clustering the information by the type of controllable device.

Table 6 IE 2.1.3 (Flexibility Control Algorithms) at PEB 1.9 and PEB 2.2

IE 2.1.3 - Flexibility Control Algorithms at PEB 1.9 and PEB 2.2	
Goal and description of the IE at the PEB 1.9 and PEB 2.2	
In PEB 1.9, Flexibility Control Algorithms were deployed in July 2022 (M34) to control the Energy Flexibility provided by a battery storage system composed of a LG Chem RESU 6.5 kWh 48V battery and a Victron MultiPlus-II 48/3000/35-32 inverter, which is installed in a residential building that also comprises a 1.4 kWp PV installation, which uses a GW1000-XS Goodwe inverter. Figures below present both the battery storage system (Figure 17) and PV installation (Figure 18) that can be found in the referred residential building.	
	

Figure 17 PEB 1.9 Residential Building's 6.5 kWh storage system

Figure 18 PEB 1.9 Residential Building's 1.4 kWp PV installation

Flexibility Control Algorithms are deployed at UNINOVA's servers and defined, at each 1-min. resolution time-step, the power available at the inverter's AC side to i) improve PV self-consumption; and ii) reduce electricity costs in this residential building. To achieve these objectives, Flexibility Control Algorithms not only charge the battery energy storage system when PV surplus is registered, and discharge it when demand surplus exists, but also impose a charging process during the night (when electricity tariffs are lower) to further increase electricity savings and maximize the use of the storage capacity, therefore increasing the benefits associated with the investment carried out on the purchasing of the battery storage system. Nevertheless, it is important to note that, with the goal of prioritizing PV self-consumption improvement, this night charging process is conducted only if the SoC is foreseen not to reach 100% in the next day. In more detail, every night at 10:00 PM (the instant the cheapest tariff starts), Flexibility Control Algorithms run the energy consumption and generation forecasts for the next day and estimate the SoC to be achieved with the forecasted demand and generation profiles without the night charging process. Then, the night



charging process is carried out to ensure 100% SoC with the forecasted demand and generation profiles and therefore fully using the storage capacity available during the next day. Figure 19 illustrates this operation of the Flexibility Control Algorithms for a specific day in November 2022, where the night charging process increased the SoC from 31% to 50% to ensure 100% SoC during the next day due to battery charging with PV surplus. This figure also shows that the discharging process is registered during the most expensive hours (peak hours, from 08:00 AM to 10:00 PM) when demand is higher than generation. Note that 15-min. resolution profiles are depicted in this figure since the net energy consumption at each one of these time-steps (i.e., curve “Meter”) is the metric considered by the electricity supplier to compute the respective costs for the consumer.

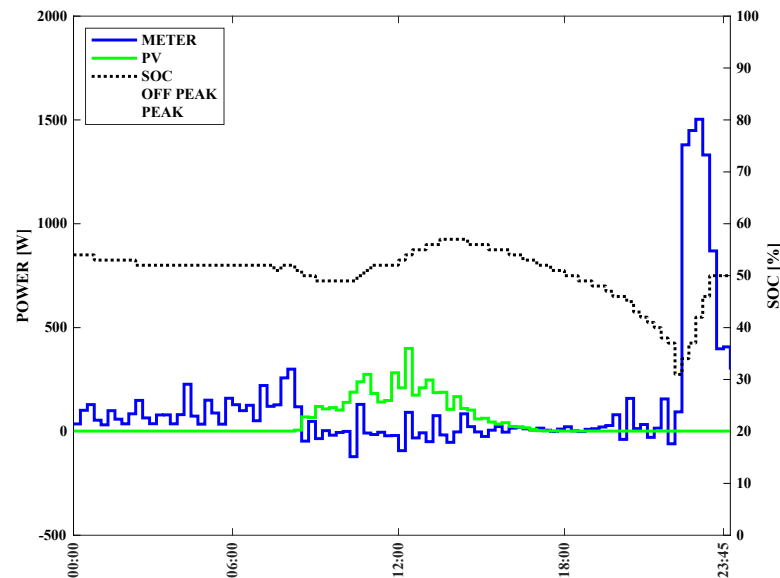


Figure 19 Results from PEB 1.9 Residential Building illustrating the operation of the Flexibility Control Algorithms (real data collected during November 2022)

To obtain the next day forecasted demand and generation profiles, Flexibility Control Algorithms use a set of Long short-term memory (LSTM) artificial neural networks specifically designed for the respective type of data (consumption or generation). Historical demand and generation data are used to train the artificial neural networks and update the forecasting methods every day. Data resolution was decreased during forecasting to reduce the prediction horizon and therefore improve the quality of the obtained results, as it was verified that estimated SoC values for the next day are not highly sensitive to the resolution of the obtained forecasted demand and generation profiles. Demand and generation data are based on the measurements provided by IE 1.1.10 (HEMS) and IE 4.3.2 (Wi-Fi Data Acquisition System), respectively.

Demonstration activities of Flexibility Control Algorithms in this residential building located in PEB 1.9 require the cooperation among several Innovative Elements from ETT#1, ETT#2, and ETT#3, as illustrated in Figure 20. In terms of interaction with the Victron MultiPlus-II 48/3000/35-32 inverter, this is achieved using a local hardware interface solution developed by UNINOVA for POCITYF, which is based on an ESP32 powered microcontroller with integrated Wi-Fi that communicates with the inverter using Modbus protocol over a RS485 physical connection. This microcontroller receives the monitoring and control requests from the Flexibility Control Algorithms and ensures the respective communication with the Victron MultiPlus-II 48/3000/35-32 inverter. AC and DC power values, SoC, AC and DC voltage values, DC current, and alarms are the variables being monitored at each 1-min. resolution time-step. The control variable refers to the power available at the inverter's AC side. Imposed values range from -2000 W to +2000 W (discharging process requires negative setpoints, while charging uses positive ones). Flexibility Control Algorithms also interact with the Data Lake (IE 4.3.3) to communicate the amount of money saved during each day (defined as “Smart Savings”) due to the use of the energy flexibility available. These values are used by the P2P Energy Trading Platform (IE 2.1.4) during its operation.



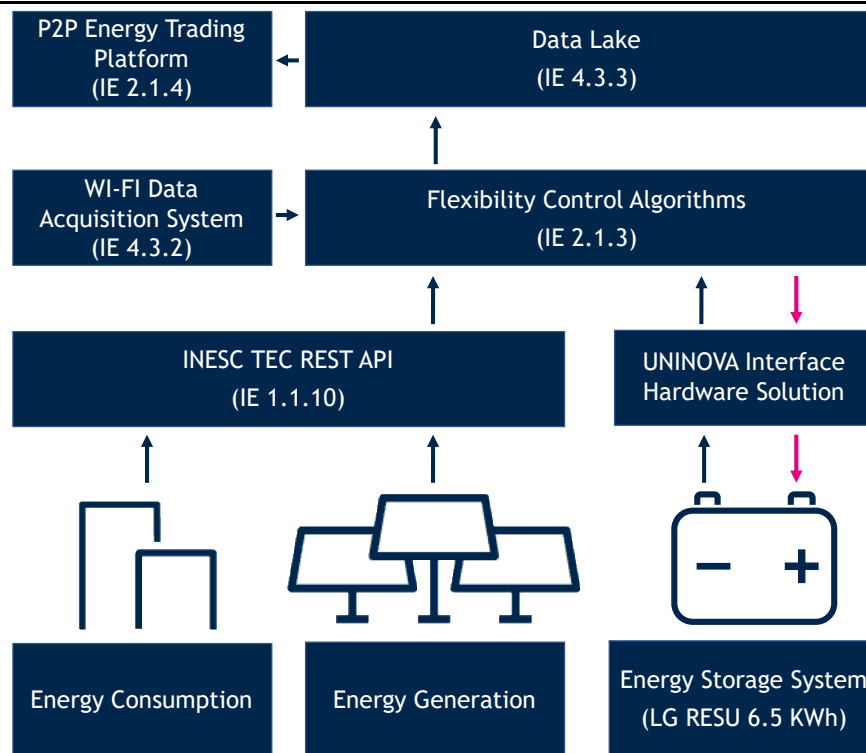


Figure 20 Solutions involved in the demonstration of Flexibility Control Algorithms in PEB 1.9

The demonstration of the Flexibility Control Algorithms in PEB 2.2 will use the energy flexibility provided by a LG Chem RESU 9.8 kWh 48V battery, which interfaces the AC grid using a Victron MultiPlus-II 48/3000/35-32 inverter. This demo site is also equipped with a 13.65 kWp PV installation composed of Q.PEAK DUO L-G5.2 390 PV modules and a Huawei 12 KTL inverter. The specific building of PEB 2.2 where these demonstration activities will take place is highlighted in Figure 21 (Building Ário Lobo de Azevedo) and comprises professors and researchers' offices, classrooms, and a bar, exhibiting the typical characteristic of a university campus' building. The considered set of solutions is similar to the one presented for PEB 1.9 (Figure 20), with a single modification regarding the collection of energy consumption and generation data. In this case, a metering system allowing Modbus protocol-based communication is considered, being the data sent to UNINOVA's servers using an ESP32 powered microcontroller with integrated Wi-Fi capabilities.



Figure 21 Building Ário Lobo de Azevedo at PED2 University Campus



Role of POCITYF partners involved
- INESC TEC (IE 1.1.10, HEMS) and University of Évora: provide buildings' total consumption and generation; - DECSIS: Data Lake receives buildings' total consumption and generation made available by IE 1.1.10 (Home Energy Management System); - Kimatica: P2P Energy Trading Platform (IE 2.1.4) can access data referred to in the previous point from the Data Lake to ensure the platform operation. - CMÉ: pilot site (PEBs) owner and responsible POCITYF partner.
Progress achieved to M38 (provide a progress and timeline on preparation, delivery, installation, operationalization, and monitoring)
- The Flexibility Control Algorithms are already being demonstrated in PEB 1.9 since M34. - Flexibility Control Algorithms demonstration activities in PEB 2.2 will start during M42. - From M34, in PEB 1.9, and from M42, in PEB 2.2, Flexibility Control Algorithms operation will be monitored to assess the benefits introduced by this solution in terms of PV self-consumption improvement and reduction of electricity costs.
Faced barriers and lessons learned
COVID-19 related restrictions limited the access of UNINOVA personnel to the laboratories where the software and hardware components are developed (e.g., difficulties related to interface testing with controllable devices, or the assessment of the benefits introduced by the Flexibility Control Algorithms). To mitigate the impact of this barrier, UNINOVA and the University of Évora developed efforts to accelerate the demonstration of Flexibility Control Algorithms in PEB 1.9 and effectively solve the interaction with battery energy storage systems based on LG Chem RESU batteries and Victron inverters, given that a similar solution will be demonstrated in PEB 2.2. Additionally, simulation tools have been developed to prepare the demonstration activities in PEB 1.9, which have been used in the development of a Master thesis (Barros, 2022) and are now being further improved to prepare the submission of a manuscript to an international journal that will disseminate the preliminary results collected in this early phase of the demonstration/monitoring period.
Next steps
- Continue demonstration activities in PEB 1.9; - Finish preparation of demonstration activities in PEB 2.2 until the end of M41; - Start demonstration activities in PEB 2.2 during M42.
Connection to other IEs within ETTs
In PEB 1.9/PEB 2.2, IE 2.1.3 (Flexibility Control Algorithms) demonstration is/will be conducted in cooperation with the following Innovative Elements: IE 1.1.10 (Home Energy Management System), IE 4.3.2 (WI-FI Data Acquisition System), IE 2.1.4 (P2P Energy Trading Platform) and IE 4.3.3 (Data Lake).



Table 7 IE 2.1.3 (Flexibility Control Algorithms) at PED1 Municipal Buildings

IE 2.1.3 - Flexibility Control Algorithms at PED1 Municipal Buildings**Goal and description of the IE at the PED1 Municipal Buildings**

In PED1 Municipal Buildings, this Innovative Element will control the energy flexibility made available by the Energy Router (IE 1.1.7) to reduce electricity costs and improve self-consumption of the future PV installations that will be installed at five municipal buildings (PEB1.1 - May 1st Municipal Market, PEB1.4 - EB1 S. Mamede school, PEB1.5 - Town hall, PEB1.7 - Rossio School, PEB1.8 - Interpretative Centre (LVpDE)).

In this case, the referred energy flexibility results from the 5.0 kWh battery storage systems that are located at each installation place. The Flexibility Control Algorithms interact with the storage systems through an interface provided by the Energy Router that allows monitoring and control of data exchange at 1-min. resolution. Collected data comprise generation and consumption data made available by Schneider Electric Building Management System (IE 1.1.8), as depicted in Figure 22.

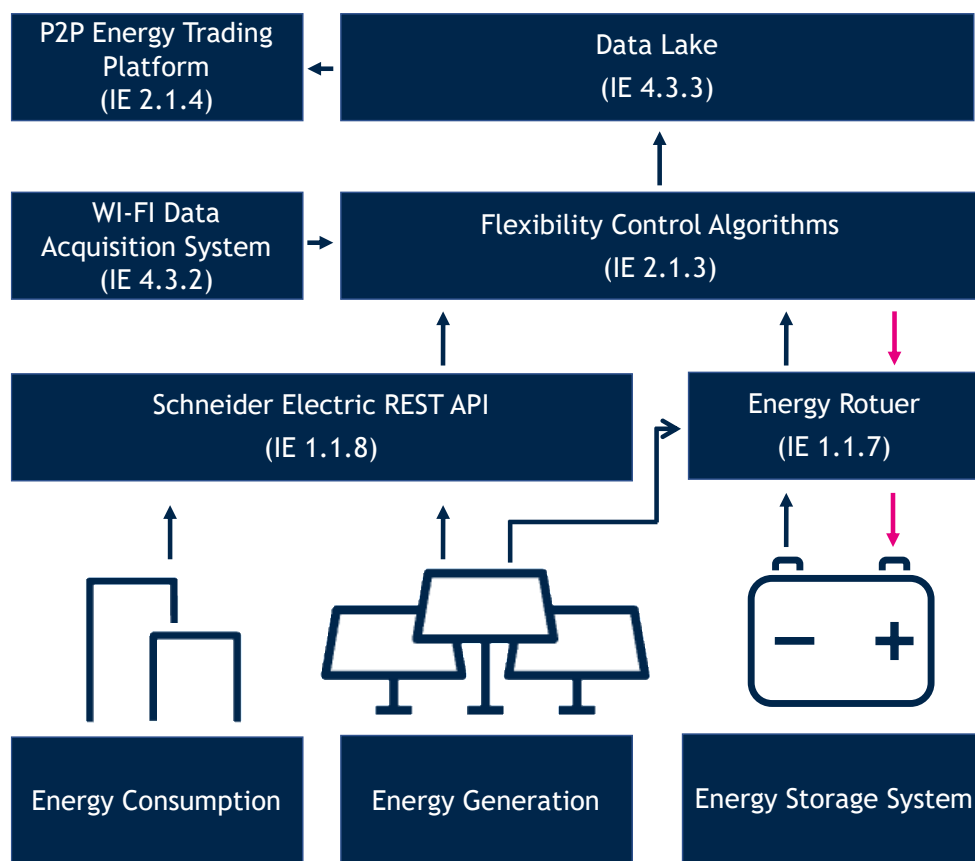


Figure 22 Different solutions involved in the demonstration of Flexibility Control Algorithms in PED1 Municipal Buildings

Through a REST API made available by Schneider Electric as part of IE 1.1.8 (Building Management System), Flexibility Control Algorithms, which are deployed at UNINOVA's servers, will collect buildings' total consumption and generation data with 1-min. resolution. Additionally, with the same time resolution, Flexibility Control Algorithms will collect generation and storage (SoC, charging/discharging power and alarms) data provided by the Energy Router (IE 1.1.7). Using these data, and consumption and generation forecasts relying on weather data provided by WI-FI Data Acquisition System (IE 4.3.2), the Flexibility Control Algorithms will define the optimal charging/discharging strategy for each one of the 15-min. resolution time-steps of a specific day. It is important to note that the net energy consumption at 15-min. resolution time-step is the metric the electricity supplier considers to compute the respective costs for the consumer. Therefore, IE 2.1.3 aims to i) maximize PV self-consumption; and ii) reduce electricity costs by minimizing net energy impost during peak tariff periods.



Role of POCITYF partners involved
- Schneider Electric: provide buildings' total consumption and generation data based on IE 1.1.8 (Building Management System); - DECSIS: Data Lake receives buildings' total consumption and generation made available by IE 1.1.8 (Building Management System) and the daily savings achieved by the Flexibility Control Algorithms; - Kimatica: P2P Energy Trading Platform (IE 2.1.4) can access data referred to in the previous point from the Data Lake. - CMÉ: pilot site (PEBs) owner and responsible POCITYF partner.
Progress achieved to M38 (provide a progress and timeline on preparation, delivery, installation, operationalization, and monitoring)
- The Flexibility Control Algorithms are ready to be demonstrated at PED1 Municipal Buildings since M34 (the same month demonstration activities started at PEB 1.9); - However, Flexibility Control Algorithms must use the energy flexibility provided by the battery energy storage systems made available by the Energy Router (IE 1.1.7), which have not been installed yet due to i) lack of PV system at the Municipal Buildings; and ii) tests at EDP LABELLEC; - As reported in deliverable D6.5, Energy Router (IE 1.1.7) has been tested at UNINOVA facilities in terms of functionalities (with positive results) during M37 and M38 and will be tested at EDP LABELLEC in terms of functionalities (for double check) and safety during M40; - As reported in deliverable D6.5, PV systems are foreseen to be installed at the Municipal Buildings during 2023. It is important to note that Energy Router (IE 1.1.7) installation requires the PV systems to be installed before.
Faced barriers and lessons learned
Two main barriers impacted the development of the Flexibility Control Algorithms for PED1 Municipal Buildings. The first one is related to the lack of controllable devices available at the Municipal Buildings. The second one is transversal to all development activities and refers to the impacts imposed by COVID-19 that restricted the access of UNINOVA personnel to the laboratories where the software and hardware components are developed (e.g., difficulties related to interface testing with controllable devices, or the assessment of the benefits introduced by the Flexibility Control Algorithms). To mitigate the impact of these barriers, POCITYF partners developed large efforts under WP1, task T1.4, to prepare the demonstration of the Flexibility Control Algorithms in PED1 Municipal Buildings and remotely developed software simulation tools to assess the benefits introduced by the Flexibility Control Algorithms using consumption data provided by Évora Municipality and weather data provided by the University of Évora. In fact, these simulation tools were the basis for the publication of one conference paper (Queiroz, 2022), which focused on the assessment of benefits introduced by Renewable Energy Communities for a set four Municipal buildings.
Next steps
- The next steps refer to the starting of the demonstration phase as soon as the Energy Routers are installed (foreseen for June 2023, see deliverable D6.5 for more information);
Connection to other IEs within ETTs
In PED1 Municipal Buildings, IE 2.1.3 (Flexibility Control Algorithms) demonstration is conducted in cooperation with the following Innovative Elements: IE 1.1.7 (Energy Router), IE 1.1.8 (Building Management System), IE 2.1.4 (P2P Energy Trading Platform), IE 4.3.2 (WI-FI Data Acquisition System) and IE 4.3.3 (Data Lake).



Table 8 IE 2.1.3 (Flexibility Control Algorithms) at PEB 2.1

IE 2.1.3 - Flexibility Control Algorithms at PEB 2.1
Goal and description of the IE at the PEB 2.1
Taking advantage of the monitoring and control infrastructure deployed in PEB 2.1 buildings during previous H2020 projects (e.g., INTEGRID), Flexibility Control Algorithms will be demonstrated to explore the energy flexibility provided by existing controllable devices. IE 2.1.3 will also be used to increase the benefits of ten 2nd Life Batteries (4.6 kWh storage capacity per storage system) that will be installed, as described in Section 4.1.1, by ensuring the real-time control of the installed systems considering buildings consumption and generation profiles. Figure 23 presents the different solutions that will be considered in these demonstration activities. <pre> graph TD P2P[P2P Energy Trading Platform IE 2.1.4] DL[Data Lake IE 4.3.3] WIFS[WI-FI Data Acquisition System IE 4.3.2] FCA[Flexibility Control Algorithms IE 2.1.3] CWA[CleanWatts REST API external partner] BRAB[Batteries REST API IE 2.1.1] EC[Energy Consumption] EG[Energy Generation] L2LB[2nd Life Batteries] WIFS --> FCA CWA --> FCA FCA --> P2P FCA --> DL FCA --> BRAB BRAB --> L2LB EC --> FCA EG --> FCA L2LB --> FCA </pre> Figure 23 Different solutions involved in the demonstration of Flexibility Control Algorithms in PEB 2.1 In all PEB 2.1, consumption and generation data with 1-min. resolution will be collected through a REST API made available by an external partner (i.e., CleanWatts) that was involved in previous H2020 projects whose demonstration activities took place in the same residential buildings. Additionally, this API will be used to send instructions to the existing controllable devices that were installed before POCITYF. Control signals to the 2nd Life Batteries will be sent through a REST API developed by Betteries for control and monitoring activities. Since all the considered PEB 2.1 buildings are equipped with a 1.5 kWp PV system, Flexibility Control Algorithms demonstration activities will aim for the improvement of PV self-consumption rates and the reduction of electricity costs for the involved consumers. The operation of the Flexibility Control Algorithms is similar to the one already described for the demonstration at PEB 1.9. In this case, 2nd Life Batteries (2.1.1) will be discharged when the demand surplus is verified and charged when PV occurs and during the night to take advantage of lower electricity prices. Night charging will take place only if the forecasted SoC does not reach the maximum value during the next day. Control of devices from previous H2020 projects will also prioritize PV self-consumption and extend the use of energy flexibility to reduce electricity costs (if available) by taking advantage of time-of-use tariffs. Flexibility Control Algorithms are also responsible for sending buildings' consumption and



generation data to the Data Lake (IE 4.3.3), together with the daily savings from the available energy flexibility. All these data are used by the P2P Energy Trading Platform (IE 2.1.4) during its operation.

Role of POCITYF partners involved

- Batteries: provide batteries' monitoring data and ensure control signals are sent to 2nd Life Batteries through the REST API made available by this partner.
- DECSIS: Data Lake receives buildings' total consumption and generation made available by IE 2.1.3, which are acquired by a solution from an external partner and made available through a REST API, and the daily savings achieved by IE 2.1.3.
- Kimatica: P2P Energy Trading Platform (IE 2.1.4) can access data referred to in the previous point from the Data Lake.
- CMÉ: pilot site (PEBs) owner and responsible POCITYF partner.

Progress achieved to M38 (provide a progress and timeline on preparation, delivery, installation, operationalization, and monitoring)

In addition to the details provided in Table 3, the following should be highlighted:

- Several meetings and working sessions have taken place with Batteries to develop the interaction with 2nd Life Batteries' REST API and associated monitoring and control instructions, while also understanding the operation of these batteries.
- Flexibility Control Algorithms can remotely monitor and control 2nd Life Batteries since M36 and therefore are ready to be demonstrated at PEB 2.1 residential buildings.
- Regarding the remaining controllable device, which requires the infrastructure developed during previous H2020 projects, information about the respective REST API (from the external partner CleanWatts) was provided and analysed during M38 and tests were carried out during M40.

Faced barriers and lessons learned

Two main barriers impacted the development of the Flexibility Control Algorithms for PEB 2.1 residential buildings. The first one refers to the delayed installation of 2nd Life Batteries and to the delayed interaction with controllable devices from previous H2020 projects, which is dependent on an external partner and requires the development of additional interoperability tools. This barrier is being tackled with support from EDPL to interface the contacts for the establishment of the required cooperation with CleanWatts thus speeding up the process. The second barrier is transversal to all development activities and refers to the impacts imposed by COVID-19 that restricted the access of UNINOVA personnel to the laboratories where the software and hardware components are developed (e.g., difficulties related to interface testing with controllable devices, or the assessment of the benefits introduced by the Flexibility Control Algorithms).

Next steps

- Development of tests with CleanWatts during M40 to collect consumption and generation data from PEB 2.1 residential buildings.
- Engagement activities targeting users from PEB 2.1 residential buildings, which are led by EDPL, to be continued (finillized by M40/41) and start the installation of 2nd Life Batteries.
- Start the demonstration phase as soon as 2nd Life Batteries are installed and access to the infrastructure from previous H2020 projects is granted to UNINOVA to collect consumption and generation data from the involved buildings and start the required monitoring and control activities.

Connection to other IEs within ETTs

In PEB 2.1 Residential Buildings, IE 2.1.3 (Flexibility Control Algorithms) demonstration is conducted in cooperation with the following Innovative Elements: IE 2.1.1 (2nd Life Batteries), IE 2.1.4 (P2P Energy Trading Platform), IE 4.3.2 (WI-FI Data Acquisition System) and IE 4.3.3 (Data Lake).



Table 9 IE 2.1.3 (Flexibility Control Algorithms) at PED3

IE 2.1.3 - Flexibility Control Algorithms at PED3**Goal and description of the IE at the PED3**

The demonstration of Flexibility Control Algorithms in PED3 will be focused on the use of energy flexibility provided by thermal loads to increase PV self-consumption and reduce electricity costs. In PED3 SONAE Building, IE 2.1.3 will control freezers/refrigerators, while in PED3 DECSIS and PED3 PACT buildings this innovative element will control the operation of existing air conditioning systems. Additionally, in PED3 SONAE and PED3 DECSIS this innovative element will also consider the operation of IE 3.1.6 (Intelligent and optimal control algorithms), which optimizes the EVs charging process (see deliverable D6.9) associated to IE 3.1.5 (Smart lamp posts with EV charging and 5G functionalities) and IE 3.1.2 (EV charger prototype with PV integration), to further increase the benefits introduced by the entire set of POCITYF solutions.

Figure 24 presents the solutions involved in the demonstration at PEB 3.1. IE 1.1.8 (Building Management System) provided by SE that interacts with existing infrastructure and allows the required monitoring and control activities (Table 12). At each 1-min. time-step, Flexibility Control Algorithms will collect all the required data and define the operation mode of each controllable freezer/refrigerator, which, depending on the goods being stored, impact the inside temperature of the respective storage compartments and the energy consumption of the building (Table 12). To define this operation mode, IE 2.1.3 considers the following information: i) forecasted PV generation; ii) forecasted total energy consumption; iii) scheduled EV charging processes to take place in the future; and iv) applied electricity prices, which depend on time-of-use tariffs and spot market prices set by the Iberian Electricity Market. Like in the remaining demonstration activities, consumption and generation profiles will be forecasted using Long short-term memory (LSTM) artificial neural networks specifically designed for the respective type of data. Data used to train and update these neural networks will be acquired from IE 1.1.8 (Building Management System), using a REST API made available by SE, and from IE 4.3.2 (Wi-Fi Data Acquisition Systems). Additionally, black-box models of each controlled freezer/refrigerator have been developed (using historical data provided by SONAE), which, together with the aforementioned information, will be used to define the optimal operation mode of each individual controllable system and thereby modify energy consumption to increase PV self-consumption and reduce electricity costs. Consumption and generation data are then uploaded to the Data Lake for the later computation of considered KPIs.

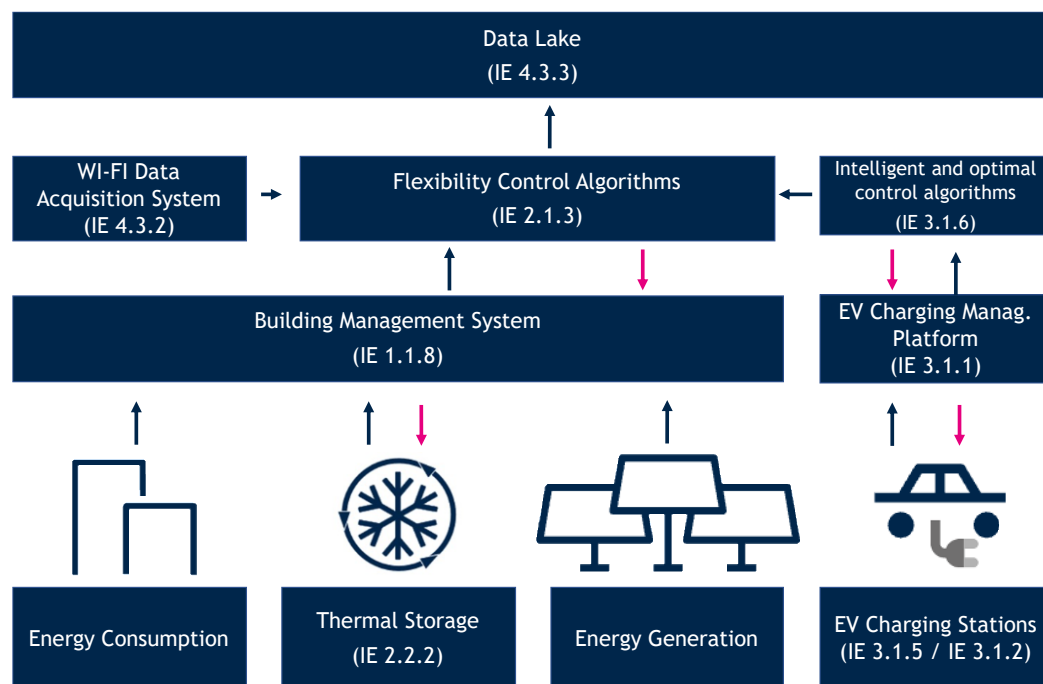


Figure 24 Different solutions in the demonstration of Flexibility Control Algorithms in PED3 SONAE



Demonstration activities at PEB 3.2 and PEB 3.3 will comprise a similar set of solutions but taking advantage of energy flexibility provided by existing air conditioning systems. In the case of PEB 3.3, UNINOVA is developing a component (both hardware and software parts) that will collect indoor temperature and humidity with 1-min. resolution and receive the setpoints defined by the Flexibility Control Algorithms with the same time resolution. This component is specifically design for the existing SANYO air conditioning system. In the case of PEB 3.2, Flexibility Control Algorithms will interface the recently installed LG systems through the AC Smart 5 central controller that can manage individual or groups of indoor units in one space. The goal is to monitor and control the indoor units allocated to common spaces of the new building (see Figure 25 referring to an illustrated space whose temperature will be controlled by the Flexibility Control Algorithms). AC Smart 5 central controller accepts communication using Modbus protocol over a RS485 physical connection. UNINOVA will use a local ESP32 powered microcontroller with integrated Wi-Fi capabilities to receive the set points defined by the Flexibility Control Algorithms and to collect all the monitoring variables.

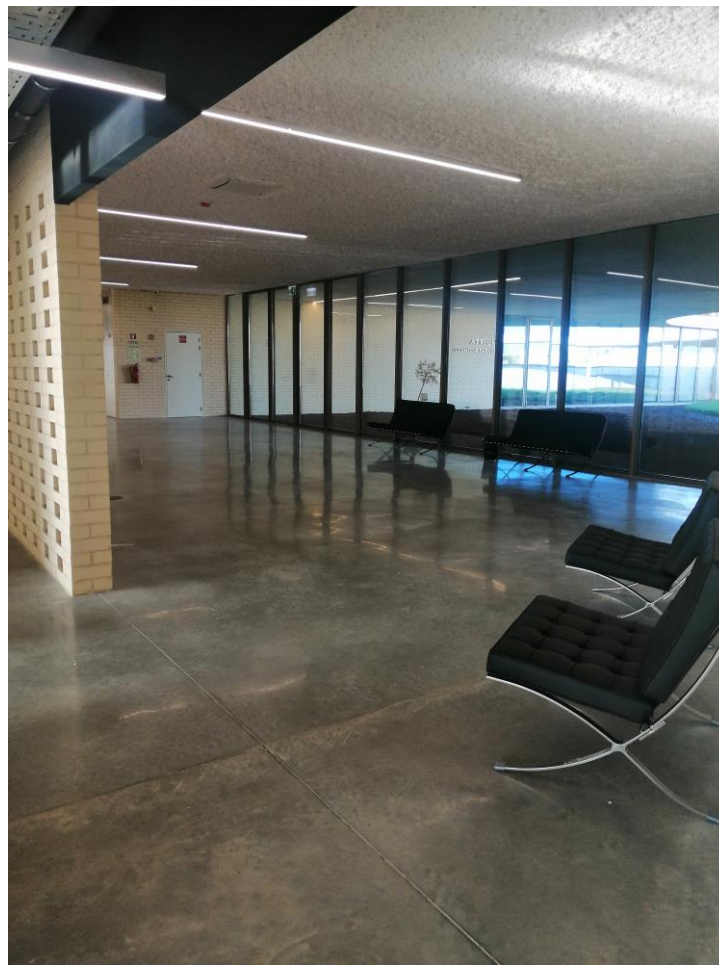


Figure 25 PEB 3.2 space whose temperature will be controlled by Flexibility Control Algorithms

Role of POCITYF partners involved

- Schneider Electric: provide PEB 3.1 total consumption and generation data based on IE 1.1.8 (Building Management System);
- DECSIS: Data Lake receives buildings' total consumption and generation made available by IE 1.1.8 (Building Management System).
- CMÉ: pilot site (PEBs) owner and responsible POCITYF partner.



Progress achieved to M38 (provide a progress and timeline on preparation, delivery, installation, operationalization, and monitoring)

- Two technical visits have been conducted to PEB 3.1 in M12 and M36;
- Two technical visits have been conducted to PEB 3.2 in M12 (old building) and M36 (new building);
- Two technical visits have been conducted to PEB 3.3 in M12 and M36;
- Development of black-box models for PEB 3.1 freezers/refrigerators using historical data concluded by M24;
- Identification of existing controllable devices at PEB 3.2 and PEB 3.3 finished at M38;
- Development of components (both hardware and software parts) to interact with existing air conditioning systems at PED3 DECSIS and PED3 PACT started at M38.

Faced barriers and lessons learned

Given the complexity and novelty of the solution to be deployed at PEB 3.1, several barriers were found, which are detailed in Table 12 in terms of required infrastructure. Another challenge was related to the improvement of systems' controllability since before the black-box modeling activities and preliminary studies carried out by UNINOVA based on historical data provided by SONAE, only ECO and NORMAL operation modes were available. Following this initial work, the additional operation BOOST operation mode, which is required to anticipate energy consumption, was made available as a result of large efforts carried out by SONAE to modify existing infrastructure based on services from internal and external entities in the COVID-19 restrictive context.

Regarding PEB 3.2 and PEB 3.3, the main barriers are related to finding devices whose energy flexibility can be remotely controlled. In PEB 3.3, the main reason for this barrier is related to cyber-security concerns from DECSIS due to its core business being related to data storage/servers and therefore external access to existing devices was not possible from DECSIS side until M38. In PEB 3.2, the main reason is related to the lack of remote access to the air conditioning system available in the old building and to the fact that information concerning the air conditioning system of the new building was not available before M38. To overtake these barriers several remote meetings and technical visits were carried out to find feasible and secure solutions.

Next steps

- PEB 3.1: Finalize integration of Schneider AS-P and UNINOVA Flexibility Control Algorithms until M40;
- PEB 3.1: start monitoring phase during M41;
- PEB 3.2 and PEB 3.3: finalize development of components (both hardware and software parts) required to interact with existing air conditioning systems until M42;
- PEB 3.2 and PEB 3.3: start monitoring phase during M43.

Connection to other IEs within ETTs

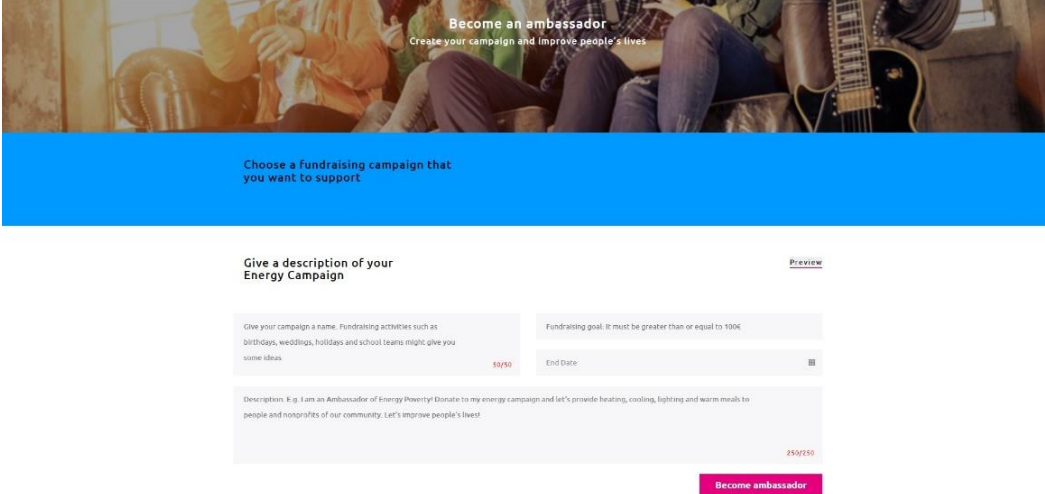
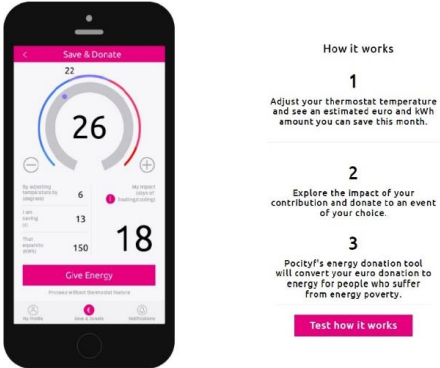
In PED3, IE 2.1.3 (Flexibility Control Algorithms) demonstration is conducted in cooperation with the following Innovative Elements: IE 1.1.8 (Building Management System), IE 4.3.2 (Wi-Fi Data Acquisition Systems), IE 3.1.5 (Smart lamp posts with EV charging and 5G functionalities), IE 3.1.2 (EV charger prototype with PV integration), IE 3.1.6 (Intelligent and optimal control algorithms), and IE 4.3.3 (Data Lake).



1.4.4 Demonstrating IE 2.1.4 (P2P energy trading platform)

KIMATICA will develop/extend a state-of-the-art cloud platform, designed for energy donations and transactions that helps utilities engage, retain, and cultivate a community of energy donors with the ability to donate or sell energy and help alleviate energy poverty.

Table 10 IE 2.1.4 (P2P Energy Trading Platform)

IE 2.1.4 - P2P Energy Trading Platform
Goal and description of the IE at the PEB
The P2P energy donation platform integrates the most engaging donation features in one platform customized for the needs of electric utilities. The platform increases engagement with gamification features through the concepts of become an ambassador, save and donate energy or share your solar energy which are all part of a modern and state of the art energy donation process to increase engagement and help utilities digitize their social responsibility programs. The expected outcome is a campaign driven, social responsibility effort for Évora that will support thousands of low-income residents to pay for their energy needs. The platform functionalities include:
- Become an ambassador (Figure 26) - users can become fundraisers, create their own campaign, and give a start date, description, and goal.

Figure 26 Become an ambassador
- Save and donate (Figure 27) - saving tips to help users save money that is converted to energy and donate it to an event.

Figure 27 Smart giving



- Smart energy for free (Figure 28) - Inform users about their solar production and then select a percentage of solar savings to donate to an event.

Even a small percentage of your produced energy has a great impact.

Tell us about your solar panel and we will provide you with an estimation of your produced energy and savings on your bill. You can then choose to donate.

Annual Produced Energy
kWh Value

OR

Installed Capacity
kW Value

Average Purchased Price Of Solar Energy
€/kWh

Calculate

0€  0 kWh

This is an estimation based on the EU project JRC EU.

 Share  Tweet

Figure 28 Smart energy for free

The P2P energy donation platform has been tested in both the USA and EU regions (see Figure 29). More precisely it was tested with the largest energy retailer in North America called Direct Energy, the energy provider of Grenoble in France called GEG and the energy retailer in Greece called HERON. They all created social responsibility programs to support low-income residential customers who suffer from energy poverty. An interesting successful example of the usage of a P2P energy donation platform was demonstrated after the environmental disaster of Hurricane Harvey. A dedicated campaign was created, within 24 hours of the Hurricane, to financially support the victims. In less than 24 hours the fundraising goal was covered by 200%.

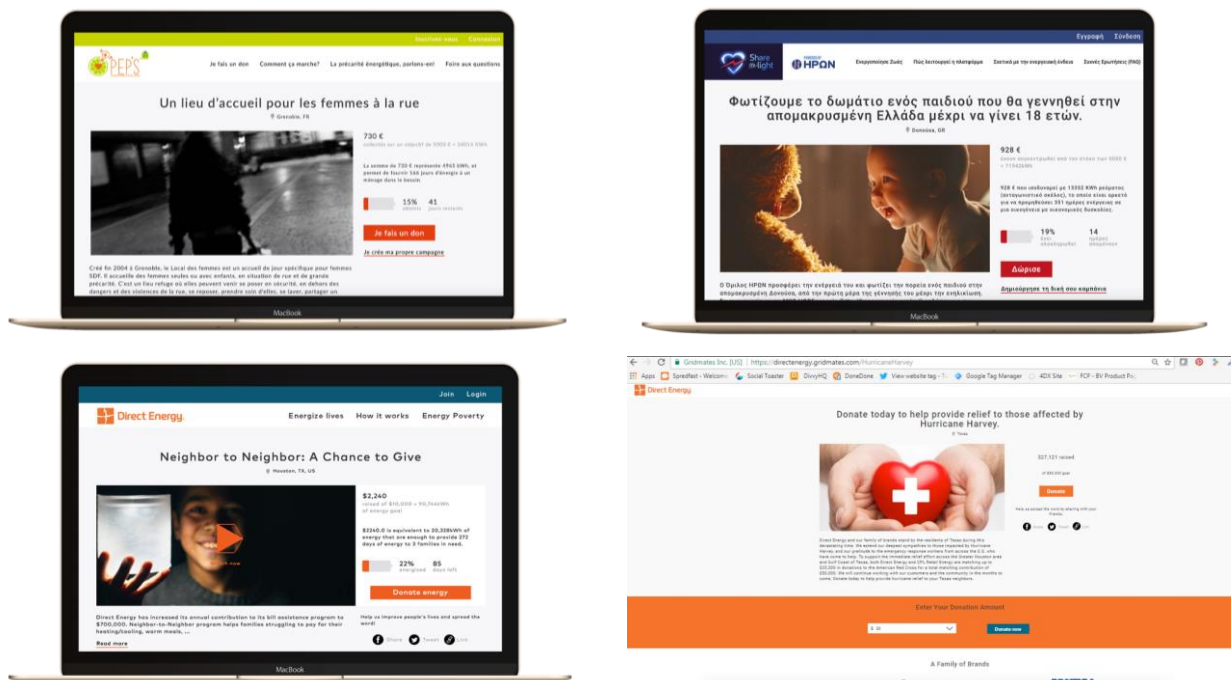


Figure 29 Examples of energy donation campaigns



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 864400.



The Houston, Grenoble and Athens pilots were part of the client collaboration of KIMATICA. They all developed campaigns to support their local communities to alleviate energy poverty. Direct Energy in Houston created the program called Neighbor to Neighbor, HERON in Athens created the program ShareTheLight and GEG, in France, created the program called Programme d'énergie partagée solidaire (PEPs). Each program hosted fundraising campaigns.

P2P Energy Trading Platform is a cloud platform in the AWS environment for P2P energy donations and transactions, developed in the Ruby on Rails backend and Angular JS frontend. The platform hosts important integrations with APIs to enable the whole operations. These are a) PayPal API, b) PV Watts API, c) Facebook API, d) Twitter API, e) EIA API, and f) Weather API. For communication with end users the platform has a mail server that sends receipts in real time with the donation. The platform offers two dashboards, one for the user and one for the admin user. The user can access information about his/her transactions and also connect with other users. The admin user dashboard is an analytics portal and management tool that offers 100% management capabilities to create, edit and monitor campaigns and transactions. The engagement features implemented in the platform are a) Ambassador, b) Save and Donate, c) Smart Giving (Thermostat), and d) Share the solar (<http://demo.kimatica.com/>).

An innovative P2P energy trading platform will be employed where the users/owners of the buildings in Évora can buy/sell energy to each other and sell flexibility to the DSO. The expected outcome is a campaign driven, social responsibility effort of Évora that will provide help with energy needs whilst protecting the environment and engaging the community. An additional feature of the platform includes the tokens marketplace management system, where users' sustainable behaviours are rewarded with tokens and can be exchanged for goods and services offered by local merchants and other entities.

First, the user registers with a single sign on the system (SSO) that directs to the P2P energy trading platform. It then leads to a second registration process to give the authorization to further proceed with the identification and the collection of relevant data, such as utility account number, home address, solar panel etc. to be able to enter the community. The landing page (Figure 30) consists of the Donation, Wallet, and Analytics tabs. The user can choose which of the abovementioned pages to redirect. Some additional pages of the platform are presented below.



Figure 30 Landing page



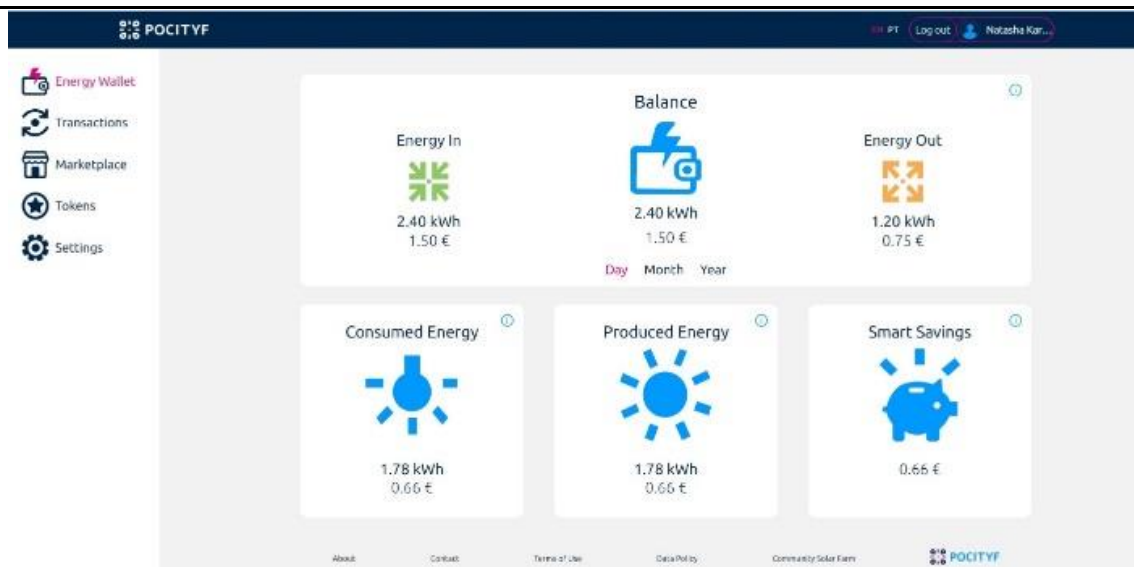


Figure 31 Energy Wallet page, where users have access to data of their Consumed Energy, Produced Energy, Smart Savings, Balance, and Tokens

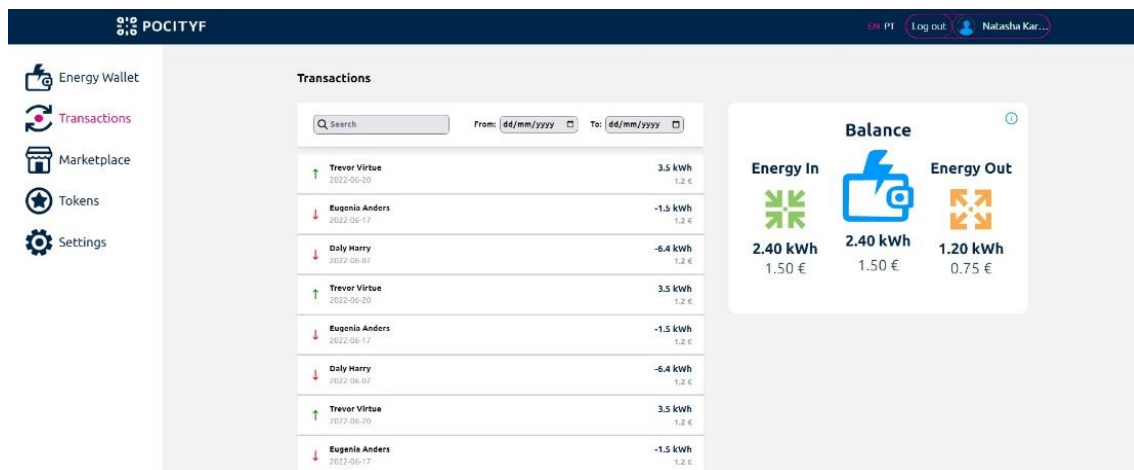


Figure 32 Transactions, where users have access to the history of the transactions performed so far

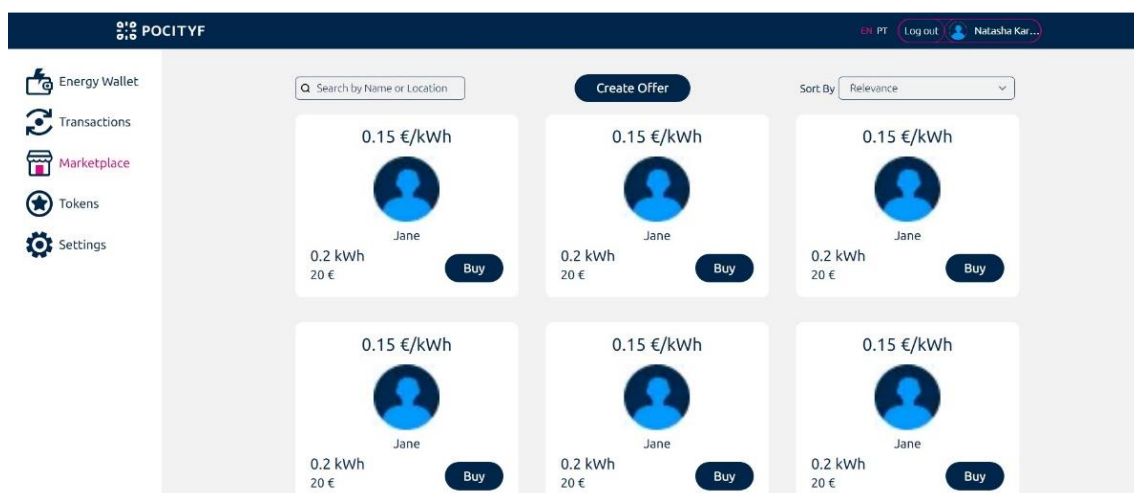


Figure 33 Marketplace page, where users can trade energy with the other users of the community



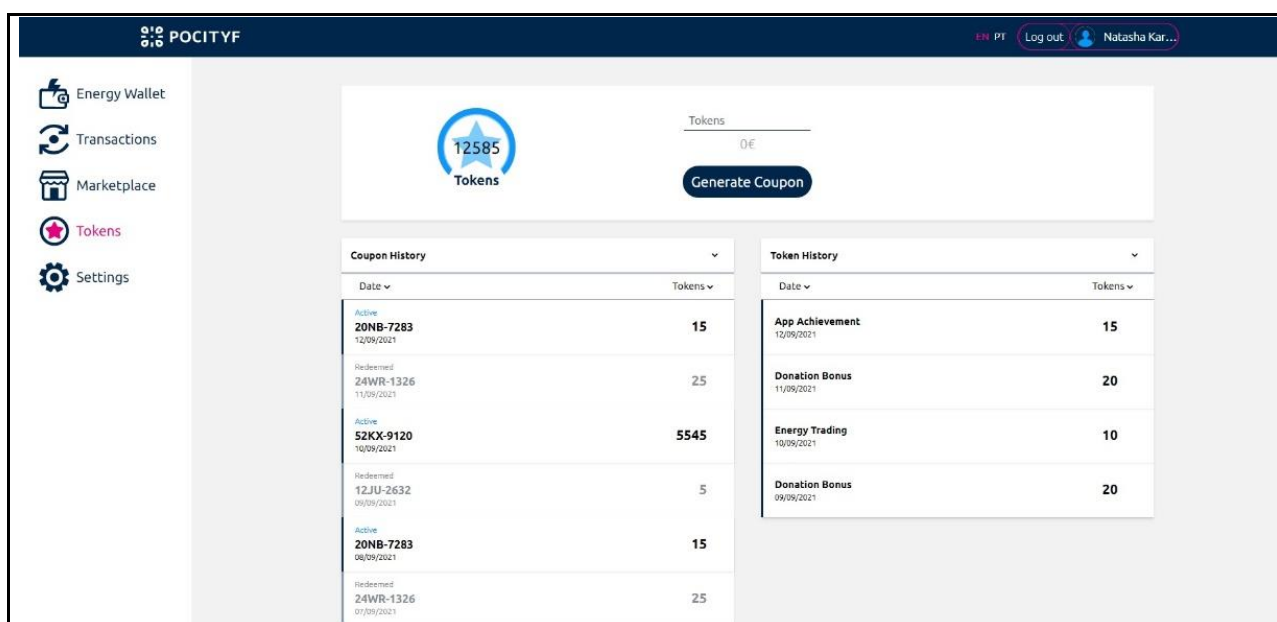


Figure 34 Tokens page, where users have access to coupon/token history and are able to generate and redeem coupons

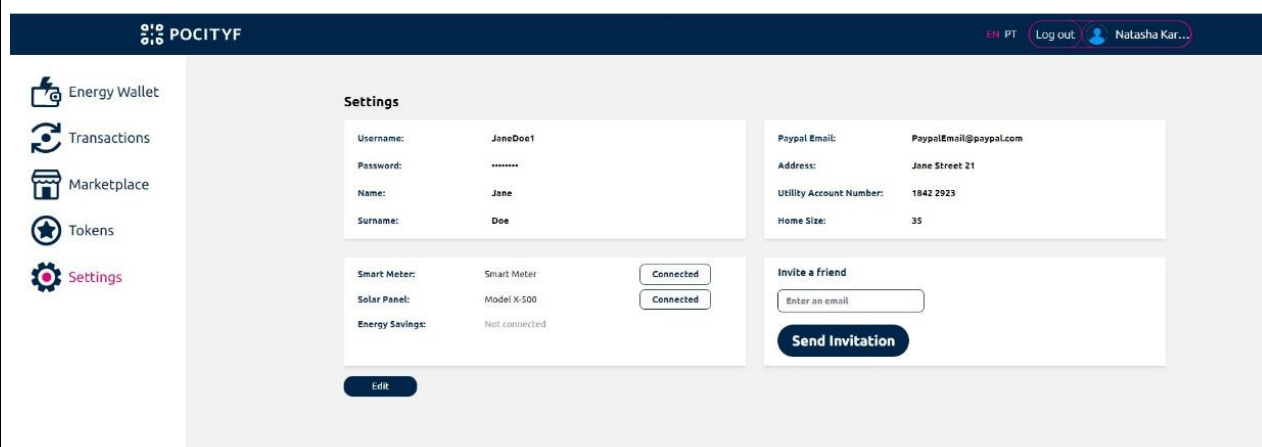


Figure 35 Settings, where users can edit their profiles (i.e., username, password, name, surname, smart meter, solar panel, PayPal information) as well as find the feature Invite a friend

KIMATICA will monitor, gather, and present data analytics of the platform. For data analytics, two different options are suggested: a) an open access dashboard in a URL that will present the analytics and b) sending all the data to the data lake.

Open Access Analytics: The analytics will provide information for i) location of transaction/donation; ii) recipient name of transaction/donation; iii) donor name (if applicable, else anonymous); iv) amount of transaction/donation in Euros; v) equivalent amount of transaction/donation in kWh; and vi) Infographic with aggregated information (total amount, etc).

Furthermore, the platform gathers data from different types of sources such as platforms or services for consumed energy, produced energy, energy flexibility, social KPIs and the tokens marketplace. These data will be gathered from the data lake via APIs.

Two groups of data will be generated from the platform and sent directly to the data lake.

- Social KPIs - Data regarding the social media platforms.
- Generated data - data regarding the transactions between two users in the energy trading platform, donations of each user of the events of the donation platform and the tokens that users are generating.



The P2P energy trading platform is in an advanced development state and is being subjected to testing and redesigning. P2P is a cloud platform hosted on HEROKU, built on nodejs for the back-end service, and, Nextjs for the front-end application. It has a RESTful API architecture for communication between the server, the client and any other third parties involved such as the wso2 identity server, the data lake API, the gamification API, and transaction services such as PayPal and Stripe. The beta version of the desktop web application is deployed and monitored on (<https://p2p-energy-trading-client.herokuapp.com>).

Role of POCITYF partners involved

- UNINOVA - Participation in the exchange of data process for smart savings;
- EDPL - Participation in the exchange of data process for consumed, and produced energy;
- DECSIS - Participation in the process for data pool and SSO;
- CERTH - Participation in the exchange of data process for tokens management and gamification activities.

Progress achieved to M38 (provide a progress and timeline on preparation, delivery, installation, operationalization, and monitoring)

The P2P energy trading platform is in an advanced development state and is being subjected to testing, redesigning, and then will be deployed in the PEBs of Évora.

Faced barriers and lessons learned

- In terms of lessons learned about the usability of the donation platform, it was shown that electric utilities should make intense and correct marketing outreach to communicate the solution to the end users.
- Restrictions from the Portuguese legislations regarding P2P energy trading had to be considered and adjustments to incorporate them had to be carried out.
- The main lesson learned is the need to guarantee anonymization standards and ensure the protection of the user's personal data. To accomplish that we had to identify and analyse the needs of the platforms that compose the POCITYF ecosystem regarding the users' data. Then, proceed with an authorization and authentication layer responsible for assigning a unique user identifier for each platform the user has given consent and registered. Any user data shared between the POCITYF ecosystem applications are anonymous and can be related to a specific user through a unique identifier.

Next steps

- Complete data lake integration to fetch necessary data (waiting for other partners);
- Implement transactions and payment features (waiting for local legislation update);
- Complete the redesign of the pages (M39);
- Define rules in the Gamification platform (M39).

Connection to other IEs within ETTs

IE 2.1.4 (P2P energy trading platform) demonstration is conducted in cooperation with the following Innovative Elements: IE 1.1.8 (Building Management System), IE 2.1.3 (Flexibility Control Algorithms) and IE 4.3.3 (Data Lake).



1.5 POCITYF Solution IS 2.2 in Évora

Innovative Elements belonging to Integrated Solution 2.2 (*Flexible and Sustainable District Heating/Cooling with Innovative Heat Storage Solutions*) will be demonstrated in all Évora Positive Energy Districts (PEDs) using resources available at, both, building and community level, as described in Table 11. Detailed information about these demonstration areas has been provided in deliverable D1.6, which represents one of the outputs of the preparatory work developed under WP1 from M03 to M12 and from M28 to M30.

Table 11 ETT#2: IS 2.2 Innovative Elements in Évora LH



Innovative Element	Responsible Partner	Évora Demonstration Area
IE 2.2.1 Freezing storage in store	SONAE	All PEDs
IE 2.2.2 Extended market-oriented building flexibility services	EDPL	PED3 - Industrial and Science Park PEB3.1 - SONAE commercial building

The information presented in the remaining of this section was provided by the partners responsible for the respective Innovative Elements through the fulfilment of the form that can be found in Annex A.



1.5.1 Demonstrating IE 2.2.1 (Freezing storage in store)

Freezing storage in store aims to take advantage of the thermal inertia of the freezers/refrigerators to store cold when the energy price is lower / RES generation is higher, therefore, decreasing consumption when the energy price is higher, increasing self-consumption of local renewable energy. This IE can usually be implemented using the existing equipment or with minimal updates, with considerable potential for replication / large scale exploitation, therefore allowing a non-negligible impact.

Local hardware was installed in the store and integrated with the Schneider Electric AS-P controller. This integration will allow UNINOVA to collect operational data of the cold system through the AS-P and send control signals with the schedule of the operation modes (ECO / BOOST / NORMAL). This solution is being implemented in the Continente de Évora store (PEB 3.1), where additional investments were made to maximize the impact of the solution, namely, the installation of an oversized PV with a surplus that will be used to boost the production of cold.

Table 12 IE 2.2.1 (Freezing storage in store)

IE 2.2.1 - Freezing storage in store
Goal and description of the IE at the PEB
The goal of the innovative element is to increase positivity through increasing energy self-consumption. Flexibility Control Algorithms (2.1.3) will use the energy flexibility available in the refrigeration systems to increase PV self-consumption and decrease energy costs while ensuring the temperature ranges allowed for each refrigeration unit are maintained. A predictive model approach will be followed to control the refrigeration systems, taking into consideration the building's energy demand and generation profiles together with the existing energy tariffs. Additionally, Flexibility Control Algorithms will consider the operation of other solutions deployed at the building (e.g., EV charging management platform) in order to find the best solution at each time-step. To deploy this solution, UNINOVA and Schneider Electric will interact through secure REST-API communication where a list of variables will be made available to UNINOVA, per equipment: - SetPoint - Imposed temperature [°C] - Temperature - Actual temperatura [°C] - ValveAKV - Valve opening [%] - Ventilador - Ventilation status [I/O] - Defrosting - Defrosting status [I/O] - Light - Iluminação - Mode STATUS - Imposed operation mode (0=Normal; 1=ECO ; 2=BOOST) - ModeFeedback - Actual mode (0=Normal ; 1=ECO ; 2=BOOST) - ActivePowerColdNegative - Power demand of negative cold [kW] - ActivePowerColdPositive - Power demand of positive cold [kW] - BuildingTotalActivePower - Overall building power demand [kW] - PvActivePower - PV power generation [kW] All this information is available through a LINX module from Loytec, also installed at the store, and interacts between Schneider Electric and the cold system controller, XWEB via BacNET IP protocol. This controller will act as a gateway, ensuring that data flows between the two components (cold controller XWEB and Schneider controller AS-P) as well as a safety layer, monitoring critical variables and resetting to default operation any equipment whenever the pre-established criteria are violated. All equipment and associated goods are mapped through the AS-P and many will be managed through UNINOVA algorithms: - Negative Cold chambers - Fish / Meat / bread (Normal=-20°C; ECO=-15°C; BOOST=-25°C); - Positive Cold chambers - Fruit / vegetables / fresh fish / fresh meat (Normal=2°C; ECO=4/6°C; BOOST=0°C); - Negative Cold cabinets - Fish / Meat / bread (Normal=-20°C; ECO=-15°C; BOOST=-25°C) - Positive Cold cabinets - Fruit / vegetables / fresh fish / fresh meat (Normal=2°C; ECO=4/6°C ; BOOST=0°C); - Some specific equipment will not be managed as the associated goods are more sensitive to temperature variations.



Role of POCITYF partners involved
- Sonae MC - End user, responsible to set solutions requirements. Promote additional investments to maximize solution impact. - Elergone Energia - Off-taker, coordinate pilot demonstrations, coordination of store assessment local interventions and solution deployment. Interact with all partners to ensure all stakeholders requirements are fulfilled during the pilot. - UNINOVA - Solution provider, responsible to develop the Flexibility Control Algorithms to dynamically manage the cold system for self-consumption maximization. - Schneider Electric Italy - Solution provider, responsible to provide hardware and software for local integration (with the cold system) and remote integration (with UNINOVA algorithms).
Progress achieved to M38 (provide a progress and timeline on preparation, delivery, installation, operationalization, and monitoring)
- Site visit to store - done during 2020 - High level architecture - done during 2020 - Additional technical site visits - done during 2021 - Historical data analyzed - done during 2021 - Solution discussed with third party provider - during 2021 - XWEB cold system controller upgrade - done during 2022 - Safety layer LINX controller installation - done during 2022 - Integration of LINX controller and Schneider AS-P - done during 2022 - Integration of Schneider AS-P and UNINOVA algorithms - ongoing - end of 2022 - Fully operational demonstration - beginning of 2023
Faced barriers and lessons learned
- Health and safety - Cold systems need to ensure a certain temperature range for different types of food. These limits raised some initial barriers that were circumvented with a joint effort from the health and safety, internal food auditing, cold supply chain and cold O&M teams. - Cyber-security - Some barriers emerged to the initial architecture. To ensure a high level of cyber-security, the solution was discussed with the IT department a VPN tunnel was implemented for access from outside Sonae network. - Administrative - Initial approach on Purchase Orders was not approved by the administrative services. - Cold system management - Several barriers were identified during the discussions on the cold system management. Initial thought that temperature set points could be sent to the cold controller was regarded as risky leading to the inclusion of LINX hardware to act as a safety layer where 3 different pre-established modes are available (ECO / BOOST / NORMAL). Additional limitations were identified in what concerns the granularity of the control, leading to the clustering of cold units
Next steps
- Finalize integration of Schneider AS-P and UNINOVA algorithms - ongoing - M41.
Connection to other IEs within ETTs
- IE 2.2.1 (Freezing storage in store) demonstration is conducted in cooperation with the following Innovative Elements: IE 1.1.8 (Building Management System) and IE 2.1.3 (Flexibility Control Algorithms).



1.5.2 Demonstrating IE 2.2.2 (Extended market-oriented building flexibility services)

The Extended market-oriented building flexibility services is a tool that will simulate, for the City of Évora and different future scenarios, the potential value of community flexibility, optimized in an operation based on the energy market. The scenarios will provide results that can support CME to reach the potential value of flexible assets for energy communities in Évora and stimulate interest in future investments to complement the Community Solar Farm (IE 1.2.5). Individual flexibility assets - that will be optimized in municipal, residential, and commercial buildings through the Flexibility Control Algorithms (IE 2.1.3) during the POCITYF project, - can also be considered as part of the aggregated “community flexibility”. Nonetheless, this IE will first focus on batteries at community scale, with the intention of integrating smaller scale flexibility assets at a later stage.

Table 13 IE 2.2.2 (Extended market-oriented building flexibility services)

IE 2.2.2 -Extended market-oriented building flexibility services	
Goal and description of the IE at the PEB	
Market-Oriented Building Flexibility Services, MOBFS, is a simulation environment that calculates the value potential of the flexible assets in aggregated buildings across a PED district, where the main goal is to maximize revenue in energy markets for an aggregator or community manager. The platform monitors market conditions and, in a commercial stage, will send a set point to control equipments in order to optimize the flexible load and generation available in a community or aggregated communities. Prerequisites to demonstrate this IE include a characterization of the flexible loads across the district, consumption and generation data from the pilot sites and defined scenarios for flexibility value potential. In a commercial phase, not only monitoring equipment connected to load and generation assets will be needed, but also actuation devices to be able to activate flexible assets when indicated. As of now, the IE is based on simulation, until appropriate legal and technical conditions allow otherwise.	
Role of POCITYF partners involved	
- EDPL - Partner responsible for the development of the innovative solution. - CMÉ - Pilot site (PEB) owner and responsible POCITYF partner.	
Progress achieved to M38 (provide a progress and timeline on preparation, delivery, installation, operationalization, and monitoring)	
The MOBFS envisioning and definition was followed by the definition of the module requirements and functionalities, via a specification by example approach where the functionality requirements for the platform were illustrated with the development of functional prototypes. The prototypes, illustrated below (Figure 36 to Figure 39), served as a basis to further develop the module’s requirements and functionalities iteratively. In the MOBFS dashboards the EC Managing entity can gather information regarding the flexible operation of said EC. The dashboards will contain information such as overall KPIs (e.g., the number of flexible assets or revenue generated, exemplified in Figure 36) for each EC managed by the entity (see Figure 38 M and Figure 38 M). Additionally, as exemplified in Figure 39 , MOBFS will allow the managing entity to access data and forecasts of a (foreseen) flexibility market and its operation. Also, the mockups are presented to better illustrate the module’s functionalities. The EC manager or aggregator will be able to see different performance metrics related to all flexible assets which are operating within all of the managed ECs.	



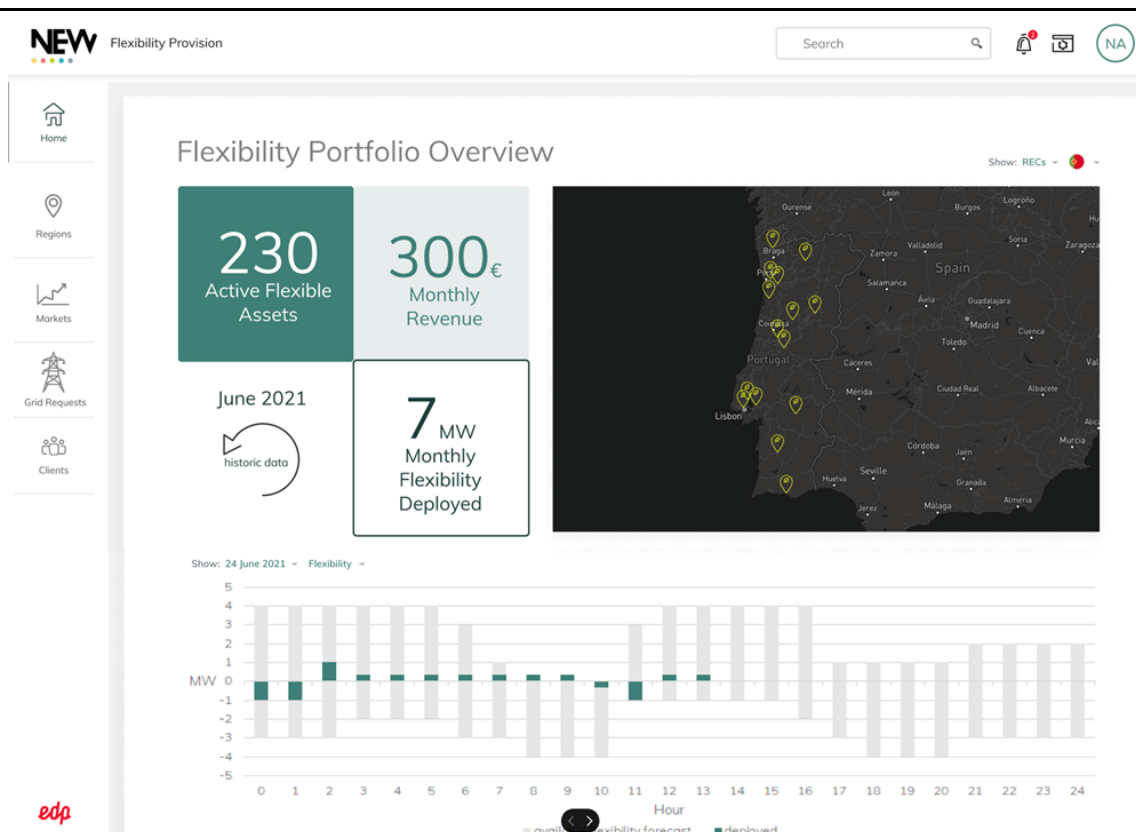


Figure 36 Building Oriented Market Flexibility Services homepage mockup

Filtering by region, the EC manager will be able to single out the flexible assets for each EC.

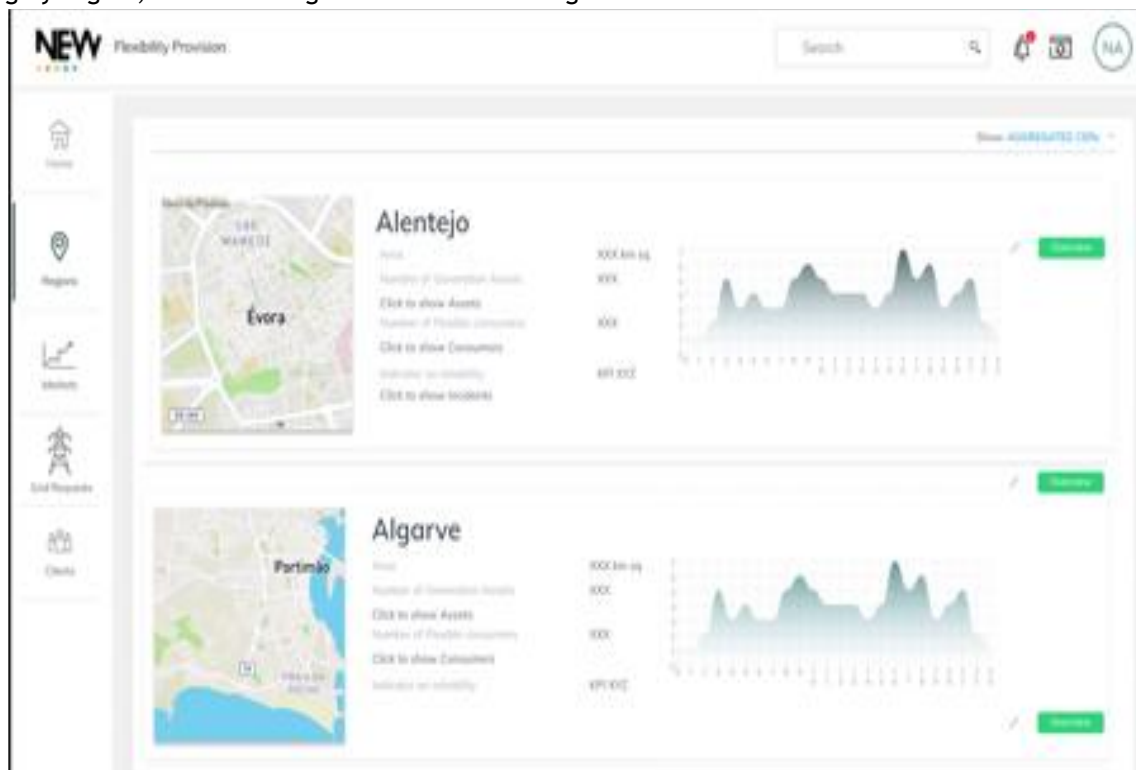


Figure 37 MOBFS dashboard mockup number 2



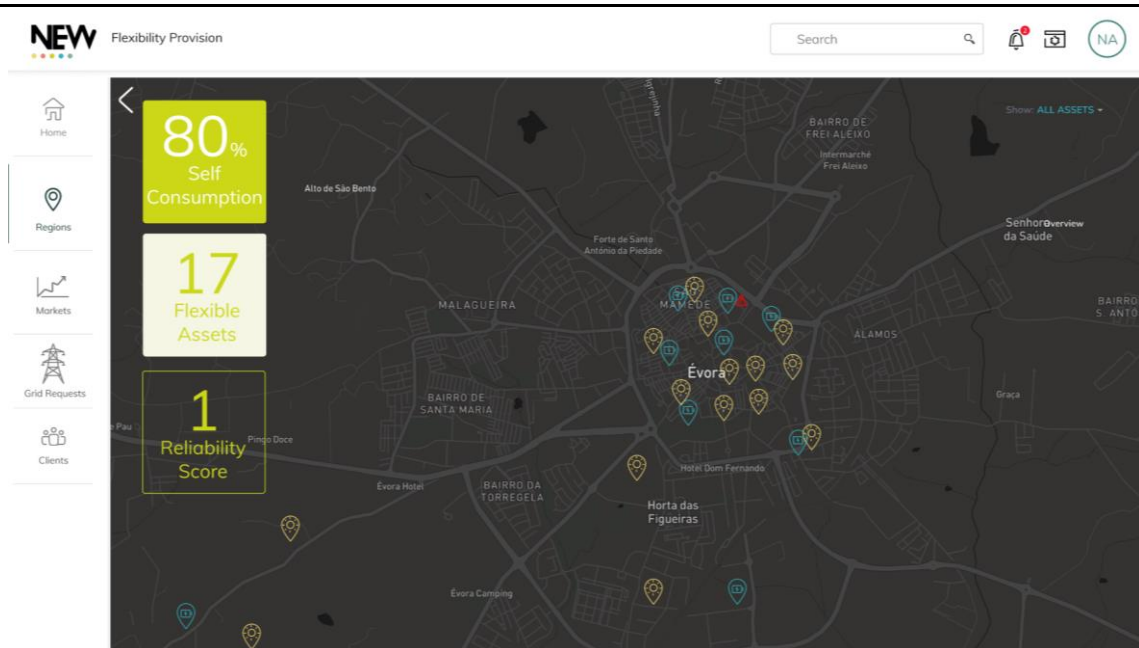


Figure 38 MOBFS dashboard mockup number 3

Additionally, the MOBFS module will showcase and simulate how could the EC manage the flexibility potential and assets to provide market services (e.g., participate in day-ahead or intra-day markets to sell excess energy and/or flexibility).

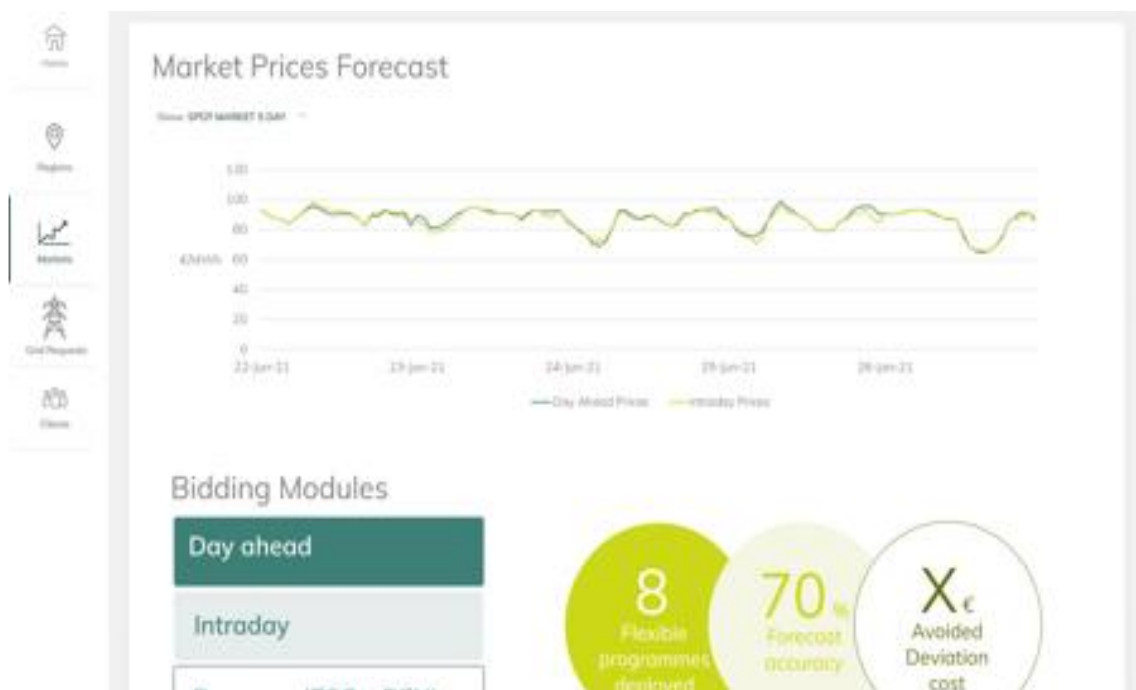


Figure 39 MOBFS dashboard mockup number 4

The module is currently under development and is expected to be finalized/submitted by July 2023, alongside IE 4.1.2 Gamification Platform. Following its implementation stage (during August 2023), MOBFS innovative solution is to be operationalized in the Lighthouse city of Évora. From August 2023 forward and until the end of POCITYF demonstration activities, the MOBFS operation will be monitored.



Faced barriers and lessons learned

The main barriers that EDPL faces when it comes to IE 2.2.2 are of regulatory and energy market-related nature. In Portugal, the process of selling electricity generated from renewable sources, by small-scale producers, to the grid is very demanding in terms of the licensing process due to its bureaucracy. Nowadays, the time spent on issuing a license for a producer is much longer than the recommended three years. Furthermore, there is no longer the feed-in tariff, and excess energy can only be valorized by large market participants with portfolios for optimization. Also, building level flexibility does not benefit from market mechanisms, as the TSO still relies on large hydro and thermal for most balancing activities and large industrial consumers in some cases. On the DSO level, there is no established market in Portugal where market rules can be followed. Using case study examples of where lower capacity flexibility markets are established (e.g., the UK, where 5 DSO use PicloFlex to sell distributed flexible assets) alongside the flexibility needs of the balancing zones within Portugal, has permitted learnings on what will be the best scenarios to simulate would be. The scenarios will give results that can help CME understand the potential value of flexible assets for energy communities in Évora, and stimulate interest in future investments, when smaller scale flexibility markets are established.

Next steps

The most pressing next steps concern the solution development, currently under progress. Alike IE 2.1.2, the front-end and the solution's visualizations are to be adapted to the mockups while the back-end connection and link to other IE's, within the ETT's (e.g., IE 4.3.3, Data Lake intelligence for positive communities), is to be conducted. From August 2023 (M47) forwards the simulation-based innovative solution will be deployed within the Lighthouse city of Évora and monitored from that point on.

Connection to other IEs within ETTs

The MOBFS module, extending the capabilities of the Energy Community management platform (described above in IE 2.1.2) and sharing the same virtual environment/scope/interface, will communicate directly with other project solutions to receive inputs regarding the energy flexibility potential of buildings and the EC as a whole (e.g., IE 4.3.3, Data Lake intelligence for positive energy communities; IE 1.2.5, Community Solar Farm; IE 2.1.1, 2nd life batteries; IE 2.1.3, Flexibility Control Algorithms).



Conclusions

The integration of energy conversion systems based on primary renewable energy resources and the increasing electrification of energy demand impose challenges to existing energy distribution grids that energy flexibility can help to address. In this context, POCITYF ETT#2 (P2P Energy Management and Storage Solutions for Grid Flexibility) solutions aim to maximise self-consumption of renewable energy sources; ii) reduce grid stress, avoiding load and generation curtailment; and iii) increase the financial value of existing resources through flexibility services to the grid. ETT#2 also aims to support both ETT#1 (Innovative Solutions for Positive Energy (CH) Buildings and Districts) and ETT#3 (e-Mobility Integration into the Smart Grid & City Planning) in achieving their objectives while maximising the benefits introduced to consumers and other stakeholders, including grid operators.

Building upon the work developed under WP1, which led to the City Vision and Master Plan for ETT#2 Solutions (deliverable D1.6), the development of ETT#2 Innovative Elements took advantage of cooperation among different partners (even from different ETTs) to increase the benefits delivered to POCITYF stakeholders. This is the case of IE 2.1.3 (Energy Flexibility Control Algorithms) at PEB 3.1 (SONAE commercial building), which controls the available energy flexibility considering data acquired by IE 1.1.8 (Building Management System) and IE 4.3.2 (Wi-Fi Data Acquisition Systems) and the impacts imposed by IE 3.1.6 (Intelligent and optimal control algorithms) on building's energy consumption due to the optimization of EVs charging process associated to IE 3.1.5 (Smart lamp posts with EV charging and 5G functionalities) and IE 3.1.2 (EV charger prototype with PV integration), which are monitored and controlled through the IE 3.1.1 (EV Charging Management Platform).

Under IS 2.1 (Flexible and Sustainable Electricity Grid Networks with Innovative Storage Solutions), demonstration activities comprise four Innovative Elements using resources available in all Évora PEDs. IE 2.1.1 (2nd Life Batteries) is already under demonstration in PEB 2.2 (Polo da Mitra), where a mobile battery storage system is available, and battery models have already been developed to help understand the systems operation. IE 2.1.3 (Energy Flexibility Control Algorithms) is also under demonstration since M34, exploring the flexibility provided by a battery storage system installed at PEB1.9, while demonstration activities in other locations are about to start. Remaining Innovative Elements, namely IE 2.1.2 (Renewable Energy Communities Management Platform) and IE 2.1.4 (P2P energy trading platform), have been facing barriers related to regulatory issues, mostly related to the concept of Renewable Energy Community, that impacted the development and deployment phases of these state-of-the-art solutions. These impacts are expected to fade out as the first Renewable Energy Community starts to operate in Portugal.

Regarding IS 2.2 (Flexible and Sustainable District Heating/Cooling with Innovative Heat Storage Solutions), demonstration activities will consider two Innovative Elements. IE 2.2.1 (Freezing storage in store) required large efforts to reduce the impact of identified barriers (e.g., related to health and safety) and to develop the required infrastructure with cooperation among several POCITYF partners (SONAE, UNINOVA, SE), given that interaction between different Innovative Elements is required, and SONAE group entities (e.g., SONAE's group company responsible for cyber-security is involved). This demonstration activities at PEB 3.1 (SONAE commercial building) are foreseen to start during M41. IE 2.2.1 (Extended market-oriented building flexibility services) is facing barriers similar to the ones identified for IE 2.1.2 (Renewable Energy Communities Management Platform) and, as a result, demonstration activities are expected to start during M47.

The next version of this deliverable (D6.8) will report on the main findings and lessons learned during demonstration activities, which will be conducted until M60, and detail all Innovative Elements operation. The cooperation structure among POCITYF partners and external entities partially put in place during WP1, and refined from M13 to M38 according to WP6 needs to develop the work described in this deliverable, will continue being used during the remaining of the project to ensure smooth cooperation among Innovative Elements belonging to different Energy Transition Tracks and the achievement of POCITYF objectives.



Annex A: Template for data collection

IE X.X.X - XXXXX
Goal and Description of IE at the PEB
Role of partners involved
Progress achieved to M38 (partners to provide input on timeline of IE, research, delivery, installation, testing, etc.)
Current status of the IE (what has been achieved?)
Faced Barriers and Lessons Learned (M0 - M38)
Next steps (what will be done/what still has to be done - add dates if known)
Connected IEs within ETTs



References

Barros, R. (2022), *Sistema de Gestão do Armazenamento de Energia em Baterias. Uma Abordagem Focada na Maximização do Autoconsumo Fotovoltaico e Redução dos Custos*, NOVA School of Science and Technology.

Foles, A., Fialho, L., Winzer, J., García, N., Horta, P. & Collares-Pereira, M. (2022). *Upcycling Lithium-Ion Batteries: A Case Study*. 8th World Conference on Photovoltaic Energy Conversion. 10.4229/WCPEC-82022-5CO.10.4

Queiroz, H., Amaral Lopes, R., Martins, J., Fialho, L., Bravo Dias, J., Bilo, N. (2022). *Assessing the Benefits of Renewable Energy Communities: A Portuguese Case Study*. In: Camarinha-Matos, L.M. (eds) Technological Innovation for Digitalization and Virtualization. DoCEIS 2022. IFIP Advances in Information and Communication Technology, vol. 649. Springer, Cham. https://doi.org/10.1007/978-3-031-07520-9_2

