POCITYF

Technical and Innovation Management Plans

D11.7: Technical and Innovation Management Plans

WP11, T11.3

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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	POCITYF
Project Title	A POsitive Energy CITY Transformation Framework
Project Coordinator	João Gonçalo Maciel EDPL JoaoGoncalo.Maciel@edp.com
Project Duration	60 months (from October 2019 – to September 2024)

Deliverable No.	D11.7
Dissemination level*	PU
Work Package	WP11 – Project Management
Task	T11.3 – Technical and Innovation Management Plans
Lead beneficiary	38 (CERTH)
Contributing beneficiary/ies	1 (EDPL); 2 (CME); 3 (UNINOVA); 4 (UEVORA); 5 (UW); 6 (DECSIS) ; 7 (SE); 9 (SONAE) ; 10 (ONYX) ; 11 (TEGOLA) ; 12 (AMPS) ; 13 (Kimatica); 14 (INESC TEC); 15 (GA); 16 (SEV) ;17 (Inholland); 18 (HVC); 19 (TNO); 20 (Woonwaard); 21 (Van Alckmaer); 22 (DBL); 23 (Connexxion); 24 (ALI); 25 (Neroa); 35 (MoI); 36 (HVK); 38 (CERTH); 40 (ICONS); 45 (Enersis); 31 (MoC); 27 (APEGR); 42 (CIRCE); 15 (GA); 39 (VTT).
Due date of deliverable	31 March 2020
Actual submission date	02 April 2020

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)

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0.1	10/11/2019	CERTH	Nikos Nikolopoulos
0.2	01/02/2020	CERTH	Konstantinos Kourtzanidis; Nikos Nikolopoulos
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This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement N° 864400.

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1.3	10/03/2020	CERTH	Draft version sent to reviewers (VTT and NEROA)
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Executive Summary

The current deliverable D11.7 – Technical and Innovation Management Plans – presents the strategic plans for innovation assurance including coordination and management procedures as well as the project progress and diagnosis in terms of achieved innovation, evolving market needs/changes and business models linked to the project objectives.

The information provided in this deliverable report is focused on the first semester progress of POCITYF and it thus serves as an introductory Technical and Innovation Strategic Plan to be updated twice during POCITYF duration (M36 and M60). Even at this early stage, the information provided in this document is very useful towards the correct implementation of the innovative solutions as well as the good roll-out of the technical and innovation side of the project. The methodology of data collection and structure of partners interactions through POCITYF is essential for efficient communications between the large ecosystem of POCITYF. The main focus of this work has been put on the progress report per innovative element to be deployed in LHs and replicated in FCs. The data provided therein forms a strategic plan for monitoring not only the technical innovation required by POCITYF but also important aspects (market, business, regulatory, etc.) that may influence the project objectives. At this early stage, detailed information for some progress results might be pending, not available or quite speculative (linked to identified risks and mitigation actions) and it is to be updated accordingly in a timely manner throughout the following months. We explicitly state parts where information is currently not available.

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Abbreviations and acronyms

Abbreviation	Definition
ATES	Aquifer Thermal Energy Storage
BEMS/HEMS/CEMS	Building/Home/City Energy Management System
BMS	Building Management System
CA	Consortium Agreement
CPB	Consortium Plenary Board
D&C	Dissemination and Communication
DHC	District Heating Cooling
DSM	Demand Side Management
DSO	Distribution System Operator
ETT	Energy Transition Track
EV	Electric Vehicle
FC	Fellow City
GA	Grant Agreement
IE	Innovative Element
IPR	Intellectual Property Rights
IS	Integrated Solution
LH	LightHouse
LV/MV	Low Voltage/Medium Voltage
NZEB	Near Zero Energy Buildging
P2P	Peer-to-Peer
PAYT	Pay-As-You-Throw
PC	Project Coordinator
PCM	Phase Change Materials
PEB	Positive Energy Building
PED	Positive Energy District
PV	PhotoVoltaic
RES	Renewable Energy Source
SME	Small to Mid-size Enterprise
T&I	Technical and Innovation
TIB	Technical and Innovation Board
TIM	Technical and Innovation Manager
TIPPING	The Innovation Perspective for New Governance on Islands
TRL	Technology Readiness Level
V2G	Vehicle to Grid
VPP	Virtual Power Plant
WP	Work Package

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1 Introduction

Smart cities can shape their sustainable future and transform their urban ecosystem through the implementation of innovative technical solutions and citizen/ stakeholder engagement. On this basis, the POCITYF smart city project mobilises two Lighthouse (LH) cities (Evora-PT and Alkmaar-NL), and six 6 Fellow (FC) cities (Granada-ES, Bari-IT, Celje-SI, Ujpest-HU, Ioannina-GR and Hvidovre-DK) which share knowledge and coordinate their efforts towards energy transition focusing on four Energy Transition Tracks (ETTs) They will all shape their own, unique 2050 bold city visions by capitalizing on their own unique characteristics while taking care of their cultural heritage. The later can be critical for environmental sustainability as energy efficiency goals seem to contradict with the legislation for the protection of historical buildings.

POCITYF's city leaders have embraced the smart city concept with enthusiasm and seized the opportunity with the aim to transform their cities into more efficient, healthy, open, accessible, sustainable, prosperous, and thus, more attractive living environments. Building upon already implemented pre-pilot activities, Evora and Alkmaar will demonstrate integrated solutions for: positive energy blocks (ETT#1), grid flexibility (ETT#2), e-mobility integration into the grid and city planning (ETT#3) and citizen-driven innovation supported by the integration of innovative apps into enhanced City Information Platforms (ETT#4).

In total, four mixed-use districts – among them the historical city center of Evora, characterized as a World Heritage Site by UNESCO - have been selected for the demonstration activities in the LH cities representing an area of 739Ha hosting 17,500 residents. Demonstration will be performed in 21 building complexes covering a total floor area of 87,480 m^2 with current energy needs of 13.25GWh/year. For this purpose, overall 10 integrated solutions (IS) have been defined for demonstration, comprising **73 individual innovative elements (IE) (technologies, tools, methods)** that have been identified as a result of an intensive and laborious collaborative process. These IEs are the innovation backbone of POCITYF. A number of appropriately designed citizen and community engagement strategies, along with open innovation and co-creation activities will be deployed in parallel to ensure an increase of citizens awareness on energy transition issues and its benefits that can impact the successful replication and roll out of the demonstrated activities.

To further strengthen and facilitate demonstration activities, POCITYF will introduce IS-specific business models applied at sharing, barter and circular economy settings. Along with the LH cities, the FCs ecosystem of 13 partners will work on the preparation of the targeted replication activities. The project's monitoring, evaluation and impact assessment activities will ensure effective demonstration, fast replication and wide scale roll out within POCITYF cities and across Europe. Among them, the Technical and Innovation Management Plans will ensure that POCITYF will generate and manage effectively innovations deriving from the technical activities carried out during the project in the most appropriate way for maximizing impact.

1.1 Objectives and Scope

The current deliverable D11.7 – Technical and Innovation Management Plans – presents the POCITYF strategic planning for managing innovation including the coordination of procedures for monitoring the project progress and diagnosis in terms of achieved innovation, evolving market needs/changes, business models linked to the project objectives and also potential bottlenecks that may hinder innovations envisaged.

1.2 Relation to other activities

T11.3, and subsequently its respective deliverable D11.7, has a cross-cutting relation to activities throughout POCITYF, reporting on the coordination and monitoring of technical and innovation aspects of the whole project while providing feedback towards novel solutions and ideas.

1.3 Structure of the deliverable

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Chapter 2 – Methodology of Coordination and Monitoring
Chapter 2 outlines the methodology developed and applied for monitoring and coordinating technical issues, including guidelines and recommendations on how all necessary information will be gathered and monitored.

Chapter 3 – Communication and Dissemination of Technical Results
Chapter 3 presents, the communication and dissemination activities that have been concluded in the reported period and are highly relevant to the technical and innovation results of POCITYF. A special emphasis is given on presenting the scientific publications, technical conferences, workshops and intellectual and property rights (IPR) resulted from the technical and innovation activities of POCITYF.

Chapter 4 – Technical and Innovation Progress
Chapter 4 provides a detailed presentation of technical and innovation progress. The information included in Chapter 4 is structured in three main pillars: a) Information on innovation and novel ideas that have/will be achieved during POCITYF towards the TRL leaps of the technologies; b) Information on the market needs, changes and challenges that may influence the technologies implementation, innovation and market value during POCITYF as well as the overall project's Objectives; c) Information on novel business models that may and should arise through innovation.

Chapter 5 – Critical implementation risks and mitigation actions
Chapter 5 presents a brief presentation and discussion of key critical implementation risks and mitigation actions regarding technical and innovation progress (the specific issues are addressed in detail in D11.4 – T11.2).

Chapter 6 – Impact on SMEs
Chapter 6 presents the impact of POCITYF in SMEs, leveraging from the innovative demonstration activities and the potential of replicating them.

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2 Methodology of Monitoring and Coordination

Technical coordination provides a collaborative environment where LH and FC, service providers, experts and technology providers can implement POCITYF's integrated solutions and support each other in the innovation process. This section describes the methodology for monitoring and coordinating the technical and innovation issues of POCITYF and describes the next steps and actions planned to be performed in the upcoming periods setting the framework to manage innovation in a collaborative way. All technical and innovation issues on critical aspects are discussed during the Technical Coordination Board meetings, while all relevant updates will be included in the next versions of this Deliverable (updates).

2.1 Monitoring and Coordination

POCITYF has set up a process to monitor and coordinate the technical and innovation progress of the demonstrations. This process is built around the project's Objectives which are directly linked with the Energy Transition Tracks (ETTs) and Integrated Solutions (ISs) therein. To this respect, as part of the first semester work, the monitoring process focuses on the Innovation Elements (IE) and ICT solutions, aiming to provide technical support on the design of their implementation, risk assessment, and mitigation and contingency actions to involved partners. Moreover, it also targets the project's Key Exploitable Results (KER), aiming to facilitate the identification of market needs, link those needs to the value proposition of the innovative elements and recognize potential business models that will allow for the successful deployment and exploitation of the IEs.

The monitoring of the technical and innovation progress of the POCITYF's integrated solutions includes not only the purely technical evolution and related novelties. An essential part of the technical and innovation management activities is to monitor the continuously evolving market needs in order to adjust the implementation of POCITYF solutions to better address those needs and challenges. Thus, information is collected in 4 main pillars:

- **The technical progress** of implementing the POCITYF's integrated solutions and respective IEs.
- **The progress on the innovation side** of the ISs and respective IEs. This progress includes information on innovation and novels ideas that have/will be achieved during POCITYF towards the TRL advancements of the technologies.
- **The market needs, changes and challenges** that may influence the technologies implementation, innovation and market value during POCITYF as well as the overall project's Objectives.
- **Novel business models** that will arise through the implementation of the innovations.

The project's deliverables are the main source of primary knowledge regarding the demonstrations in LH cities. The deliverables document the progress in LH cities as well as on the horizontal issues. All the POCITYF's deliverables are available on the project's Microsoft Teams repository. There are four main categories of deliverables that can be used as knowledge carriers for the Technical and Innovation Management Team:

- **WP1 deliverables (M9-M30):** These deliverables provide an overview of the POCITYF's solutions.
- **LH cities (WP6 & WP7) deliverables (M24-M60):** These deliverables provide specific knowledge for the POCITYF demonstrations in Evora and Alkmaar. Comparing to WP1 deliverables, these deliverables contain updated and more detailed information.
- **FCs (WP8) deliverables (M36-M60):** These deliverables (i.e. the Replications Plans and City Vision for the POCITYF's five Fellow Cities) present the replicability of the POCITY's solutions in the context of each FC.

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- **Horizontal WPs deliverables (M5-M60):** These deliverables cover horizontal topics, which intersect all technical solutions, such as: Business modelling, financing, IPR management, exploitation, monitoring & evaluation, citizen engagement, communication and dissemination, etc.

In order to follow the technical progress of the POCITYF's integrated Solutions, the Technical and Innovation Management Team participates in the regular calls of WP6 and WP7 where the progress of the implementation in Evora and Alkmaar LH cities is discussed, along with WP1 related calls towards the City Vision Master Plans for LHs and FCs. During these calls, the team provides technical expertise and background for the progress of the work. Moreover, the team participates in the discussions related to deviations to the initial plan and advises the LH Site Manager and the project coordinator on the proposed mitigation actions. The Technical and Innovation Management Team created specific tools to facilitate the data collection and the monitoring process:

POCITYF Demonstrations progress tracker: The LH cities use the tracker to present the current status of their demonstrations. The tracker shows the current phase of each demonstration and also the actual vs planned status. There are four phases in each demonstration:

- **Planning:** Creation of a detailed project plan
- **Developing:** Creation of components that will be deployed as part of the demonstrator (pre-construction)
- **Implementation:** Deployment, installation or construction of the demonstrator (start = "launch of demonstration activities")
- **Monitoring:** The operation phase of the demonstrator (start = "launch of monitoring")

The demonstration tracker is available online as a Google Spreadsheet for the LH cities Site Managers and ETT Task Leaders. A demo screen is presented in ANNEX II – Documents supporting monitoring and coordination. In the first semester, the tracker is preliminary and will be completed/updated accordingly during the project rollout.

Technical and Innovation progress questionnaire: The LH cities and respective local partners use the questionnaire to provide information on the IEs and ICT solutions progress based on the 4 main pillars as described above. The questionnaire has been prepared by the Technical and Innovation management team in order to facilitate the monitoring process and create a homogeneous data collection system. Each local partner responsible for each IE, fills in the questionnaire, which is then consolidated by the LH site manager and the Technical and Innovation management team. The data collected are used in Section 4. A template of the questionnaire can be found in the Annex section (ANNEX II – Documents supporting monitoring and coordination). To complement the data collection, LHs and FCs provide information on regulatory related innovation linked to POCITYF's Objective 10. In the first semester, the questionnaire and data provided in Section 4 are detailed per IE (whenever possible) in order to obtain a detailed description of each technology – an important step for the upcoming phases of the project. In the updated forms of this deliverables, an aggregation of the IEs when relevant, will be performed.

For the monitoring of dissemination and exploitation of POCITYF results, the Technical and Innovation Management Team collaborates with ICONS that leads WP10 Project Communication, Dissemination and Exploitation. D10.1 POCITYF Communication and Dissemination Plan (M4) and D10.15 POCITYF IPR Management and Library of Exploitable Results present the methodologies regarded dissemination and exploitation of results. In Section 3, a brief overview of these activities is presented.

Regarding risks, the technical and innovation management team coordinates with EDPL that leads WP11-T11.2 Quality and Risk Management to ensure that any bottlenecks and major risks which may affect the technical and innovation side of POCITYF will be mitigated efficiently without major effects on the project's impacts. Moreover, the team provides technical guidance towards the mitigation actions. If needed, section

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5 will include major/critical implementation risks and mitigation actions. Identified bottlenecks from the data collection process will be included in the ANNEX of this deliverable.

Market needs and new Business Models emerging. Regarding the potential of the IEs to be widely deployed in the market through sustainable business models while systematically recognizing the changes in the market that impact the wider solutions roll-out, CERTH as the Technical and Innovation Management leader in collaboration with RINA-C, as WP5 leader (acting as well as Business Modelling Manager) as well as with the Exploitation Manager (ICONS) will conduct market research exploring: a) various market sources on industry outlook, b) identify target customers, and c) gather additional data using credible sources (commerce websites, trade journal articles, market surveys, etc.) This market research will be updated twice during the project duration (the first version of the market research is provided therein, while the second version will be provided on M36) and analysis of findings will be shared with the WP5 coordinator, RINA-C, responsible for the Business Modeling of the POCITYF solutions. This envisaged cooperation and coordination of work among the two WPs (i.e. WP2 and WP5) will form the basis upon which the Technical and Innovation Manager will be able to identify the impact of POCITYF towards bringing new products and services to the market and the creation of spin-offs and startups based on innovative business models. This data is reported in Section 6.

Figure 1 depicts the main synergies between the T&I Management team and rest of POCITYF activities.

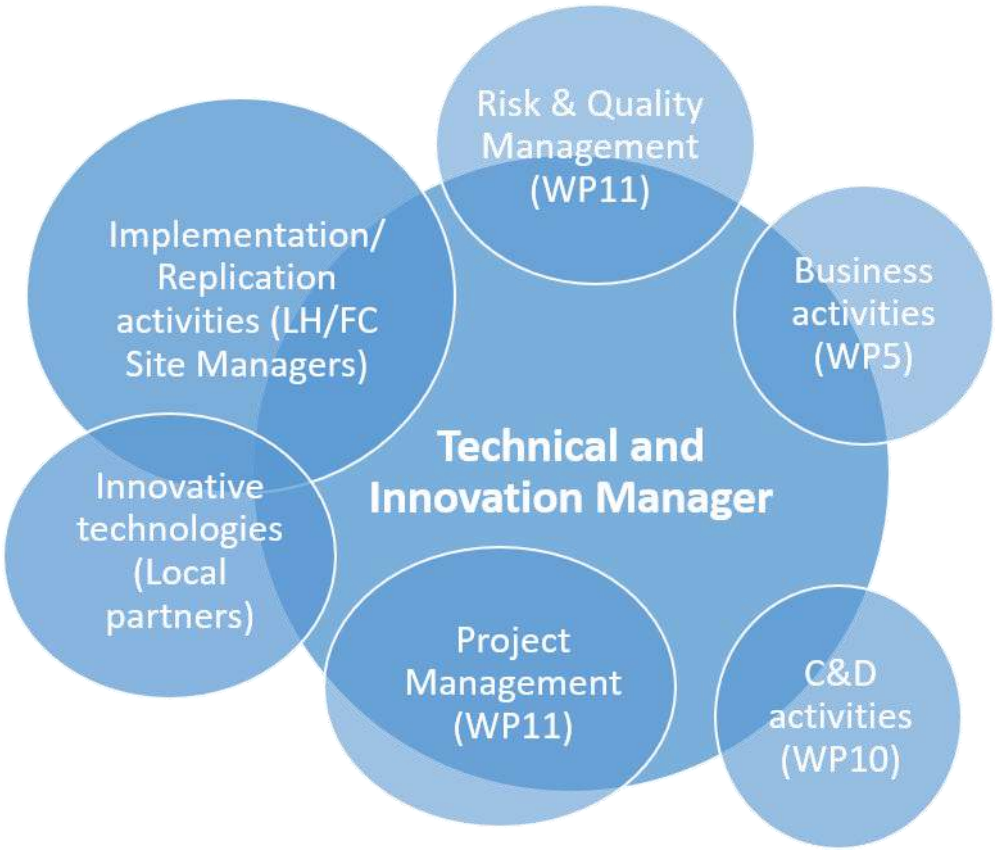

Figure 1 The main synergies between T&I management and POCITYF activities

The Technical and Innovation Management Team presents the technical and innovation progress in every Consortium Plenary Board meeting.

2.2 Actions planned for the upcoming period

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The actions planned for the upcoming period in order to manage and coordinate technical and innovation progress is outlined in Table 1 presenting foreseen actions until M36 when the update of this deliverable is due and upcoming activities will be revisited until M60 when this deliverable will be finalized.

Table 1 Upcoming activities for managing POCITYF technical and innovation progress

Upcoming activity (till M36)	Participant	Details
Participation and collaboration with other related WPs	CERTH, RINA-C, ICONS	• Participate and contribute in the discussions for the WP1 deliverables that will provide the technical details and the overview of implementation of the IEs • Participate and contribute in the discussions for the WP6 & WP7 deliverables that will provide the implementation details of the IEs • Participate, contribute in the discussions and exchange information with the WP5 coordinator of deliverables that will provide the business modelling details for the wide scale roll-out of the ISs. • Participate in horizonal deliverables that intersect financing, IPR management, monitoring and evaluation, exploitation and communication and dissemination aspects.
Organization and Coordination of Technical & Innovation Board meetings	CERTH, RINA-C, ICONS, Demonstration Coordinator, ETT leaders (with technology providers if required)	• CERTH will organize 5 Technical & Innovation Board Meetings to discuss the technical innovations implementation and discuss potential critical issues that may arise during the design and the implementation of the IEs. The meetings will be part of the CPB physical meetings (M9, M15, M21, M27, M33).
Demonstration Progress Tracker	LH Managers, CERTH	• The two LH Managers will complete the first version of the Demonstration Progress Tracker on Ongoing activity starting in M12. CERTH will analyze and report the results while it will participate in any discussions for designing potential mitigation actions in the occurrence of a risk.
Technical and Innovation progress questionnaire	CERTH, LH Managers, RINA-C, ICONS	• The two LH Managers with the cooperation of local ecosystems partners will be completing the Technical and Innovation progress questionnaire on M34 and results will be reported on the next version of this deliverable (M36).

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3 Communication and Dissemination of Technical Results (1st semester)

POCITYF aims to achieve broad acceptance of its results among citizens and stakeholders, increasing awareness and fostering the uptake of the demonstrated solutions. To this respect, the widespread dissemination of the project outcomes at EU/international and local levels is an imperative aspect for completing this goal.

POCITYF will demonstrate its full potential impact by promoting the dissemination of its outcomes towards different target groups and potential adopters of the demonstrated solutions at different EU geographical areas. In close collaboration with communication and dissemination actions, the development of an overall roadmap to the market for the project results will receive attention from early on taking into account partners' business models and their plans to support the uptake of POCITYF model, as a standard approach for an integrated and sustainable urban regeneration. The exploitation and dissemination activities delivered by the POCITYF consortium are structured in such a way as to make the project outcomes scalable, exploitable and replicable. Follow-on activities and supporting actions are to be planned to secure the uptake and impact potential of the POCITYF solutions towards this objective.

A detailed analysis of the communication, dissemination and exploitation strategy towards the achievement of POCITYF desired impacts is the objective of WP10 – Project Communication, Dissemination and Exploitation. Therein, the implementation of the C&D strategy will lead to the identification and mapping of exploitable results (T10.5) and the strategic plan for exploitation fostering replicability beyond LHs and FC cities and assuring the post-project sustainability. The Communication and Dissemination (C&D) Plan represents the first milestone governing the overall POCITYF internal and external C&D activities. It identifies the C&D management structure and the key elements of the C&D strategy, which include the targeted audiences (WHO), the key messages to be conveyed (WHAT), the tools and channels employed (HOW) and the timing of the planned activities (WHEN), the geographical level (local, European) (WHERE) providing a guide for the project's and partners' dissemination activities.

In this document, as part of the technical and innovation management, the C&D activities relevant to the scientific and technical level of the project are summarized. The reader may refer to WP10 related deliverables for a complete picture of the C&D planning and exploitation results.

The general instructions for handling dissemination activities and open access of information are settled under Section 3 (Rights and obligations related to background and results)/Article 29 of the consortium agreement (CA, No 864400). In summary, the most important aspects relevant to the T&I management are:

Obligation to disseminate results
Unless it goes against their legitimate interests, each beneficiary must — as soon as possible — 'disseminate' its results by disclosing them to the public by appropriate means (other than those resulting from protecting or exploiting the results), including in scientific publications (in any medium).

Open access to scientific publications
Each beneficiary must ensure open access (free of charge online access for any user) to all peer-reviewed scientific publications relating to its results.

Open access to research data
Regarding the digital research data generated in the action ('data'), the beneficiaries must: deposit in a research data repository and take measures to make it possible for third parties to access, mine, exploit, reproduce and disseminate — free of charge for any user the data needed to validate the results of scientific

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publications and other data as specified and within the deadlines laid down in the 'data management plan' (see Annex 1 of CA, No 864400);

Table 2 summarizes the dissemination and communication activities performed or planned at the current stage of the project. The table is not an exhaustive list as it contains only activities relevant to T&I progress and it is to be updated accordingly during the project.

Table 2 Dissemination and communication activities related to Technical/Innovation side of POCITYF

Type of D&C activities	Participant	Details
Organization of a workshop	EDPL	Workshop during SSPCRS December 2019. Partners that attended: EDPL, ICONS, RINA, TNO.
Exhibition	Ubiwhere	Presentation of POCITYF smart solutions with the partner companies, public authorities and research institutions from ERTICO - ITS Europe on a visit to Silicon Valley and the Consumer Electronics Show CES, in Las Vegas (USA) in January 2020
Participation to a conference	EDPL (José Miguel Costa)	Presentation of POCITYF during the Demi talks on December 9th 2019
Participation to a workshop	EDPL (José Miguel Costa)	Presentation of POCITYF during the final workshop of the FIRST project on December the 17th February 2020
	EDPL	Presentation of POCITYF during the EERA NET Smart Cities workshop in Bolzano, Italy
	TNO (Joke Kort)	Workshop organized by the SMILE project https://newenergycoalition.org/events/workshop-verduurzamen-van-eilanden-op-texel/
Organization of Webinar	CERTH (with IRIS)	Webinar on numerical software tools for smart cities projects in December 2019
Other	TNO (Joke Kort)	Presentation of POCITYF during the BRIDGE General Assembly in February 2020

Scientific Publications

No scientific publications have been published in the first semester. The list of scientific publications will be updated accordingly during the project.

Intellectual property rights resulting from technical and innovation side of project

Over the next period of project implementation, technical innovations to be produced during POCITYF (e.g. company know-how, patents, licensing, scientific publications) will require adequate and just handling and protection of IPR. Although the IPR Management will be addressed in detail in WP10, since this is an issue of great significance also for innovation assurance, the general principles-guidelines for handling Knowledge and Intellectual Property Rights are summarized below and they are settled in the consortium agreement (CA, No 864400) and especially Section 3 (Rights and obligations related to background and results) and Section 4 (Other rights and obligations). These principles are in line with H2020 Intellectual Property Rights recommendations.

Ownership: Each participant will own the foreground it generates.

Joint ownership: When the foreground is generated jointly, participants will have to reach an agreement.

Protection use and dissemination: Results capable of an industrial or commercial application must be protected, taking into account legitimate interests. Prior notice of dissemination must be given to other

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participants (not to EC, unless no protection, in which case the latter may request to protect on its own behalf). Any dissemination must indicate the Community financial assistance.

Access right: Partners may define the background needed in any manner and may exclude specific background. It is possible to grant exclusive licenses to background and foreground if the other partners waive their access rights and depending on previous agreements. Partners may agree to additional or more favorable access rights than those provided for in the consortium agreement. At this stage, partners agreed on open access publishing. However, in the future, partners may also opt for gold or green access to peer-reviewed scientific publications.

Management of knowledge in POCITYF: A process of knowledge management will be implemented. This process will provide the consolidation of the knowledge spiral, enable co-operation and will allow for the creation of new knowledge. The process is divided into different steps: First of all, the information will be gathered and shaped. After that, it will be indexed in order to be correctly disseminated. This will be followed by an appropriation period, which provides for the creation of new knowledge. Some tools will be set up to support social interactions, knowledge processing (files will be organized thanks to semantic links, to facilitate future searches) and intelligent distribution of knowledge (push and pull actions to optimize the distribution of knowledge). The current Deliverable D11.7 (to be updated on M36, M60) is a first good start for gathering and consolidating information that can serve as the basis for the creation of new knowledge to be derived from technical results and relevant innovations.

The POCITYF IPR strategy: The IPR strategy and the exploitation management is handled in the CA, as well as in the T10.5. The IPR strategy of the project is an important part of the project exploitation plan. During the project meetings, the internal results will be reviewed to identify important ideas and define an individual strategy for the positioning of these ideas in the standardization and commercialization processes. IPRs will be managed in accordance with general EC policies and consortium agreement concerning ownership, exploitation rights, confidentiality, commercial utilization of results, availability of the information and deliverables to other EU funded projects and disclaiming rules.

No intellectual property rights have been applied for and protected in the first semester.

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4 Technical and Innovation Progress (1st semester)

The monitoring of the technical and innovation progress of the POCITYF integrated solutions includes not only the purely technical evolution and related novelties but also the monitoring of the continuously evolving market needs in order to appropriately align the main innovations of the project with the continuous market changes and challenges occurred during the implementation of the project. Thus, the work reported in this section presents the baseline (and will report the subsequent progress) of the POCITYF planned innovations to be implemented and monitored during the project. The information is structured along 3 main pillars:

Pillar 1: Report the progress on the innovation side of the ISs and the respective IEs. This progress report includes information and presents the progress on innovation and novel ideas that have/will be achieved during POCITYF towards the TRL advancements of the technologies. In the 1st semester report, this progress mainly concerns updated information on the innovative elements and the justification of the TRL advancement to be achieved throughout the project's duration.

Pillar 2: Identify the market needs, changes and challenges that may influence the technologies implementation, innovation and market value during POCITYF as well as the overall project's Objectives. In the 1st semester report, this information includes mainly envisioned changes and challenges.

Pillar 3: Describe novel business models that may and should arise because of the demonstration of innovative solutions. Within this 1st semester report, such envisioned business models are indicative of the business-related innovation that will be achieved in POCITYF.

As the technical and innovation management should always have in mind the timely and accurate achievement of POCITYF's main Objectives, the progress reporting is structured under the 5 (out of a total of 10) Project Objectives which are directly linked with the technical/innovation side of the project. Under each Objective subsection, a short description is provided. For Objectives 1-5, the three main pillars as mentioned above are detailed in table formats while for Objective 10, the regulatory related innovation is also reported in a table format. Finally, for Objectives 1-3 and 5, the reporting is structured by IS as these objectives are aligned with ETT#1-4.

The information presented below has been gathered by the technology providers and consolidated by the T&I management team as described in Section 2. In the cases where this was not possible (due to lack of information provided or speculative/uncertain data in this early stage), information has been extracted from the GA and proposal stage of POCITYF as well as from other credible sources for identifying market needs. Envisioned business models integrate knowledge from previous Smart City Projects along with the information provided by the local technology providers whenever this data was available. Risks and bottlenecks (see also Section 5 and ANNEX III) might influence the information currently provided. The information is thus to be further consolidated and updated during the following months and at this stage it should be considered preliminary to a large extent.

4.1 Progress related to Project Objective #1

Objective 1: Demonstrate solutions at building and district level that enable the increase of energy self-consumption, energy savings and high share of locally produced renewable energy – leading to energy positive districts, located in mixed use urban districts including that of cultural heritage ones.

POCITYF will demonstrate innovative and near to market technologies (TRL≥6), tools and methods identified in ETT#1 repository of solutions to enable major energy savings and the optimization and dynamic operation of RES harvesting solutions in both new and near-zero/positive retrofit buildings and districts of mixed use.

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Most of those solutions have already been pre-piloted. POCITYF aspires to deliver greener, less energy-intensive from a life cycle perspective, multi-functional and easily applicable building-oriented solutions. These technologies will be combined and integrated to form hybrid retrofitting solutions for buildings (matching RES and if necessary, fossil-based energy sources), while being flexible enough to support all three energy vectors (electricity, heating, cooling) operation. Waste streams originating from different sources will be utilized for local energy production, applying circular economy principles. Profiling extraction techniques will be used to design a smart, optimized operation network, which will be demonstrated with the support of IoT solutions. POCITYF solutions will be realized and will be demonstrated in a series of mixed-used urban districts, capitalizing on the know-how from the pre-pilots in the two (2) LHs cities, while transferring the know how to other EU (FCs and beyond them) cities.

Objective 1 is aligned with the activities under POCITYF Energy Transition Track #1: Innovative Solutions for Positive Energy (CH) Buildings and Districts. ETT#1 encompasses 3 Integrated Solutions (IS): IS-1.1 deals with Positive Energy (stand-alone) Buildings. IS-1.2 deals with Positive Energy Districts Retrofitting while IS-1.3 deals with Feeding of PEDs with Waste Streams (heat/materials) promoting Symbiosis and Circular Economy.

Tables 2-35, report on the three main pillars as described in the beginning of Section 4. As various innovative elements fall into multiple Objectives (or ETTs), duplication of information is avoided by pointing out the specific Obj. and IS where this IE has been detailed. The progress reporting is structured per Integrated Solution.

4.1.1 Integrated Solution 1.1: Positive Energy (stand-alone) Buildings

POCITYF will demonstrate different technologies on a building level (at first level), capable of producing excess amounts of energy for heating and cooling along with electricity (**Positive Energy Buildings**), which can be redistributed to the interconnected networks. Alkmaar city has a considerable know-how on respective technologies, allowing Evora and FCs to build upon success stories and replicate them in their territories. Evora citizens and local authorities, by its side, face a set of legal and regulatory constraints in what concerns the deployment of solutions that would impact the façades of historical buildings, classified as UNESCO World Heritage Sites. Nevertheless, this challenge can be counterbalanced by the huge potential that this area has in terms of PV generation and the panoply of previous projects that already have endowed Evora with an advanced smart grid, awarding the city with the title of first Iberian Smart Grid City.

The innovative elements which for the IS-1.1 are listed below while the following tables contain the progress relative to the three main pillars as described in the introduction of Section 4.

IS-1.1: Positive Energy (stand-alone) Buildings (PV glass // PV canopy // PV skylight // Tegosolar PV // Traditional PV shingle // Bidirectional smart inverters // Energy router // BMS // 2nd life residential batteries // HEMS/BEMS // Positive Computing Data Centre // Insulation with circular materials // Triple glazing // Solar roofs and facades // Thermo acoustic heat pumps // Hybrid wind/solar generation system (Powernest) // Li-ion batteries // Cascaded heat pumps // Composite façade panels // PCM in the floor)

Table 3 Technical and Innovation Progress for IS-1.1

Innovative Element (IE) #	1.1.1	Description/Title	PV Glass
Innovative aspects of the IE:			
The specific IE refers to the adaptation and demonstration of aesthetically and fully customized advanced BIPV glass-glass according to the typology of the building and needs based on c-Si and a-Si technologies. This is a highly innovative system due to its multifunctional character, since it provides energy generation, lets natural light in, provides thermal and sound insulation, filters 99% of harmful UV radiation and up to 95% IR radiation. Crystalline silicon glass features more power installed per SqFt in comparison to amorphous silicon glass. This means that under direct sunlight crystalline silicon glass can yield twice as			

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much energy as amorphous silicon glass. This PV glass technology is suitable for those buildings and facilities with good solar orientation which seek maximum energy output. Crystalline silicon PV glass is the most suitable material to be used on canopy and skylight applications, spandrel glass, solid walls and guardrails. Crystalline silicon glass can be easily customized, especially in terms of shape, even trapezoids can be fabricated without difficulty using this technology. The a-Si technology PV glass produces more power than crystalline silicon glass in overcast weather and high temperatures and it can offer different visible light transmittance levels, up to 30%.

Advancement of TRL levels (TRL7→8):

Relevant system prototypes have already been demonstrated in operational environment (e.g. under the H2020 PVSITES project in terms of aesthetics, flexibility in design, cost-effectiveness, high performance, reliability and compliance with standards of a-Si PV glass) (TRL7). During POCITYF, this IE will be customized according to the typology of the demonstration buildings (in terms of shape, color, size, thickness, and semi-transparency degrees), resulting in a complete and qualified system – also addressing cultural heritage buildings' needs (TRL8).

Innovative Element (IE) #	**1.1.2**	**Description/Title**	**PV Canopy**

Innovative aspects of the IE:

The specific IE refers to a photovoltaic canopy which offers renewable energy generation, sun protection and shelter in accordance with building codes and architectural designs, making it fitted for historical areas. Depending on the type of canopy, the electricity yielded can be consumed in different ways: self-consumption for surrounding buildings, courtesy lighting, ad-box illumination, back-up systems, charging point for EVs, as well as injection to the grid. Design options are almost unlimited: one, two or multiple slopes, different tilts and orientations, multiple glass design options (silk-screening, ceramic frits, colors, etc.). PV glass on canopies can be supported using a variety of structural systems, including point-supported systems, U channels and skylight-like structures. Crystalline silicon PV glass is the most suitable material to be used on canopy.

Advancement of TRL levels (TRL6→7):

Relevant system prototypes have already been demonstrated in operational environment (e.g. PV canopy solution based on c-Si PV glass was piloted under R2CITIES project (FP7), where the energy generated by the PV glass installed in the canopy is used to satisfy the needs of the charging point for EVs; or PV canopy solution based on c-Si technology and transparent fiber reinforced composite material as innovative module manufacturing technology piloted under PVCOM project (Eurostars) (TRL6). During POCITYF, this IE will be designed and customized according to the building codes and architectural designs, making it fitted for historical areas (TRL 7).

Innovative Element (IE) #	**1.1.3**	**Description/Title**	**PV Skylight**

Innovative aspects of the IE:

The specific IE refers to a photovoltaic skylight which generates clean and free energy at the same time that it provides bioclimatic properties of thermal comfort to the building. It has an optimized solar filter, which absorbs almost all of the ultraviolet and infrared rays, which are harmful to the occupants of the building. The air chamber of the insulating glass guarantees a better thermal performance inside the building. The advantages mentioned above help to reduce considerably the CO2 and other greenhouse gas emissions, which significantly reduces the carbon footprint of buildings. Both, crystalline silicon or amorphous silicon PV glass can be used depending on the building needs.

Advancement of TRL levels (TRL6→7):

The specific technology has already been demonstrated in historical buildings/areas such as Bejar historic market, Alzira town hall – Spain; Le Petit Echo de la mode - France, having obtained reductions of buildings' energy grid-consumption up to 40%, generating power at only 0.015 €/kWh (TRL6). During POCITYF, this IE will be designed and customized according to the building codes and architectural designs, making it fitted for historical areas. Since each project is different and depends on the combination of a customized PV glass and tailored fixing system, which can be the one already existing or a new one, depending on the characteristics, the starting TRL is 6 and will be advanced to achieve TRL7.

Innovative Element (IE) #	**1.1.4**	**Description/Title**	**Tegosolar PV**

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

Innovative aspects of the IE:

Tegosolar PV is a novel roofing system that uses the technology of thin-film triple-junction amorphous silicon to produce electricity from renewable sources. Its flexibility and lightness make Tegosolar PV an ideal solution for any type of roof, with the possibility of installation on pitch roof from 5° to 60°, offering waterproofing guarantee and it's a very light roofing element.

Advancement of TRL levels (TRL7→8):

Tegola Canadese have tested prototypes of this system in several locations-typical buildings around the world (TRL7). During POCITYF, Tegosolar PV will be advanced: a) an increase of energy efficiency from 16 to 14m^2 per kWp; b) unit surface of a module will pass from 2.15m^2 to 1.96m^2; c) junction box will be improved with water tightness and anti-release connector thus increasing safety and energy efficiency of the roof; d) corners of the PV module will be more protected due to roundage of the plastic covering finishing on the border area, resulting in a complete and qualified system that can serve the needs of old-historical buildings (TRL8).

Innovative Element (IE) #	**1.1.5**	**Description/Title**	**Traditional PV Shingle**

Innovative aspects of the IE:

Traditional PV shingle is a PV roofing shingle which allows to use PV modules in traditional roofs with a high degree of integration. It combines the functionality of a tile in clay with modern photovoltaic technology, maintaining the appearance of the building almost unchanged. Thermal inertial properties typical of terracotta are not modified or altered and installation method does not require tubs and/or fixing brackets, reducing to zero all problems related to infiltrations and thermal bridges.

Advancement of TRL levels (TRL6→7):

This technology has been validated and demonstrated in typical buildings (TRL6). During POCITYF the traditional PV shingle will go beyond the innovation of Tegosolar PV, by developing a more efficient module – system prototype, passing from 18-20 m2/kWp to 12-15, with an aesthetic shape that will reproduce the shape of the roof in which application is forecasted. An increase of the ventilation channel between the PV module and the bent tile will make the system less sensitive to high summer temperatures (lower temperatures imply greater yield). The cables will be also optimized, aiming to improve installation speed by 20%. Different colored cells will be deployed, depending on the demonstration building, rendering PV shingle a suitable solution for old-historical buildings (TRL7).

Innovative Element (IE) #	**1.1.6**	**Description/Title**	**Bidirectional Smart Inverters**

Innovative aspects of the IE:

The specific IE refers to the adaptation and demonstration of innovative bidirectional smart inverters with storage and PV integration. With the coordinated operation of both resources, the self-consumption on a typical house can be drastically improved and a significant amount of flexibility is added to the LV network. The key innovative aspects of this IE include a) improved flexibility and controllability of multiple sources using a single equipment; b) rich user interface (stand-alone or using HEMS platform); c) intelligent techniques to optimize yield and self-consumption.

Advancement of TRL levels (TRL6→7):

The initial versions of the bidirectional smart inverters were installed in several domestic buildings in Caldas da Rainha, Alcochete, Graça do Divor and Valverde (both part of Evora district) within the InteGrid, SENSIBLE and SuSTAINABLE projects (TRL6), having achieved up to 47% improvement regarding RES cut-off due to network congestion and an integration of up to 80% of PV generation. During POCITYF, this IE will be demonstrated under different setups (performing hardware and/or firmware optimizations, extensive testing and pre-certification when applicable)) and in mixed use buildings leading to universal system prototype (TRL7).

Innovative Element (IE) #	**1.1.7**	**Description/Title**	**Energy Router**

Innovative aspects of the IE:

The Energy Router will be able to fully integrate energy components (renewable production, storage, grid and home connection) and optimally managing the energy flux between them. The Energy Router, due to

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its Power Electronics Building Blocks (PEBB) modular design and to its control openness and interoperability capabilities, will implement, in a seamless way, the foreseen associated POCITYF services.

Advancement of TRL levels (TRL6→7):

The specific technology has been demonstrated in the H2020 NOBELGRID and Storage4Grid projects (TRL6), with very promising results regarding its effectiveness in managing the energy flux, leading to 20% improvement in the self-consumption ratios of the pilot buildings. During POCITYF the energy router will be upgraded with IGBT power devices, AC and DC inductors, grid transformer and control components which besides their intra-building energy management capabilities, will also allow for their interconnection at district-level. During POCITYF the Energy Router will reach TRL 7, by enhancing the digital services and controls which are necessary for specific smart cities and positive energy blocks operations tailored for the POCITYF project portfolio. This prototype will be demonstrated in operational environment – within PEBs (TRL7).

Innovative Element (IE) #	**1.1.8**	**Description/Title**	**Building Management System (BMS)**

Innovative aspects of the IE:

Building Management Systems, are fundamental pieces of a building technological infrastructures, as they act as central or distributed controllers of the different systems (HVAC, natural and artificial lighting, special system etc.). The specific IE refers to the adaptation and demonstration of advanced Building Management System (BMS) in buildings enabling real time monitoring and management of HVAC, lighting, energy consumption/production and/or other systems. IP-enabled hardware and software address the entire building ecosystem, with easy integration of devices and cloud services, delivering the performance and data-throughput needed for small and medium buildings. The goal of the BMS system in Evora will be to make the buildings of the city more sustainable, by reducing the energy consumption, while optimizing indoor comfort for occupants.

Advancement of TRL levels (TRL7→8):

Several projects were already carried out by Schneider Electric, in particular for historical buildings, having achieved up to 30% of energy savings (TRL7). During POCITYF the BMS will be adapted to a variety of building typologies and needs, test benched and demonstrated leading to a complete and qualified system (TRL8). The goal is to create a solution which is especially fitting the retrofitting of historical buildings (therefore with characteristics of lower invasivity, by wireless or more flexible solutions).

Innovative Element (IE) #	**1.1.9**	**Description/Title**	**2nd Life Residential Batteries**

Innovative aspects of the IE:

2nd life residential and multipurpose batteries (batteries) to be demonstrated during POCITYF, is a modular and mobile battery system that re-uses Li-Ion battery modules coming from EVs, extending the productive life of EV battery modules through the residential application by another 5-7 years. Each batteries system can store up to 12 kWh of energy, offers fast charging capability and can flexibly deliver up to 5 kW of electric AC as well as DC power. batteries are modular in configuration to be stacked horizontally or vertically and can charged by a variety of energy sources (solar, wind, hydro, grid). Smart electronics including Wi-fi and GPS enables batteries systems to be remotely monitored and controlled through an IoT platform. Rugged and waterproof, batteries offer solutions for e-mobility, off-grid productive use and on-grid backup power. Betteries mission is to make affordable energy storage based on 2nd life Electric Vehicle (EV) Li-Ion battery modules available for emerging markets and developed economies. The goal is to re-purpose (re-manufacture and re-package) used 1st life EV batteries in smaller standardized and modular DC battery units, paired with application specific interface modules (AC and DC) to provide a fast, affordable, flexible, scalable and smart access to renewable grid and off-grid power for multiple use cases in the following target market segments: Small Businesses, Residential Storage, Farming & Fishing, Mobility, Disaster Relief, Tourism, Leisure.

Advancement of TRL levels (TRL6→7/8):

Regarding 2nd life residential batteries, it has been tested in laboratory and field conditions (TRL6). Betteries prototype hardware has been tested in the field to provide light electric mobility, mobile power to small events for several productive use cases. Betteries participates since 2017 in a Siemens Stiftung (Siemens foundation) led project to deliver clean energy solutions to fishermen at Lake Victoria, Kenya.

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Main focus of the project is to replace highly inefficient, unreliable and environmental unfriendly ICE engines with electric propulsion systems to power the fishing boats at the lake (50.000 boats in total). As such powered mock-ups and prototype hardware have been tested in 2018 in this harsh environment. In the POCITYF project, the system will be tested and demonstrated in the operational environment as well for residential storage use case as well as in a disaster relief use-case and as modular, mobile and multipurpose battery centrally charge by PV and used on a construction site. Furthermore, certification tests will be done during this project, which will bring this IE to a TRL7/8.

Innovative Element (IE) #	**1.1.10**	**Description/Title**	**HEMS/BEMS**

Innovative aspects of the IE:

(Evora): POCITYF will adapt and demonstrate an innovative Home Energy Management System, serving as the central intelligence node for future-proof buildings, that is able to forecast the local energy production and detect the consumption profile to establish the optimal building operation considering energy usage and comfort preferences. The key innovative aspects of this IE include: a) improved flexibility and controllability of residential and commercial buildings; b) rich user interface and user experience for increasingly demanding users; c) intelligent techniques to optimize energy usage and cost; d) provide added-value services for electric grid.

(Alkmaar): POCITYF will adapt and demonstrate an innovative HEMS/BEMS offering monitoring and control within buildings to increase awareness, reducing waste and increasing comfort. Through a self-learning system, the building is continuously becoming smarter. Estimated reduction on heating costs is 10 – 15%.

Advancement of TRL levels (TRL6/7→7/8):

(Evora: TRL6→7): Relevant HEMS have been tested in laboratory and pre-field conditions to replicate the operating conditions likely to be found in different residential buildings (TRL6). The initial versions of these HEMS were installed in several domestic buildings in Caldas da Rainha, Alcochete and Valverde (part of Evora district) within the H2020 InteGrid project. During POCITYF a system prototype will be finalized (being able to control various assets introduced in demo buildings such as stationary batteries performing hardware and/or firmware optimizations, extensive testing and pre-certification when applicable) and demonstrated in operational environment (TRL7).

(Alkmaar: TRL7→8): Relevant HEMS/BEMS have been included in 130 pilot houses of Alliander's "City of the sun" project. NEROA has created a HEMS in the MeppelEnergie pilot, in which 120 pilot houses were equipped with an energy management system connected to a broader neighborhood-wide system (TRL7). During POCITYF a system prototype will be developed (being able to control various assets introduced in demo buildings such as stationary batteries) and demonstrated in operational environment, leading to a complete and qualified system (TRL8).

Innovative Element (IE) #	**1.1.11**	**Description/Title**	**Positive Computing Data Centre**

Innovative aspects of the IE:

Datacenter energy consumption are based on heterogeneous behaviors from customer's equipment, computational usage profiles, facilities efficiency and external weather conditions. Based on data collection and analytics innovative methodologies, processes and equipment are to be installed to improve PUE results (PUE is the ratio of total amount of energy used by a computer data center facility to the energy delivered to computing equipment). Multidimensional real-time analysis needs to be in-place to allow corrections to computational and thermal conditions that influence energy consumption. Based on the European Code of Conduct for Data Centers adaptive measures and innovative solutions will be experimented in a controlled manner, with deep risk-analysis. Regarding energy production and new energy production plant multiple sources of energy must be integrated (grid, autonomous and local community-based) applying deep demand-offer analysis to increase efficiency. POCITYF will improve datacenter efficiency by reducing the PUE and increasing local production.

Advancement of TRL levels (TRL7→8):

DECSIS has already tested system prototypes in operational environment (TRL7). During POCITYF the system will be upgraded with cloud computing and storage capabilities to be tested through demonstration. Many technologies and processes already in place are to be tested, optimized and applied in the Datacenter operations transforming energy related efficiency to a new level of management.

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Positive computing will benefit from integrated actions to reduce global energy consumption for each computing unit (PUE 1.45→PUE 1.25) and to integrate data center energy requirements in a local cluster of energy block, source diversification and resilience. The actions that DECSIS will implement respecting strictly follow the data center certifications (ISO20000 and ISO27001) and high resilience requirements (TIER3/4), as well the most relevant initiatives, such as the European Code of Conduct for Data Centre Energy Efficiency, leading to a complete and qualified system (TRL8).

Innovative Element (IE) #	**1.1.12**	**Description/Title**	**Insulation with Circular Materials**

Innovative aspects of the IE:

During POCITYF, state-of-the-art insulation including circular materials such as flax, linseed and with very high insulation properties (Rc>6-7 and Rc=8 in the roof) will be implemented in various buildings to be renovated in a prefab construction process.

Advancement of TRL levels (TRL7→9):

The use of insulation material based on circular raw materials is increasingly gaining ground. The housing companies of Alkmaar ecosystem (Woonwaard and Van Alckmaer) have significant experience with state-of-the-art circular materials for insulation when renovating their property towards NZEB. Circular/green materials such as flax, linseed and hemp and their properties have been researched extensively in a lab environment at Inholland University (TRL7), but their use is not yet commonplace. During POCITYF these novel systems will be proven in realistic and operational environment (actual wide-scale renovation works) whereas outcomes from this process will serve as the basis for the housing companies to roll-out replication (TRL9), offering a suitable and sustainable alternative to conventional insulation materials.

Innovative Element (IE) #	**1.1.13**	**Description/Title**	**Triple Glazing**

Innovative aspects of the IE:

Triple glazing with a low solar entry factor (G-value) is an already complete system (TRL8). In the case of POCITYF, a special seam and crack seal will be used in the window frames to minimize the infiltration of cold air by 80% in comparison with the standard values (NEN 2686).

Advancement of TRL levels (TRL8→9):

Duurzaam Bouwloket has installed triple glazing with a low ZTA and extra seam and crack sealing (SK12 system Schipper Kozijnen) in the Building "The Future", whereas during POCITYF this system will be proven in both commercial and residential buildings (TRL9). During the use of the demo buildings, the impact of this IE will be measured, and the positive effects will be disseminated to residents and professionals.

Innovative Element (IE) #	**1.1.14**	**Description/Title**	**Solar Roofs and Facades**

Innovative aspects of the IE:

Solar panels at buildings are mainly installed on pitched roofs and flat roofs. Because apartment buildings have a relatively small roof area in relation to the number of households, the capacity of solar energy (which is of course directly related to the amount of roof surface) will therefore be not that high. Facades of housing buildings also offer space for installing vertical solar panels. Due to required architectural changes in the appearance of buildings, this is not yet widely used. The specific IE refers to the local production of electricity with (collective) solar roofs and integrated PV elements in roofs (TRL7→8); local production of electricity with vertical solar façades with building integrated PV (TRL6→7) and glass/glass PV panels on the façade (TRL8→9).

Advancement of TRL levels (TRL6-8→7-9):

(Solar roofs: TRL7→8 // Vertical solar panels (facades): TRL6→7 // Glass/glass PV panels (facade): TRL8→9): Alkmaar Energie, a local energy cooperation subsidized by the municipality and the province of Noord Holland, has experience with collective Solar roofs and a relevant system is currently operating at an apartment building at de Gedempte Nieuwesloot in the city-center of Alkmaar with a capacity of 75 kW (350 solar panels) and a coverage area of 700 m^2. Consortium partner HVC has currently more than 10MW of solar roofs in operation. Another goal is to use the experience with solar façade panels and especially solar panels mounted in a vertical position. When applying this kind of panels aesthetic aspects are more important than for solar panels on rooftops. Alliander has participated in the project 'The Circle', in which all black façade solar panels (500 m^2) have been installed (2017) leading to energy savings up to 80,000 kW/y. Another good relevant example is the project 'The Future' (Duurzaam Bouwloket was a participant)

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– Houthaven Amsterdam where every facade has solar panels installed (2018) with a capacity of 220 kWp (450 m^2) leading to energy savings up to 185.000 kWh/year. During POCITYF, all these systems will be adapted to the demo-building's needs and will be proven in operational environment through extensive monitoring of their performance (TRL7-9 – advancement varies depending on the applied technology).

Innovative Element (IE) #	**1.1.15**	**Description/Title**	**Thermo Acoustic Heat Pumps**

Innovative aspects of the IE:

Electrical driven thermo-acoustic heat pumps are closed systems that are filled with Helium under pressure. Electrical driven drivers send an acoustic wave through the pump. At the point where Helium is compressed, heat is exchanged by a heat exchanger. At the point where the helium is expanded, heat from the source is added using a second heat exchanger. Between the two heat exchangers, a regenerator is placed. Within the regenerator, a thermal cycle arises. In this way, the regenerator creates a temperature difference or a so-called thermal pump or heat pump. The heat exchangers are connected to either the source or heatsink, depending on the demand of the consumer.

Advancement of TRL levels (TRL6→7):

Innovative thermo acoustic heat pumps, from Blue Heart Energy have been pre-piloted in the IDEA incubator (part of Inholland) (TRL6). During POCITYF this system will be adapted to act both as booster and as part of an integrated hybrid heating/cooling system (e.g. though its connection to the HEATmatcher) and be demonstrated in actual operational environment (TRL7).

Innovative Element (IE) #	**1.1.16**	**Description/Title**	**Hybrid wind/solar generation system (Powernest)**

Innovative aspects of the IE:

The Powernest is an innovative combination of urban wind and solar production system that can be installed on top of high-rises (buildings with many floors). The installation uses the natural strong airflow by wind over high-rise buildings to generate wind energy and combines this wind energy with solar PV energy. The façade of the high-rise building will push the wind over de roof of the building into the wind turbine. The installation generates a more constant energy production. At night, when there is no solar energy, the wind turbines provide energy. At days without any wind, the solar panels will produce solar energy.

Advancement of TRL levels (TRL7→8):

The Powernest system (version 1.0) has been installed at Eemshaven in an industrial area in the Netherlands and in Utrecht on a similar to the Alkmaar demo-site building (also 10 stories high) in 2017 (TRL7). The system produces 162,000 kWh/year of renewable energy per year covering 70% of the building's energy needs. During POCITYF this system will be upgraded (version 2.0) and demonstrated in a high-rise residential apartment complex. Additionally, it will be connected to its novel energy management system and control system (HEATmatcher) to match supply and demand, enabling the fine-tuning of the system (TRL8).

Innovative Element (IE) #	**1.1.17**	**Description/Title**	**Li-ion Batteries**

Innovative aspects of the IE:

Electrical storage in dwellings with Li-ion batteries is an already complete and qualified system (TRL8). POCITYF will generate a large capacity of electricity. To minimize the peaks on the grid, innovative control technology will be used for the heat pumps and heat buffering. However, this will not be sufficient to be able to dispose of the surplus electricity within the own building, so battery storage will be used in the project. In this way, energy can be exchanged with the environment for transport and other purposes, but also with the apartments within the building, as these are partly carried out with direct current networks.

Advancement of TRL levels (TRL8→9):

Electrical storage solutions in dwellings have been pre-piloted in the 'Stad Van De Zon' (Sun City) pilot in Heerhugowaard (7 km from the Westrand demo site). 35 out of 500 of the NZEB were fitted with Li-ion energy storage, micro CHP's, heat pumps and smart appliances (e.g. washing machines). During POCITYF, these storage systems will be adapted to the demo-buildings needs based on USEF (Universal Smart Energy Framework) and will be proven in operational environment under different set-ups (interconnection with BEMS/HEATmatcher) through extensive monitoring of their performance (TRL9).

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Innovative Element (IE) #	1.1.18	Description/Title	Cascaded Heat Pumps
Innovative aspects of the IE:			
POCITYF will apply a novel concept according to which cascades of small heat pumps will provide the basic heat load of a building or small group of buildings with individual small heating systems per apartment.			
Advancement of TRL levels (TRL7→8):			
Cascaded heat pumps and buffering has been pre piloted in the IDEA incubator, which is part of consortium member Inholland and in 'The Future' project (TRL7). During POCITYF the use of cascades of smaller heat pumps, combined with PV-thermal panels and aquifer thermal energy storage (ATES, a ground sourced heat pump) will be demonstrated to create an integrated high-efficient hybrid heating concept – to be used as a ready-to-be used complete system (TRL8).			
Innovative Element (IE) #	**1.1.19**	**Description/Title**	**Composite Facade Panels**
Innovative aspects of the IE:			
The specific IE refers to the adaptation and demonstration of vacuum composite facade panels with insulation and bio-composite façade with solar cells (combining insulation and electricity production).			
Advancement of TRL levels (TRL6→7):			
Composite façade panels with different characteristics have been demonstrated on a lab scale at Inholland composite lab (TRL6). In bio-based materials, InHolland Composites has been involved in the development of a prototype bridge, electrical scooter, and bench. Notably the possibilities integration of systems, renovation, and bio-based materials have not been fully explored to date. Thus, development of the intended prototype panels will require applied research. During POCITYF these system prototypes will be demonstrated in operational environment whereas they will be further equipped with detection sensors (TRL7).			
Innovative Element (IE) #	**1.1.20**	**Description/Title**	**PCM in the floor**
Innovative aspects of the IE:			
POCITYF will provide a complete PCM in the floor solution, which functions as thermal battery, leading to a more stable climate. The PCM climate floor absorbs heat from 23 degrees and stores it. At a temperature lower than 23 degrees, the heat is released again. One kg PCM has the same cumulative capacity as 30 kg of concrete. By applying the PCM in the floor, the internal cooling load for the building is reduced.			
Advancement of TRL levels (TRL7→8):			
PCM's in the floor as a thermal buffer have been prepiloted by Duurzaam Bouwloket in the project "The Future" in Amsterdam (TRL7). During POCITYF, the PCM floor system will be completed and qualified for its utilization as a thermal buffer for the heating system (TRL8).			

Table 4 Market needs, changes and challenged for IS-1.1

Innovative Element (IE) #	1.1.1	Description/Title	PV Glass
Current market needs that the IE will address:			
Architectural constraints (e.g. appearance of the building cannot change) especially in old/protected buildings/areas pose significant barriers for the installation of conventional RES systems, thus there is a need for highly customizable and integrated solutions // Building integrated PVs (BIPVs) are gaining popularity among construction/renovation stakeholders // Increased aesthetics of PV systems can support their acceptance especially when installed in public spaces.			
Value proposition of the IE:			
This IE offers multiple functionalities under one product, since it provides energy generation, lets natural light in, provides thermal and sound insulation, filters 99% of harmful UV radiation and up to 95% IR radiation // Easily customizable (e.g. in terms of shape, color, size, thickness, semi-transparency). PV glass presents the same mechanical properties as conventional architectural glass used in construction for architectural purposes. Depending on the building needs, solutions or orientation, c-Si or a-Si can be used.			
How the IE can bring a market change and how market changes may affect the IE:			
PV glass can change the way of designing/constructing buildings since it can substitute any regular glass – window, being able to also produce renewable energy while offering the same functionalities than			

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conventional ones. On the other hand, regulation and policies (especially on an EU level) are becoming more and more ambitious and strict in terms of energy performance (on various levels ranging from materials/products to the building as a whole) whereas increased self-consumption and locally produced energy is increasingly promoted (i.e. the definition of Renewable Energy Communities and Citizen Energy Communities at the recast of Renewable Energy Directive (RED II) which came into force in 2018). In that respect, the demand for products like the PV glass will most probably be increased in the forthcoming years.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#1, since they support the introduction of innovative technologies and products that can push energy performance levels beyond the levels of current EU building codes, while also enabling renewable energy production on a building level. This IE is facilitating the energy transition of historical and cultural heritage city areas.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**1.1.2**	**Description/Title**	**PV Canopy**

Current market needs that the IE will address:

Architectural constraints (e.g. determined surroundings that cannot change so a PV canopy according to the aesthetical surroundings is needed) especially in old/protected areas pose significant barriers for the installation of conventional RES systems, thus there is a need for highly customizable and integrated solutions // Building integrated PVs (BIPVs) are gaining popularity among construction/renovation stakeholders // Increased aesthetics of PV systems can support their acceptance especially when installed in public spaces //EV market is experimenting a rapid growth and a PV canopy can satisfy the needs of the charging point for EVs.

Value proposition of the IE:

This IE offers multiple functionalities under one product, since it offers renewable energy generation, sun protection and shelter in accordance with building codes and architectural designs // Depending on the type of canopy, the electricity yielded can be consumed in different ways: self-consumption for surrounding buildings, courtesy lighting, ad-box illumination, back-up systems, charging point for EVs, as well as injection to the grid// Design options are almost unlimited: one, two or multiple slopes, different tilts and orientations, multiple glass design options (silk-screening, ceramic frits, colors, etc.).

How the IE can bring a market change and how market changes may affect the IE:

Check also IE #1.1.1 // The utilization of PV canopies unlocks new possibilities in terms or renewable energy production and management on a local level. For example, the installation of a PV canopy in a parking could be coupled with EV charging stations and novel storage solutions supporting flexibility of the grid and avoiding curtailment. As e-mobility penetration will be greatly increased over the next years (further supported by the regulatory framework), technologies like the PV canopy will become more relevant. Market pull is further supported by the SET-Plan ACTION 3.2, according to which Europe plans to become a global example in terms of integrated, innovative solutions for the planning, deployment and replication of PEDs, having at least 100 PEDs until 2025.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#1, since they support the introduction of innovative technologies and products that facilitate energy systems integration and enable high shares of locally produced energy. This IE is facilitating the energy transition of historical and cultural heritage city areas.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**1.1.3**	**Description/Title**	**PV Skylight**

Current market needs that the IE will address:

Check IE #1.1.1

Value proposition of the IE:

This IE offers multiple functionalities under one product, since it generates clean and free energy at the same time that it provides bioclimatic properties of thermal comfort to the building // Photovoltaic

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skylights not only generate free electricity, but also provide natural light, as well as UV and IR filter // Local generation of PV to be installed in skylights, totally complying with aesthetic requirements of old and historical buildings // Possibility of using c-Si or a-Si technologies, depending on the building needs // From a financial point of view, while solar farms rarely exceed a 10% I.R.R., photovoltaic skylights achieve I.R.R. up to 65%. In addition, they offer an average payback time of 2 years, and decrease the energy consumption of the building by 40%. Considering all these, a PV skylight can generate power at only 0.017 US$/kWh.

How the IE can bring a market change and how market changes may affect the IE:

Check IE #1.1.1

How current and future market changes/challenges affect POCITYF's Objective:

Check IE #1.1.1

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**1.1.4**	**Description/Title**	**Tegosolar PV**

Current market needs that the IE will address:

Check IE #1.1.1 // Tegosolar fits the market need to have a full BIPV element. Not an applied PV but a roofing element that protect towards water when it's raining and create energy when the sun is shining. Furthermore, Tegosolar is a lightweight roofing system, so it is perfectly fitting the needs of restoring old buildings without increasing weight over the structure. It can be applied in every roof, with the advantage in case of hi slope roof, that are the most difficult roofs to cover, to be itself waterproofing without any need of torch on asphalt membrane or other waterproofing membranes.

Value proposition of the IE:

This IE offers high architectural standards in many settings where it would be "impossible" to fit traditional photovoltaic panels. Tegosolar's various traits – namely its slim design, flexibility and light weight – make it a winning choice for many roof types, both on new builds and renovations, on buildings for residential, commercial and public use, as well as on industrial buildings. The Tegosolar photovoltaic cells are made of triple-junction thin-film amorphous silicon: each cell absorbs the blue, green and red light in the solar spectrum through its 3 separate layers. In this way, the PV cells convert a broader spectrum of light into electricity than traditional modules, as they produce energy with direct light as well as in diffused light conditions, namely when the sun is low, when the sky is cloudy and when cells are installed where orientation and angle are less than optimal.

How the IE can bring a market change and how market changes may affect the IE:

Tegosolar PV can change the way of designing/constructing buildings since it can be installed over the existing shingles of a lightweight roof, but also as a substitute of traditional shingles. If we are considering an historical building or a school, placed in a seismic area, removing a 50 kg/m^2 traditional roofing shingle and substituting with 5 kg/m^2 PV element can bring the advantage to have an energy production but also a lighter roof, reducing the weight of the structure and decreasing its danger in case of earthquakes. The revised EPBD, together with the EE Directive (EED), the Renewable Energy Directive (RED), the Ecodesign Directive and Energy Labelling and the Roadmap of the Energy Union (through Smart Financing for Smart Buildings initiative) are the major EU legislation/policies currently aiming to boost long term renovation of the EU's building stock, creating a favorable environment for bringing innovative construction products/RES systems with better specifications into the market.

How current and future market changes/challenges affect POCITYF's Objective:

Check IE #1.1.1

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**1.1.5**	**Description/Title**	**Traditional PV Shingle**

Current market needs that the IE will address:

Check IE #1.1.1 // During the last years, extra emphasis is put on developing construction materials/systems that are characterized by quicker installation times thus decreasing costs and impact during installation as well as minimizing disturbance of the occupants // Traditional PV shingle is addressing the market needs of increasing energy efficiency of roofs in which all the roof is covered by traditional PV

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element like “coppo” and it is necessary to increase the energy value with a shape that is really similar to the surrounding traditional roofing shingles.

Value proposition of the IE:

This IE is significantly more efficient in comparison with similar systems (passing from 18-20 m^2/kWp to 12-15), with an aesthetic shape that can reproduce the shape of any roof in which application is forecasted. The cables arrangement is also optimized, improving installation speed by 20%. Key benefits of this IE include among others: a) fixing rods and/or tanks are not required for laying; this avoids all problems caused by infiltration and thermal bridges; b) the installed by-pass diode prevents any problems caused by moving or unexpected shade (trees, chimneys, aerials, leaves etc.); c) the ventilation channel between the PV module and the bent tile makes the system less sensitive to high summer temperatures (lower temperatures imply greater yield); d) in the case of a power drop due to an irregular module, the module automatically disconnects to prevent the need for replacement. If you wish to replace it, however, the snap-on multi-contact fixtures make the operation quick and easy without the need for specialist technicians; e) finally, the system offers the advantage of to be installed on an existing roof, replacing only the square meters required without incurring additional costs for perimeter waterproofing.

How the IE can bring a market change and how market changes may affect the IE:

Check IE #1.1.4 // Traditional PV shingle can bring a market change in particular in case of renovations since can be installed at the place of traditional roofing elements of the same weight and same dimensions. Geometrical integration is perfect and is available in different shades of color that help to fit in the best possible way the color of the roof, that is changing place by place and roof by roof depending on regional kind of tecrracotta shades and depending how old is the roof and the atmospheric conditions of the particular area of installation. Change in regulation that allow the possibility to install traditional pv shingle also if the upper part is no exactly curved as a traditional roofing element allow the possibility to increase installation.

How current and future market changes/challenges affect POCITYF’s Objective:

Check IE #1.1.1

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**1.1.6**	**Description/Title**	**Bidirectional Smart Inverters**

Current market needs that the IE will address:

Highly increasing the share of energy produced by RES arises potential threats to the stability of the grid due to high variability. The coordinated operation of RES production and supporting storage systems can increase the flexibility of the grid, and since the RES penetration will be increasing, there will be a stronger need for technologies/products that can serve this functionality // There is lack of integrated and storage and PV solutions with reasonable cost

Value proposition of the IE:

This IE enables the coordinated operation of PV generating systems and storage units, allowing for the drastically improvement of self-consumption on a typical house whereas a significant amount of flexibility is added to the network. These bidirectional smart inverters have managed to achieve up to 47% improvement regarding RES cut-off due to network congestion and an integration of up to 80% of PV generation. It is also a great solution for prosumers with EVs who want to maximize their own generation and optimize self-consumption.

How the IE can bring a market change and how market changes may affect the IE:

Whilst the EU strongly supports energy communities, it had not made explicit reference to them until the recast of the Renewable Energy Directive (RED II), which came into force in the end of 2018. RED II gives greater power to citizens for self-generation and consumption of electricity which is expected to highly increase the demand of products such as the bidirectional smart inverters. A massification of self-consumption market is expected in the forthcoming years.

How current and future market changes/challenges affect POCITYF’s Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#1, since they support the introduction of innovative technologies and products that facilitate energy systems integration and

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enable high shares of locally produced energy. It should be noted though, that the global offer and cost of storage elements (batteries) can increase or decrease the potential success of this IE. New local and international legislation can have a huge impact also.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**1.1.7**	**Description/Title**	**Energy Router**

Current market needs that the IE will address:

Check IE #1.1.6 // There is a growing need for technologies and solutions that can support the stability of the power networks and simplify the integration of renewables in existing power systems, avoiding and/or limiting expensive and inefficient investments on new grid infrastructures (e.g. the upgrading of existing electric lines or grid's apparatuses) as far as possible // New business opportunities are expected for energy communities or positive energy blocks, acting as aggregators as well, investing in renewable production, storage devices, and providing ancillary services through their adhesive portfolio of renewables, flexible demand response and efficiently controlled batteries.

Value proposition of the IE:

The Energy Router will execute intelligent algorithms that assure the fulfilment of operation rules and that choose the best available option, providing energy services for grid, consumer and communities. Connecting every energy related device, the Energy Router will act as a major component in the grid/consumer energy interface, being responsible for grid-to-grid communication, load management and integration of generation units and storage devices. The ability of providing distributed ancillary services to the grid can be coordinated by upper layer supervision and predictive control algorithms.

How the IE can bring a market change and how market changes may affect the IE:

Check IE #1.1.6 // The Energy Router can bring a market change by allowing the users/communities to take full control of their energy portfolio (production, consumption and storage) resulting, therefore, in benefits for both consumers and power systems operators.

How current and future market changes/challenges affect POCITYF's Objective:

Check IE #1.1.6 // Current and future regulations may restrict the integration of Energy Routers in terms of installed power. Nevertheless, Energy Routers can always play a key role in increasing energy self-consumption, energy savings and share of locally produced renewable energy.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**1.1.8**	**Description/Title**	**Building Management System (BMS)**

Current market needs that the IE will address:

BMS worldwide market is valued at approx. 6.6 Billion USD in 2016 with a CAGR of 16.71% (expected to reach 19.25 B USD in 2023)[1]. It is hard to find figures specifically related to market needs of BMS for historical building, but it is nevertheless true that countries such as Portugal, Italy, Spain etc. have an extensive part of their buildings located in historical city centers, in need of renovation and of solutions for energy savings (to meet NZEBs regulations). Therefore, the main points that will be addressed are: a) Non-invasive solutions capable of preserving the historical structures of the buildings; b) Solutions with the final goal of saving energy, while increasing occupants' comfort.

Value proposition of the IE:

The main added value for the customer, when purchasing a BMS solution is to achieve energy savings while ensuring internal comfort and usability of the building. Lately a growing value for the final customer are all those services which are built around the BMS infrastructure, such as: a) Maintenance Services, to Simplify your building maintenance and achieve real impact on operating costs, occupant comfort and asset whit the need to keep building systems performing optimally while working with limited budgetary and maintenance resources. b) Responsive and smart workspaces, digital services for building managers to create smart workplaces that optimize use of space, improve comfort and employee experience, enhance productivity, and reduce facility service costs in new or retrofit buildings. Users derive actionable insights through intuitive dashboards that analyze data from IoT sensors and systems.

[1] Building Management System Market by Software (Facility, Security, Energy, Emergency, Infrastructure Management), Service (Professional, Managed), Application (Residential, Commercial, Industrial), and Geography - Global Forecast to 2023

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The BMS solution used in POCITYF project is based on Open Protocols of communication, enabling the owners of the buildings of high flexibility once the project finishes. Thanks to the use of Open Protocols (Modbus, BacNet, Zigbee, etc.) the manager of the buildings will have the possibility to easily maintain the building once the project finishes, with availability of many products on the market and a wide range of technicians capable of managing and doing maintenance of this technologies.

How the IE can bring a market change and how market changes may affect the IE:

The promising market dynamics for a number of software solutions like BMS, HEMS, BEMS can further accelerate investments in energy efficiency building retrofitting as (a) they require the installation of a set of IoT devices/sensors and automation systems and (b) they provide the necessary analytics to assess with certainty the feasibility of retrofitting options. This is further supported by the fact that the revised EPBD introduces the "smart readiness indicator" for buildings that will take into account features such as smart meters, building automation and control systems, self-regulating devices etc. and the interoperability of those features. Indeed, the building segment of EMS is estimated to grow from $2.4 billion (2015) to $10.8 billion (2021)[2]. As previously stated, Schneider Electric solution can bring a market change thanks to the flexibility of the system and the services that are offered linked to the hardware and software solutions. Vice versa, the technology is highly influenced by policies, today for a complete renovation of a building, it is needed to achieve certain energy savings target (NZEB buildings, European buildings regulations etc.) and it is mandatory to achieve a certain level of automation (EN15232, new Smart Readiness Indicator SRI).

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#1, since they support the introduction of innovative technologies and products that facilitate energy systems integration and significant energy savings through better monitoring and management of building energy assets.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**1.1.9**	**Description/Title**	**2nd Life Residential Batteries**

Current market needs that the IE will address:

Achieving very high percentages of RES penetration and self-consumption requires the introduction of novel storage solutions. In the current energy market for productive loads and residential storage systems, the high investment costs in combination with unknown financial and technical risk of Lithium-batteries are causing a main drawback for the further development of the energy transition towards renewables. The utilization of Li-ion batteries is gaining momentum and continuously increases its market share; however, this is not a sustainable choice for EU in the long-term. Lithium is not available in Europe and as a result there will always be a dependency from worldwide markets. Thus, it is critical to find solutions that can either substitute Li-ion batteries and/or extend its productive life. This need is addressed by this IE by a "Battery-as-a-service" model. i.e. the end-user will just pay a monthly fee for energy security and availability and do not have to care about the lifetime or pre-financing of a battery system. By this, the user experiences this new technology also as more reliable. Due to the 2nd-life aspect, the total levelized costs of energy and storage can be reduced compared to other technical alternatives. Furthermore, the high value of a battery system shall be used as much as possible by increasing the operating use cases of a single battery by having a mobile, modular and multipurpose energy supply system. To properly support the renewable and environmental aspect of the energy transition a storage system which is CO_2-neutral and has a low resource demand is needed.

Value proposition of the IE:

Betteries has designed an innovative solution to help solve two major global environmental problems - 1) the upcoming wave of obsolete electric vehicle (EV) batteries and 2) lack of affordable and flexible renewable energy options for demanding markets - with its innovative Advanced Mobile Power Systems. batteries re-purposes used lithium ion EV batteries to bring mobile and affordable energy storage to on-grid and off-grid customers worldwide. batteries' systems can serve multiple-use cases (e-transport, productive use, back-up power, e-propulsion, humanitarian aid) across multiple geographic markets (SEA,

[2] BEMSs: Software, Services, and Hardware for Energy Efficiency and Systems Optimization: Global Market Analysis and Forecasts', Navigant Research, 01/2015

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Africa, Middle East, Europe). Betteries combines deep technology know-how and frontier market experience to deliver scalable CO_2 savings and protect scarce resources, while ensuring circular economy principles by recycling the EV batteries at the end of its second life.

How the IE can bring a market change and how market changes may affect the IE:

Electrification will be boosted using batteries from EVs and the proposed IE has the competencies to support the electrification process. EV battery supply market will undergo a major expansion over the coming years which is also expected to affect material demand and increase price pressure[3]. Extending the productive life of a product (in this case the EV batteries) is highly in accordance with the principles of circular economy which is highly supported by EC as a mean to cope with climate change and achieve sustainable development. By introducing a large number of 2nd-life batteries to the market, the car industry will become more aware of the value of easy to disassemble EV-batteries and comprehensive 1st-life operation data, which will drive the development in these fields for the future EV-batteries. This on the other hand, will decrease remanufacturing effort and reduce the costs for the end-user, which again will reduce the reduce and energy footprint of electric mobility. In a more generic view, the availability of affordable (because reused) batteries will enable the energy transition towards renewables in many fields, where energy storage is still the missing link, i.e. distributed PV installations, backup-power, light-electric vehicles, productive use, etc.

How current and future market changes/challenges affect POCITYF's Objective:

Check IE #1.1.2 // With continuously lower costs for PV installations, a constantly increasing share also in the residential field is expected, that will cause even further increasing overcapacities and therefore a stronger demand for battery storage systems and also other strategies to spread the yielded energy among the consumers according to their current energy demand. However, this will only be done, if the local people are educated and encouraged to participate in the energy transition

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**1.1.10**	**Description/Title**	**HEMS/BEMS**

Current market needs that the IE will address:

Check IE #1.1.8 // Lack of integrated smart Home/Building solutions with reasonable cost // No adoption of flexibility services for domestic buildings.

Value proposition of the IE:

This IE is able to forecast the local energy production and detect the consumption profile to establish the optimal building operation considering energy usage and comfort preferences. Through a self-learning system, the building is continuously becoming smarter. This is a perfect solution for demanding users who want to optimize the energy usage and cost and a tool for the evaluation of the deployment of energy solutions (e.g. smart inverters, battery storage, PV generation).

How the IE can bring a market change and how market changes may affect the IE:

Check IE #1.1.8 // Massification of smart buildings, increased integration of renewable generation and electric mobility and energy community participation are key market changes that affect this IE.

How current and future market changes/challenges affect POCITYF's Objective:

Check IE #1.1.8. It should be noted that upcoming years present some major challenges in cybersecurity and data management which can accelerate or decelerate the deployment of smart building solutions. New local and international legislation can have a huge impact also.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**1.1.11**	**Description/Title**	**Positive Computing Data Centre**

Current market needs that the IE will address:

Worldwide energy consumption increase in Datacenter is a real challenge to sustainable ecosystems and operational results. The increasing usage of cloud-based technologies increases the pressure in energy grid supplying Datacenter facilities making it fundamental to use more efficient technologies but also make operations more efficient and more capable to adapt to growing needs. The Data Centers Energy Efficiency

[3] BCG, The Boston Consulting Group, The future of battery production for electric vehicles, 2018.

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CoC has been established in response to increasing energy consumption in data centers and the need to reduce the related environmental, economic and energy supply security impacts. The Code of Conduct aims to achieve this by improving understanding of energy demand within the data center, raising awareness, and apply energy efficient best practice and targets. Renewable Energy production for Datacenter is also the other aspect to optimize

Value proposition of the IE:

This IE is able to integrate multiple sources of energy supply (grid, autonomous and local community-based) to support data center sustainability, while increasing energy efficiency and highly reducing energy consumption for managing/controlling data. The design and testing of improved processes regarding energy efficiency provides knowledge that can be applied and disseminated in similar Datacenters. The full scope of the value proposition in its full dimensions are still being assessed, but value is expected in the Datacenter results but also in the suppliers of technology used in the Datacenter.

How the IE can bring a market change and how market changes may affect the IE:

Higher resilience requirements and relevant initiatives such as the European Code for Data Centre Energy Efficiency, in response to the increasing consumption in data centers, are stimulating data center operators and owners to reduce energy consumption in a cost-effective manner without hampering critical function of data centers. The market share of relevant solutions is thus expected to grow in the future. The optimization on equipment and management processes can provide the market, both manufacturers like Schneider, Johnson, and operation teams more data to improve PUE effectiveness. The work done will also contribute to the Data Centers Energy Efficiency CoC. Also, the market and the guidelines from manufacturers and the Data Centers Energy Efficiency CoC will provide new solutions that can be more effective.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#1, since they support the introduction of innovative technologies and products that facilitate energy systems integration and significant energy savings through more energy efficient data centers. This IE aims to achieve a better energy balance in the Datacenter, both in energy efficiency and renewable energy production. Expected market changes in equipment providers will probably produce a positive impact in the project, having more efficient solutions, but also more efficient and integrated management procedures. Better energy and cooling machines will have positive impact, more supercomputing (HPC) units can have a negative impact in the energy balance.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**1.1.12**	**Description/Title**	**Insulation with Circular Materials**

Current market needs that the IE will address:

The adoption of circular economy means rethinking and redesigning urban development in order to minimize waste streams, promote maximum re-use and recycling and develop novel synergies among businesses to reduce usage of raw materials. Technologies and services that can facilitate this transition from a linear to a circular economy are already becoming a necessity if we are looking towards sustainable urban development. This is possible by making more use of circular of recyclable materials. This is becoming increasingly important with renovation, demolition and new construction projects.

Value proposition of the IE:

By using used or natural materials, there is a substantial reduction in CO_2 emissions, partly because no new raw materials are mined. However, not much is used in the current new construction. By applying this now in the POCITYF demo area (Alkmaar) and working it out in more detail, this can already serve as a standard for future new construction projects

How the IE can bring a market change and how market changes may affect the IE:

On 2 December 2015, the European Commission put forward a package including a Circular Economy Action Plan to support the EU's transition to a circular economy. This Action Plan included 54 ways to "close the loop" of product lifecycles. It puts a major emphasis on finding new, innovative means to move away from a 'take-make-dispose' culture, for instance by recycling and re-using products for longer. In the

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context of Circular Economy Action Plan, various initiatives have been adopted (e.g. a proposal for a directive on the reduction of the impact of certain plastics, report on critical raw materials etc.) that promote the utilization of circular materials. The revised legislative framework on waste (OJ, L150, 14 June 2018) sets clear targets for reduction of waste and establish an ambitious and credible long-term path for waste management and recycling. On 4 March 2019, the Commission reported on the complete execution of the action plan. All 54 actions included in the 2015 plan have been delivered or are being implemented, setting fertile grounds for circular solutions wide scale roll-out.

How current and future market changes/challenges affect POCITYF's Objective:

The specific IE is indirectly contributing to Objective #1, since the utilization of circular materials is usually characterized by lower embodied energy (due to energy savings from extraction, manufacturing and waste management).

Negatively		**Neutral**	**X**	Positively	

Innovative Element (IE) #	**1.1.13**	**Description/Title**	**Triple Glazing**

Current market needs that the IE will address:

There is an increasing need for better performant, greener insulation materials and systems if we are looking towards the achievement of NZEBs or even positive energy buildings, since energy efficiency should come first before moving to the installation of RE production systems. Insulation of sound is also a significant aspect regarding glazing performance.

Value proposition of the IE:

This IE offers all the benefits of triple glazing (energy savings, lower costs, more comfort for buildings occupants) while a special seam and crack seal will be used in the window frames to minimize the infiltration of cold air by 80% in comparison with the standard values (NEN 2686).

How the IE can bring a market change and how market changes may affect the IE:

This IE will enter a growing market that is further supported in a political and regulatory level. The 2030 energy renovation market could increase by almost half of the 2015 market if a 40% energy savings target is adopted. The renovation potential in EU is extremely high, taking into account four key parameters: a) The volume of residential buildings that need renovation: According to data from EU building stock observatory[4], the EU has a residential floor area of 22.7 billion m^2 (or ≈213.7 millions of permanently occupied residential dwellings) of which 77.4% were built before 1990 and 48.8% before 1970 (latest data from 2014 for EU28 and ODYSSEE-MURE Project). b) The current low renovation rates: According to data from ZEBRA2020 data tool[5] the equivalent major renovation rate for EU countries participating in the ZEBRA2020 database ranges from 0.08% to 2.01% whereas a business as usual scenario considers a renovation rate of 1%[6]. c) The cost of deep renovation is still relatively high: Energy renovation costs range from €200-450/m^2 depending on the depth of renovation[7] but great discrepancies are observed from country to country. To reduce the cost of deep renovation, there is a need for tailored renovation kits tailored to the building needs and plug-n-play modular components and systems fully integrated with innovative materials[8]. d) EU policies and funding schemes are increasingly supporting deep renovation: EU has launched a new financial instrument the Smart Finance for Smart Buildings Initiative. The revised EPBD is also an indicative example towards this path.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#1, since they support the introduction of innovative technologies and products that can push energy performance levels beyond the levels of current EU building codes and increase energy efficiency. Due to lower energy use, CO_2 reduction will occur.

Negatively		Neutral		**Positively**	**X**

[4] EU Building Stock Observatory, https://ec.europa.eu/energy/en/eu-buildings-database
[5] http://www.zebra-monitoring.enerdata.eu/overall-building-activities/equivalent-major-renovation-rate.html
[6] BPIE, 2011, Europe's buildings under the microscope, A country-by-country review of the energy performance of buildings, ISBN: 9789491143014
[7] Artola I., Rademaekers K., Williams R and Yearwood J., Boosting building renovation: what potential and value for Europe?, Study for the ITRE Committee, Directorate-General for Internal Policies, IP/A/ITRE/2013-046, October 2016
[8] Saheb Y., Bodis K., Szabo S., Ossenbrink H. AndPanev S. (2015), Energy Renovation: The Trump Card for the New Start in Europe, JRC Science and Policy Reports, Report EUR 26888

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Innovative Element (IE) #	1.1.14	Description/Title	Solar Roofs and Facades

Current market needs that the IE will address:

Check IE #1.1.1-1.1.5 // Solar panels are generally not considered aesthetically attractive. Solar panels however are more and more applied on industrial buildings as cladding. For residential application, vertical solar panels mounted on building facades are hardly used. When the image of solar panels changes and the aesthetical attractiveness increases, many more facades can be used to produce solar energy.

Value proposition of the IE:

Check IE #1.1.1-1.1.5 // A lot of not used façade surface of residential buildings, (passive facades) can become useful to produce solar energy (active facades).

How the IE can bring a market change and how market changes may affect the IE:

Check IE #1.1.1-1.1.5 // If the appearance of solar panels is more appealing, acceptance of this IE will be easier.

How current and future market changes/challenges affect POCITYF's Objective:

Check IE #1.1.1-1.1.5

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	1.1.15	Description/Title	Thermo Acoustic Heat Pumps

Current market needs that the IE will address:

Heating and cooling are the major contributor of energy use in buildings; thus, market demand is always high for technologies and products that can lower energy bills. For climates with moderate heating and cooling needs, heat pumps offer an energy-efficient (and usually cost-efficient) alternative to furnaces and air conditioners. This IE is a new solution for renewable heating of cooling of residential and office buildings with a revolutionary heat pump technology. The market needs the heat pump to be smaller, lighter and cheaper, to be integrated in the facades.

Value proposition of the IE:

The advantage of the thermoacoustic heat pumps is that they can operate over a large range of (high) temperatures and can achieve large temperature lifts. The thermo acoustic heat pumps of POCITYF will be optimized to act both as booster and as part of an integrated hybrid heating/cooling system. These heat pumps will be applicable in facades of social housing buildings and will therefore have serious impact in reducing the energy needs of substantial number of households in the social sector as well as offices, and therefore reduce CO_2 emissions.

How the IE can bring a market change and how market changes may affect the IE:

The global residential heat pump market size was valued at USD 8.2 billion in 2018. People have been focusing on clean and green energy for sustainable heating solutions and minimizing fossil fuel consumption due to rising awareness regarding rapidly increasing global warming and climate change. Moreover, increasing importance of sustainable and cost-effective HVAC solutions, coupled with implementation of government initiatives aimed at reducing carbon emissions, is expected to promote the scope for residential heat pumps in the residential sector. According to the data provided by the European Commission, the heating and cooling solutions accounted for approximately half of the European Union (EU)'s energy consumption. In the residential sector of EU, hot water and heating alone accounted for more than 75% of total energy consumption. According to the statistics provided by the Eurostat, in 2018, 75% of energy required for heating and cooling solutions is still produced from fossil fuels and rest of the energy is generated from renewable source. During POCITYF the production of the thermo acoustic heat pump will be automated, the marked will be extended, and it will be possible to incorporate the heat pump within the facades. Costs will be lower, and the impact will be higher in comparison with the existing heat pumps.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#1, since they support the introduction of innovative technologies and products that can push energy performance levels beyond the levels of current EU building codes and increase energy efficiency. This IE will reduce the energy

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consumption substantially and improve the quality of living, while it is a silent new technology at building level.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**1.1.16**	**Description/Title**	**Hybrid wind/solar Generation System (Powernest)**

Current market needs that the IE will address:

Hybrid energy generation systems are gaining popularity since they can help overcome otherwise unsurpassed barriers (e.g. low sunshine for an extended period in the case of PV systems). Among renewables, wind brings the most widespread market impacts across countries. This impact is reflected on the percentage reduction of electricity prices that each additional unit of percentage variation dispatched from wind power plants carries out. However, in urban areas and close to urban areas there is resistance of residents against windmills. Wind energy is associated with noise pollution and loss of visual amenity. A Powernest installation is a solution which is designed to be installed in urban areas, not as a stand-alone installation like a windmill, but as an integrated part of a high-rise building.

Value proposition of the IE:

The Powernest is an installation which can be modified architecturally (color, shape, material) in conjunction to an existing high-rise building. It can be seen as a valuable addition to a building, which makes the building more attractive, instead of a technical installation, which makes buildings visually less attractive. Because the installation combines wind and solar energy production on the same roof, the yield per square meter is much higher compared to a single solar of single wind energy system.

How the IE can bring a market change and how market changes may affect the IE:

Between 2009 and 2018 the price of solar photovoltaic modules dropped more than 80%, and the cost of electricity from solar PV fell nearly 75%. The price per unit of wind power fell by about 50% (depending on the market) over the same period, and the costs of onshore wind power dropped nearly 25% between 2010 and 2018, with further dramatic declines expected in the coming decade[9]. As a result, the deployment of hybrid wind/solar generation systems is becoming more and more economically appealing, since the upfront costs are continuously reduced (until now hybrid systems were characterized by comparatively very high costs for each kWh produced). The Powernest installation can be a good solution for high-rise buildings in coastal areas. In coastal areas the average number of sun hours is greater than inland, and the wind speed is also higher than inland. In many coastal areas there are lots of high-rise buildings where this solution can be applied.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#1, since they support the introduction of innovative technologies and products that facilitate energy systems integration and enable high shares of locally produced energy. This IE is facilitating the energy transition of urban areas, especially windy areas.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**1.1.17**	**Description/Title**	**Li-ion Batteries**

Current market needs that the IE will address:

Combining grid storage with flexible demand (e.g. heat pumps, water heaters, V2G, domestic loads) and dispatchable RE units can highly facilitate RES integration. Storage can provide "load levelling" or "load shifting" by acting as a source of demand at times of low demand and a source of supply when demand increases, or other sources of supply reduce output. Today the most commonly used technologies on the market available are Lithium-ion (Li-ion), Lead-acid, Nickel-based, and Sodium-Sulphur (NaS) batteries. From these technologies Li-ion is the mostly applied solution on the market. The main reason for the success of Li-ion cells over other material-based batteries is its prime position in the Ragone plot and its continuously decreasing prices.

Value proposition of the IE:

[9] International Renewable Energy Agency, 2018

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While Li-ion batteries is an already mature technology, the key innovation to be introduced during POCITYF is their interconnection and testing with different setups (BEMS/HEATmatcher) leading to integrated solutions that are optimized to support positive energy districts.

How the IE can bring a market change and how market changes may affect the IE:

The electricity demand is expected to rise by more than a third by 2050 compared to 2000 levels, driven by the electrification of traditionally fossil-based sectors like transport and heating/cooling. Energy storage will play a crucial role to ensure a stable energy supply. The forecasted investments in the electricity grid in the lapse 2011-2050 are between €1.5 and €2.2 trillion, according to the EC[10]. Energy storage, and in particular batteries, is frequently addressed as the technology that may unlock the transition to a decarbonized and clean energy system due to their potentially broad application in the power and transport sectors. For decades, energy storage has had important restrictions due to an enormous limitation over the cost and volume of the available technologies. However, the evolution of the technology associated to batteries has led to the development of a new generation of very competitive energy storage systems, reducing both cost and volume and, therefore, enabling a tremendous growth in the last years. Worldwide market prospects for batteries are overwhelming: Li-ion batteries will reach 550GWh by 2025 from about 85GWh in 2016; battery cell manufacturing capacity (led by China) has more than doubled in 2018 (125GWh) and is projected to double again (275 GWh) by 2020[11]. The projected Li-ion batteries market size worldwide (all uses) is projected to reach $67.7B in 2022 (from $31.17B in 2016)[12].

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#1, since they support the introduction of innovative technologies and products that facilitate energy systems integration and enable high shares of locally produced energy through the integration of efficient storage solutions. On the other hand, Li-ion batteries might not be a sustainable choice for EU in the long-run due to the unavailability of Lithium in EU.

Negatively		**Neutral**	**X**	Positively	

Innovative Element (IE) #	**1.1.18**	**Description/Title**	**Cascaded Heat Pumps**

Current market needs that the IE will address:

Check IE #1.1.15

Value proposition of the IE:

This is a novel concept according to which cascades of small heat pumps are utilized to increase performance and flexibility due to increased modularity. The cascaded heat pumps can be combined with PV-thermal panels to create an integrated high-efficient hybrid heating concept.

How the IE can bring a market change and how market changes may affect the IE:

Check IE #1.1.15

How current and future market changes/challenges affect POCITYF's Objective:

Check IE #1.1.15

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**1.1.19**	**Description/Title**	**Composite Facade Panels**

Current market needs that the IE will address:

During the last years, there is a growing need on developing construction materials/systems that are highly customizable, serving multiple needs as well as being easy and quickly to install. This is attributed to the fact that many buildings (especially old-existing ones) may present special constraints (e.g. internal insulation is not possible, the appearance of the building cannot change, occupants cannot leave the building for a long time etc.), that are challenging renovation.

Value proposition of the IE:

[10] European Commission: Energy Roadmap 2050, 2011. http://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A52011DC0885
[11] EC, Batteries, European Battery Cell R&I Workshop, Final Report, 12/2/2018, Brussels
[12] https://www.statista.com/statistics/235316/global-lithium-battery-market/

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The key innovation of this IE is its multifunctional character, since it provides vacuum composite facade panels with insulation and bio-composite façade with solar cells (combining insulation and electricity production).

How the IE can bring a market change and how market changes may affect the IE:

This IE can change the way of designing/constructing buildings since it enables architects to create imposing architectural designs, which follow the contours of the building while offering insulation and electricity production capabilities. EU legislation/policies (see IE #4) are currently aiming to boost long term renovation of the EU's building stock, creating a favorable environment for bringing innovative construction products/RES systems with better specifications into the market which are able to be adapted to various building needs.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#1, since they support the introduction of innovative technologies and products that facilitate buildings renovation and enable high shares of locally produced energy.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**1.1.20**	**Description/Title**	**PCM in the floor**

Current market needs that the IE will address:

Using Phase Change Materials gave way to a unique applications of heating/cooling solutions. Phase Change Materials can store and release large amounts of heat and energy to maintain a constant temperature. They differ from insulation materials because, upon reaching their melting point, they change phase. There is unlimited number of possible applications where PCMs can be used such as buildings, glass houses, cold stores, refrigerated trucks and cooling of electronic devices. Work on PCMs has been ongoing for decades but their commercial use has only been recently unlocked due to their high production and encapsulation costs until now.

Value proposition of the IE:

The PCM floor system is a new, unique modular underfloor heating system that can be used as a thermal buffer. The cooling and possibility of heating will bring much more comfort and help avoid heat stress.

How the IE can bring a market change and how market changes may affect the IE:

The ability of PCMs to change phase at a given temperature is of tremendous benefit to the increasing demands for energy efficiency and energy savings. Various industries (such as building and construction, transportation and shipping, commercial refrigeration, textiles and packaging) require efficient heating and cooling: PCMs fulfill these requirements. Some PCMs are also bio-based and therefore environmentally friendly. Demand for PCMs in Europe is expected to grow significantly. There is an ongoing effort to integrate PCMs into increasingly more energy-hungry applications.

How current and future market changes/challenges affect POCITYF's Objective:

Check IE #1.1.15 // Because of the turnaround of giving and asking of heat at moments when wanted, the buildings will use less energy, and this will lead to CO_2 reduction and of course lower costs.

Negatively		Neutral		**Positively**	**X**

Table 5 Business models and innovation for IS-1.1

Innovative Element (IE) #	**1.1.1**	**Description/Title**	**PV Glass**

Business Models – capturing value from the IE:

- Direct installation in buildings that require both aesthetical and operational improvements, bus stops, etc. Financial revenues can emerge through the purchasing and installation of the solution.
- Design assistance for ambitious architectural buildings incorporating PV glass (or relevant) technology as means of revenue generation leveraging the technical knowledge and requirements expertise of the manufacturer.
- Direct exploitation will be achieved by means of keeping the foreground knowledge acquired in the course of the project as company knowhow for ONYX direct commercial exploitation. The commercial exploitation of the BIPV glass led by Onyx will be based on the current company pillars: International

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Sales Offices Departments, International Distribution Network in almost 40 countries, adaptation to client needs, excellent marketing and communication strategy. The clients will be supported from the design and manufacturing to installation and post-sale services.

- Buildings' flexibility trading with DSO/TSO: Study new financial revenues that can emerge from the surplus of PV generation in the buildings, by cataloguing flexibility-based products for the DSO – to solve local congestion problems at the distribution grid level – and for the TSO – within the ancillary services market, as a balancing product.
- Collective solar panels cleansing: This business model will unlock the value that accrue when owners of PV generation (at building and district-level) contract a third-party to be responsible for the cleansing of their systems without directly paying for cleaning procedure, but sharing the margin of profit that come with the improvement of efficiency stemmed from the panels cleaning.
- Retrofitting opportunities in UNESCO World Heritage Sites: during POCITYF, Evora will face a set of legal and regulatory restrictions that accrue from the World Heritage Site classification, while moving towards a positive energy performance with the group of solutions introduced. A business model will be created based in recommendations that can in the future be provided to other European cities that are struggling with the same issue, not only under a technological but also social, economic, legal, regulatory and political perspective. Evora will, therefore, act as a significant player and source of knowledge to expand POCITYF results while providing cost-benefit analysis of its experience when circumventing the barriers from its old and historical protected area. This input can be capitalized from technology providers, being a competitive asset for their products.

Innovative Element (IE) #	**1.1.2**	**Description/Title**	**PV Canopy**
Business Models – capturing value from the IE:			
Check IE #1.1.1			
Innovative Element (IE) #	**1.1.3**	**Description/Title**	**PV Skylight**
Business Models – capturing value from the IE:			
Check IE #1.1.1			
Innovative Element (IE) #	**1.1.4**	**Description/Title**	**Tegosolar PV**
Business Models – capturing value from the IE:			
Check IE #1.1.1 // This IE can be installed also in public buildings that require revamping old roofs reducing weight and seismic danger of the building.			
Innovative Element (IE) #	**1.1.5**	**Description/Title**	**Traditional PV Shingle**
Business Models – capturing value from the IE:			
Check IE #1.1.1			
Innovative Element (IE) #	**1.1.6**	**Description/Title**	**Bidirectional Smart Inverters**
Business Models – capturing value from the IE:			

- Direct installation in buildings and/or district level assets that require the coordination of PV systems and storage units. Financial revenues can emerge through the purchasing and installation of the solution.
- Product as a Service (PaaS) - Offer of renovation services as part of "integrated" renovation package solutions, including different innovative elements-set ups of POCITYF.
- Pre-certificate the product
- Protect intellectual property (if applicable)
- Demonstrate the product benefit in field
- License the product/technology

Innovative Element (IE) #	**1.1.7**	**Description/Title**	**Energy Router**
Business Models – capturing value from the IE:			
UNINOVA as a research center does not envisage profit, however, has a close cooperation with Academia and Industry. A suitable business model could be based on the mass deployment of energy routers devices. UNINOVA can use their links to industrial tissue to promote technology and knowledge transfer or support			

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the creation of spin-offs associated to the exploitation of knowledge related with the energy router. Business models of related spin off might include:

- Direct installation in buildings and/or district level that require the integration of energy components and managing the energy flux between them. Financial revenues can emerge through the purchasing and installation of the solution.
- Offer of renovation services as part of "integrated" renovation package solutions, including different innovative elements-set ups of POCITYF.

Innovative Element (IE) #	**1.1.8**	**Description/Title**	**BMS**

Business Models – capturing value from the IE:

- Direct installation in buildings to manage and real-time monitor various systems (HVAC, lighting etc.). Financial revenues can emerge through the purchasing and installation of the solution, and training of occupants/building operators as well (for very large buildings). The solution developed in POCITYF will be exploited and used for marketing purposes on the Italian and European markets. A Technical/Sale structure is already in place in Schneider Electric, regarding specifically the Building Automation sector, therefore it is no foreseen and necessary the creation of new sale forces/sale channels.
- Offer of renovation services as part of "integrated" renovation package solutions, including different innovative elements-set ups of POCITYF.
- Offer a special module, specifically adapted to cultural heritage/old/protected buildings. The BMS solution for historical building will be marketed as one of the possible configurations of EcoStruxure for Building suite (https://www.se.com/ww/en/work/campaign/innovation/buildings.jsp).

Innovative Element (IE) #	**1.1.9**	**Description/Title**	**2nd Life Residential Batteries**

Business Models – capturing value from the IE:

- To assure that at the end of the productive 2nd life period the batteries are recycled, Betteries do not sell this battery system to its B2B customers but offer a lease model. As such it always has control over the productive assets and provide a seamless "Energy Storage as a Service" solution for relevant customers. The lease rate consists out of a daily / monthly base rate and a cyclic consumption element. The rental / lease income generates the main revenue stream.
- Selling complimentary kit (e.g. charging and battery transport equipment) to customers.
- Generate CO2 offset credits by replacing carbon intensive power (e.g. generators) with this clean battery power solution.
- Offer of renovation services as part of "integrated" renovation package solutions, including different innovative elements-set ups of POCITYF.
- Lifetime extension - Potential financial revenue from sharing/absorbing the costs of collecting and treating end-of life EV batteries through a collaboration scheme with EV manufacturers.

Innovative Element (IE) #	**1.1.10**	**Description/Title**	**HEMS/BEMS**

Business Models – capturing value from the IE:

Check IE #1.1.8

- Pre-certificate the product
- Protect intellectual property (if applicable)
- Demonstrate the product benefit in field
- License the product/technology

Innovative Element (IE) #	**1.1.11**	**Description/Title**	**Positive Computing Centre**

Business Models – capturing value from the IE:

- Direct installation in data centers. Financial revenues can emerge through the purchasing and installation of the solution.
- Collected data can be used by market to improve the solutions used in the Datacenter. Also new and better management processes implemented during the analysis can provide DECSIS and partners new service capabilities to support other energy intensive facilities.

Innovative Element (IE) #	**1.1.12**	**Description/Title**	**Insulation with Circular Materials**

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Business Models – capturing value from the IE:

- Income generation and cost reduction from resource recovery techniques from waste (e.g. re-used concrete).
- Services offered for directly installing insulation material.

Innovative Element (IE) #	**1.1.13**	**Description/Title**	**Triple Glazing**

Business Models – capturing value from the IE:

- Direct installation in buildings (both new and renovated) to increase their energy efficiency. Financial revenues can emerge through the purchasing and installation of the solution.
- Offer of renovation services as part of "integrated" renovation package solutions, including different innovative elements-set ups of POCITYF.

Innovative Element (IE) #	**1.1.14**	**Description/Title**	**Solar Roofs and Facades**

Business Models – capturing value from the IE:

Check IE #1.1.1

- The renewable energy produced by the vertical solar panels will be distributed and delivered to the 130 households in the demo building. These households (tenants) will pay monthly service costs towards the owner of the vertical solar panels; the housing corporation. The housing corporation will use the service costs to cover the investment costs in the vertical solar panels.

Innovative Element (IE) #	**1.1.15**	**Description/Title**	**Thermo Acoustic Heat Pumps**

Business Models – capturing value from the IE:

- Direct installation in buildings (both new and renovated) to increase their energy efficiency. Financial revenues can emerge through the purchasing and installation of the solution. The financing of the heat pump has shifted from venture capital to private equity and subsidies.
- Offer of renovation services as part of "integrated" renovation package solutions, including different innovative elements-set ups of POCITYF.

Innovative Element (IE) #	**1.1.16**	**Description/Title**	**Powernest**

Business Models – capturing value from the IE:

- Direct installation in buildings (both new and renovated) for producing RES. Financial revenues can emerge through the purchasing and installation of the solution.
- The renewable energy produced by the Powernest will be distributed and delivered to the households in the demo building. These households (tenants) will pay monthly service costs towards the owner of the Powernest installation, the housing corporation. The housing corporation will use the service costs to make the investment in the Powernest.
- SDE+ subsidy for the Powernest system: Trading excess energy for the additional solar panels on the façade of the Woonwaard high-rise: Woonwaard will make the investment but has yet to find a party to sell the energy to; this could be one of the project partners i.e. HVC

Innovative Element (IE) #	**1.1.17**	**Description/Title**	**Li-ion Batteries**

Business Models – capturing value from the IE:

- Direct installation in buildings that can highly benefit from electrical energy storage. Financial revenues can emerge through the purchasing and installation of the solution.
- Offer of renovation services as part of "integrated" renovation package solutions, including different innovative elements-set ups of POCITYF.

Innovative Element (IE) #	**1.1.18**	**Description/Title**	**Cascaded Heat Pumps**

Business Models – capturing value from the IE:

- Direct installation in buildings (both new and renovated) to increase their energy efficiency and utilization of RES. Financial revenues can emerge through the purchasing and installation of the solution.
- Offer of renovation services as part of "integrated" renovation package solutions, including different innovative elements-set ups of POCITYF.

Innovative Element (IE) #	**1.1.19**	**Description/Title**	**Composite Facade Panels**

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

Business Models – capturing value from the IE:
• Direct installation in buildings that require both aesthetical and operational improvements, coupled with RES generation. Financial revenues can emerge through the purchasing and installation of the solution. • Offer of renovation services as part of "integrated" renovation package solutions, including different innovative elements-set ups of POCITYF.

Innovative Element (IE) #	**1.1.20**	**Description/Title**	**PCM in the floor**
Business Models – capturing value from the IE:			
• Direct installation in buildings (both new and renovated) to increase their energy efficiency and utilization of RES. Financial revenues can emerge through the purchasing and installation of the solution. • Offer of renovation services as part of "integrated" renovation package solutions, including different innovative elements-set ups of POCITYF.			

4.1.2 Integrated Solution 1.2: Positive Energy Districts

The focus of this solution is to integrate different elements that enable the deployment of **Positive Energy Districts**, by reducing energy consumption and increasing renewable production, underpinned by advanced ICT solutions that will foster flexibility enablement and activation and efficient energy flows between buildings and the upper stream distribution network. The use of grid-connected energy storage solutions will also contribute for the positive performance of the selected sites. The value of these solutions for the citizen lies in more stable and offers lower housing bills, in combination with higher comfort and indoor air quality. The primary goal of this IS, is to escalate the solutions offered in IS1.1 from the building to the district level.

The innovative elements which for the IS-1.2 are listed below while the following tables contain the progress relative to the three main pillars as described in the introduction of Section 4.

IS-1.2: Positive Energy Districts Retrofitting (Smart Lamp posts with EV charging and 5G functionalities // Energy router // Smart distribution management system // P2P energy trading platform // Community Solar Farm (P2P driven: (3)PV plants, (1) public funded ESCO PV) // DHC (biomass, waste, geothermal) // ATES (heat/cold storage) // Li-ion/Li-metal batteries // DC lighting with EV charging // Solar roads // V2G)

Table 6 Technical and innovation progress for IS-1.2

Innovative Element (IE) #	**1.2.1**	**Description/Title**	**Smart Lamps with EV Charging and 5G functionalities**
Innovative aspects of the IE:			
Smart Lampposts with EV charging and 5G network, is a modular solution of a lamppost which provides not only efficient LED lighting but also telecommunication (4G/5G and Wi-Fi) and EV charging capabilities. With this solution is possible to integrate network, computational and storage capabilities in only one infrastructure, avoiding the installation of multiple infrastructures in the city (that contribute to the visual pollution) and supported by a web platform that allows the renting of the different service providers with reduced costs. The integration of EV charging allows the dissemination of sites to recharge electric vehicles, e-bicycles etc., avoiding the proliferation of the traditional EV chargers. The Smart Lamppost solution allows the integration of V2G EV chargers.			
Advancement of TRL levels (TRL7→8):			
The Smart Lamppost solution can be classified as TRL7. The solution has been demonstrated in one operational environment by Ubiwhere, in the city of Guimaraes, contributing to the initiative "Guimarães 5G Ready". With the integration of different hardware providers in the Évora demonstration pilot, in particular, new EV chargers with V2G capabilities, we expect to upgrade the TRL to 8, closing the principal developments (complete and qualified system) and start the commercial activities to install the solution in a large-scale market.			

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Innovative Element (IE) #	1.2.2	Description/Title	Energy Router
Innovative aspects of the IE:			
Check IE #1.1.7			
Advancement of TRL levels (TRL6→7):			
Check IE #1.1.7			

Innovative Element (IE) #	1.2.3	Description/Title	Smart Distribution Management System
Innovative aspects of the IE:			
The specific IE refers to the adaptation and demonstration of a Smart Distribution Management System to enhance grid monitoring and control schemes. This IE is subject to replacement. Info will be updated in following versions of the deliverable.			
Advancement of TRL levels (TRL6→7):			
This technology has been developed in the project SENSIBLE (both EDP Labelec and INESCTEC were part of this project) (TRL6), where DSO SCADA systems make use of distributed intelligent nodes in the grid to enhanced its operation efficiency through specifically designed tools to increase the observability and controllability of MV and LV distribution networks; results showed that using advanced energy management with storage systems helped the grid to integrate large shares of renewables and reduce energy curtailment up to 98% and improve reliability indexes (SAIFI, SAIDI, CAIDI) up to 28%. During POCITYF the system prototype will be adapted to ensure the smooth connection between demo sites and grid, as well as integration with micro grids' controller platform, and be demonstrated in operational environment (TRL7). This IE is subject to replacement. Info will be updated in following versions of the deliverable.			

Innovative Element (IE) #	1.2.4	Description/Title	P2P Energy Trading Platform
Innovative aspects of the IE:			
The cloud platform for P2P energy transactions empowers the users of the network with the ability to debit and credit their energy wallets with kWh or equivalent euro amounts. Following recent advances of the banking sector, this IE mission is to directly connect prosumers of the energy network so they can exchange energy (or equivalent monetary amounts) with just a few clicks. If a user has a surplus of energy it is possible to credit the account of a friend and family member with an energy amount of his/her choice. For the case of Evora, P2P energy trading platform, will act as a cornerstone transactive layer allowing the operation of local market between selected buildings, also rewarding citizens' sustainable actions and investments and underpinning the injection of PV generation from PV plants in the surroundings of the PEBs. For the case of Alkmaar, the P2P energy trading platform will act as an implementation of the city energy management system (CEMS) where the users/owners of the buildings can buy/sell energy to each other and sell flexibility (see also Objective #4 and #5).			
Advancement of TRL levels (TRL6→7):			
P2P energy trading platform as a whole, has not been already pre-piloted. Nonetheless, its keystone module/technology – Connect with EnergyTM that allows anyone to donate energy to poor communities, via agreements with utilities, which uses this tool for improving their social responsibility – was already thoroughly tested in Greece, together with local utilities (e.g. HERON). Platform's wireframes, designs and user flow has been conceptualized as well as the proof of concept (TRL6). The next step is to make the appropriate integrations with external parties and databases of the consortium such as PowerMatcher, Meter Data Management Systems, Billing system. During POCITYF this IE will be customized according to the needs of the network whereas POCITYF will enable this element to be demonstrated as a system in operational environment (TRL7).			

Innovative Element (IE) #	1.2.5	Description/Title	Community Solar Farm
Innovative aspects of the IE:			
Community Solar Farm (defined as the integration of existing or new built PV plants with P2P trading platforms), is an innovative compensation model that allow citizens that live in old protected areas (such			

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as UNESCO heritage sites) to invest in renewable generation placed in PV plants in the outskirts of the city, via a virtual energy wallet, being rewarded for this investment.

Advancement of TRL levels (TRL6→7):

The Community Solar Farm has been tested in an emulation environment (TRL6). During POCITYF, citizens' investment will be done via Kimatica's platform, which will be updated to empower citizens with the ability to see in a dashboard their virtual energy wallet, with the possibility of using the generated energy to invest in other projects or receive the equivalent in tokens. The whole model will be tested within Evora's PEBs (TRL7).

Innovative Element (IE) #	**1.2.6**	**Description/Title**	**DHC (biomass, waste, geothermal)**

Innovative aspects of the IE:

During POCITYF, demonstration buildings will be connected to the district heating (both at high and at low(er) temperatures) which distributes heat from a biomass energy plant, which runs on (municipal waste) wood – and in a later stage the district heating will be connected with a geothermal energy source. Outcomes and lessons learned from this process can provide valuable insights for the upgrade of DHC of other cities in EU.

Advancement of TRL levels (TRL8→9):

HVC is currently operating a high temperature district heating system in Alkmaar and Heerhugowaard (the Alkmaar metropolitan area) utilizing residual heat from the biomass energy plant (which runs on municipal waste wood) and using large buffers (TRL8). This heating network is an integral part of the energy management of several neighborhoods in Alkmaar and Heerhugowaard. During POCITYF, all Alkmaar's PEB buildings (both new and retrofitted) will be connected to the district heating (both at high and at low(er) temperatures) which distributes heat from the HVC biomass energy plant, which runs on (municipal waste) wood – and in a later stage the district heating will be connected with a geothermal energy source (see also IS-2.2). These actions will serve as the basis for the wide scale roll out of a sustainable DHC network on a city level (TRL9).

Innovative Element (IE) #	**1.2.7**	**Description/Title**	**Aquifer Thermal Energy Storage (ATES)**

Innovative aspects of the IE:

The specific IE refers to the optimization and utilization of the Aquifer Thermal Energy Storage (ATES), an innovative system for heat/cold storage, that take advantage of otherwise wasted heat streams. This technique makes it easy to storage cold/heat in water storages in the ground. The heat, not needed at a specific moment will be stored in the water storage. When needed the heat can be withdrawn again.

Advancement of TRL levels (TRL7→8):

The specific technology has been tested in the project the future in Houthaven – Amsterdam (TRL7). In this project an energy positive building (including 17 apartments) was designed including 12 heat/cold storage installations (ATES), 2 x (17kW) heat pumps, 622 integrated PV panels and many other energy saving techniques. The building currently produces three times as much energy a year than it needs for itself. Energy performance is EPC – 1.25 compared to – 120 kWh/m^2. The building produces an amount of 110,000 kWh/year to the grid. During POCITYF the ATES system will be optimized to secure communication with various assets on building and district level (e.g. smart meters, RES production systems, BEMS/HEMS) to ensure optimal functioning of the system (TRL8).

Innovative Element (IE) #	**1.2.8**	**Description/Title**	**Li-ion / Li-metal Batteries**

Innovative aspects of the IE:

The specific IE refers to the optimization and utilization of electricity storage through Li-ion batteries and larger scale Li-metal storage system to be used on a district level.

Advancement of TRL levels (TRL7/8→8/9):

(Li-ion: TRL8→9 // Li-metal: TRL7→8): Alliander was previously involved in the "Stad van de Zon" (Sun City) project in Heerhugowaard and is involved in the Amsterdam City-Zen project. In the Sun City pilot, 500 NZEB (covering an area of 50.000m^2) and in the City-Zen pilot 25 NZEB were fitted with Li-ion energy storage of 260kWh capacity in total. The lessons learned and prototypes developed from these projects (TRL7/8) will be capitalized during POCITYF, to optimize secure communication and integration with

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various assets on building and district level (e.g. smart meters, RES production systems, BEMS/HEMS) to ensure optimal functioning of the systems. Li-ion/Li-metal storage systems will be proven (system proof) in actual operational environment both at building and district level (TRL8/9). In addition, DSOs in particular have the challenge of optimally integrating these storage facilities into the grid, while adding value to the grid and taking into account increasing levels of renewable electricity generation and a starting market for energy storage.

Innovative Element (IE) #	**1.2.9**	**Description/Title**	**DC Lighting with EV Charging**
Innovative aspects of the IE:			
Integrated smart solutions for a lamppost: public 5G/Wi-Fi for citizen engagement, sensors for dynamic lighting, integrated e-storage and EV changing point // It promotes the increase of large-scale local e-storage capacity // It promotes more environmentally friendly, emission free and energy saving mobility and public lightning solutions // Successful introduction of demand-supply energy management at district-level, in combination with the solar road and feeding of the DC grid by PV panels // In case of malfunctioning, the lamppost could report this itself by using smart sensors. Citizens reporting or regular inspection rounds won't be necessary anymore			
Advancement of TRL levels (TRL7→8):			
Relevant system prototypes have already been demonstrated with success (TRL7). In the Netherlands, there are already +15 projects with public lighting on DC grids on +/- 350 VDC. Also, pilots with lampposts with integrated EV charging poles are done, for example in Zeist and The Hague. During POCITYF, the possibility for directly feeding in solar energy will be further examined and tested, making all necessary adaptations in order to develop a complete system (TRL8).			
Innovative Element (IE) #	**1.2.10**	**Description/Title**	**Solar Roads (Solaroads)**
Innovative aspects of the IE:			
Check IE #3.2.3			
Advancement of TRL levels (TRL7→8):			
Check IE #3.2.3			
Innovative Element (IE) #	**1.2.11**	**Description/Title**	**V2G**
Innovative aspects of the IE:			
Check IE #3.1.4			
Advancement of TRL levels (TRL6→7):			
Check IE #3.1.4			

Table 7 Market needs, changes and challenges for IS-1.2

Innovative Element (IE) #	**1.2.1**	**Description/Title**	**Smart Lamps with EV Charging and 5G functionalities**
Current market needs that the IE will address:			
The creation of a strong technological city infrastructure boosts the public adoption of smart solutions and the implementation of a broader variety of applications at a lower cost and with more innovative components // Public lighting can be very costly for a municipality if it is not efficient and appropriately managed // The availability of EV charging stations needs to be increased rapidly to support e-mobility // Better, quicker and safer (cyber-security) communication is necessary to support "smart" transitioning of city ecosystems // The mobile operators are searching for opportunities to rapidly implement the 5G networks, with low installation costs and avoiding populating the city landscape with more and more antennas. The cities are interested in the 5G networks, but the massive deploy of new antennas are not an option. This IE takes the opportunity to explore the best of the two worlds, deploy the 5G network in an attractive infrastructure that can be also an opportunity for the city to rent this infrastructure.			
Value proposition of the IE:			
This IE, as an aggregator infrastructure of wireless, computing, networking, storage and EV charging capabilities in one product; can be a disruptive solution to the 5G market and also to other possible city services/verticals. For the cities, this IE can also be a new market opportunity with the renting of the siting/infrastructure, transforming one cost with lampposts infrastructures in one new source of return of investment.			

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How the IE can bring a market change and how market changes may affect the IE:

Initiatives like the EU Covenant of Mayors for Climate and Energy, have mobilized local governments to voluntarily commit into accelerating the decarbonization of their territories, strengthening their capacity to adapt to unavoidable climate change impacts, and allowing their citizens to access secure, sustainable and affordable energy. Under this framework thousands of local action plans have been developed that include specific actions for reducing energy consumption and carbon footprint. Among them, the upgrade of the public lighting is a key sector of intervention since it makes sense both in terms of energy reduction and costs, whereas it acts as an exemplar for the citizens. Additionally, e-mobility penetration will be greatly increased over the next years (further supported by the regulatory framework). The Smart Lamppost can change the current EV charger market because the integration in the lamppost, reduces the requirement of the installation of common EV chargers (that requiring more space in the urban landscape and power infrastructure) and the 5G market because allows the deployment of 5G networks with a lower OPEX and CAPEX.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#1, since they support energy savings on a district level while enabling higher e-mobility penetration (expansion of EV charging networks) and systems integration through better communication.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**1.2.2**	**Description/Title**	**Energy Router**

Current market needs that the IE will address:

Check IE #1.1.7

Value proposition of the IE:

Check IE #1.1.7

How the IE can bring a market change and how market changes may affect the IE:

Check IE #1.1.7

How current and future market changes/challenges affect POCITYF's Objective:

Check IE #1.1.7

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**1.2.3**	**Description/Title**	**Smart Distribution Management System**

Current market needs that the IE will address:

The rising number of expected RES PPs and the aging assets in power system is expected to become a potential threat to the grid stable and safe operation. Today, only about 1% of global demand or about 40GW of capacity is able to directly respond to shortages or excess supply. In the EU, increased storage and digitally enabled response could reduce curtailment rates of wind and solar projects from 7% in 2016 to 1.6% by 2040[13].

This IE is subject to replacement. Info will be updated in following versions of the deliverable.

Value proposition of the IE:

This IE is a holistic Smart Distribution Management System able to enhance grid monitoring and control schemes leading to reduced energy curtailment and improved reliability. It allows the integration of large shares of renewables without any problem.

This IE is subject to replacement. Info will be updated in following versions of the deliverable.

How the IE can bring a market change and how market changes may affect the IE:

Optimistic forecasts for the distributed energy resources market highly support the future adoption and success of relevant solutions. The annual installed capacity for this market is estimated to skyrocket from 16GW (2016) to 121GW (2025)[14], necessitating the deployment of appropriate building adjustments and control mechanisms to accommodate such solutions.

[13] Digitalization & Energy, International Energy Agency, https://www.iea.org/digital/

[14] Market Data: Residential Distributed Energy Resources', Navigant Research, 01/2016

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This IE is subject to replacement. Info will be updated in following versions of the deliverable.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#1, since they support the introduction of innovative technologies and products that facilitate energy systems integration and enable high shares of locally produced energy through better management and control of energy assets.

This IE is subject to replacement. Info will be updated in following versions of the deliverable.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**1.2.4**	**Description/Title**	**P2P Energy Trading Platform**

Current market needs that the IE will address:

Check IE #4.1.1

Value proposition of the IE:

Check IE #4.1.1

How the IE can bring a market change and how market changes may affect the IE:

Check IE #4.1.1

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#1, since they support the introduction of innovative technologies and practices that can enable increased renewable energy production on a building/district level and the deployment of PEDs. This IE is facilitating the energy transition of historical and cultural heritage city areas.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**1.2.5**	**Description/Title**	**Community Solar Farm**

Current market needs that the IE will address:

Although there is a clear need for RES generation on local level, this may not be the case for many buildings/districts where there is simply not enough space and the conditions to install PV systems. Increasing RES penetration in these cases is very challenging (reaching positiveness seems like an impossible task to accomplish). As a result, there is a need to provide solutions that can enable everyone to invest in RES if we are looking towards a just energy transition.

Value proposition of the IE:

This IE is an innovative compensation model that allow citizens that live in areas where the installation of large PV systems is not possible and/or is very challenging (such as UNESCO heritage sites) to invest in renewable generation placed in PV plants in the outskirts of the city, via a virtual energy wallet, being rewarded for this investment. This allows the injection of renewable energy from PV plants in the outskirts of a district (where more space is available), leading ultimately to a positive performance of the district.

How the IE can bring a market change and how market changes may affect the IE:

Check IE #1.1.1 and IE #1.1.2 (relevant to renewable energy generation, REC and PED deployment) and IE #4.1.1 (relevant to P2P trading) market changes.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#1, since they support the introduction of innovative technologies and practices that can enable increased renewable energy production on a building/district level and the deployment of PEDs. This IE is facilitating the energy transition of historical and cultural heritage city areas.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**1.2.6**	**Description/Title**	**DHC (biomass, waste, geothermal)**

Current market needs that the IE will address:

Rise in demand for RE in the power generation sector and the energy mix, changes in the dynamics of power grids from centralized to distributed, moderating costs and easy accessibility of energy storage are some of the factors driving the transformation of DHC networks. There is a growing need to help cities

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upgrade their DHC energy systems (in many cases being outdated), especially for the case of coal regions in transition. Over the period from 2004 to 2016, the renewables share in the heating and cooling sector has almost doubled from 10.3% to 19.1% and provided 99.3Mtoe[15]. DHC systems also allow for different production units in the same network enabling the aggregation of heat loads, and any waste heat streams, to progressively optimize the energy supply and switch to more sustainable fuels. DHC systems can utilize waste, geothermal heat and surplus heat and can enable the integration of large-scale solar collectors in combination with heat pumps and heat storage which increase the EU's security of energy supply.

Value proposition of the IE:

During POCITYF, demonstration buildings will be connected to the district heating (both at high and at low(er) temperatures) which distributes heat from a biomass energy plant, which runs on (municipal waste) wood – and in a later stage the district heating will be connected with a geothermal energy source. Outcomes and lessons learned from this process can provide valuable insights for the upgrade of DHC of other cities in EU.

How the IE can bring a market change and how market changes may affect the IE:

The closure of coal mines implicates social risks such as the loss of 27,000 jobs between 2015 and 2020 and 160,000 by 2030[16]. Coal accounts for nearly 25% of the total EU electric power production. Therefore, the transition of those regions needs careful planning, regional economy adaptation and decision-making policies, in order to create new opportunities for the people formerly working in the coal sector. The EC established Coal Regions in Transition Initiative[17], and the Platform for Coal Regions in Transition[18] launched in 2017, promote knowledge sharing and experience exchange between EU coal regions. Governments should plan a just and well managed phase out of coal[19]. Under this framework (as well the generic goal of achieving a low carbon economy in EU), relevant solutions are expected to gain an increasing attention during the next years.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#1, since they support the decarbonization and smartification of the DHC network.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**1.2.7**	**Description/Title**	**Aquifer Thermal Energy Storage (ATES)**

Current market needs that the IE will address:

There is a high need for replacing traditional fossil fuel dependent heating and cooling systems, with sustainable ones. In order for this transition to be successful, these systems need to utilize local renewable energy sources while being cost-effective. The need for storage and peak shaving is significant in this process.

Value proposition of the IE:

This is an innovative and sustainable thermal storage solution that takes advantage of otherwise wasted heat streams to provide heating and cooling to the buildings in a cost-effective way (also reducing associated CO_2 emissions). It is characterized by lower costs due to peak shavings and lower energy use.

How the IE can bring a market change and how market changes may affect the IE:

EU has set ambitious targets to reduce greenhouse gas emission, increase use of sustainable energy and improve energy efficiency. ATES can significantly contribute to this target due to the high contribution of building's heating and cooling needs to the carbon footprint. During the last years the development of ATES has been paid a lot of attention and the number of ATES is increasing especially in Europe (20,000 ATES systems are expected to be installed in the Netherlands until 2020[20]). ATES can be applied worldwide if the climatic and geohydrological conditions are right. On the other hand, there is a number of factors

[15] Paardekooper et al. (2018), Heat Roadmap Europe 4: Quantifying the Impact of Low-Carbon Heating and Cooling Roadmaps, http://vbn.aau.dk/files/288075507/Heat_Roadmap_Europe_4_Quantifying_the_Impact_of_Low_Carbon_Heating_and_Cooling_Roadmaps.pdf
[16] Coal regions in transition – European Commission 2019
[17] https://ec.europa.eu/info/sites/info/files/coal_regions_presentation_ema_at.pdf
[18] https://ec.europa.eu/energy/en/topics/oil-gas-and-coal/EU-coal-regions/secretariat-and-technical-assistance
[19] Europe beyond coal campaign- September 2019: https://beyond-coal.eu/
[20] Godschalk, M.S and Bakema, G. (2009). "20,000 ATES Systems in the Netherlands in 2020 – Major step towards a sustainable energy supply", Proceedings Effstock

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that can potentially delay the wide scale penetration of ATES in the market. The legal framework of shallow geothermal installations and the adoption of a maximum change in groundwater temperature is diverse among countries. ATES is currently not allowed to be applied in contaminated aquifers, due to the possible spreading of contaminants in the groundwater of the subsurface especially in urban areas. Despite the regulations made to prevent the interference between ATES and groundwater contaminants, the possibility of their encounter is however rising, because of the rapid increase of the number of ATES and slow progress of remediation groundwater contaminations in urban area.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#1, since they support the introduction of innovative technologies and products that can push energy performance levels beyond the levels of current EU building codes, increase energy efficiency and utilize local renewable energy sources. Relevant constraints may delay this process though.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**1.2.8**	**Description/Title**	**Li-ion/Li-metal Batteries**

Current market needs that the IE will address:

Check IE #1.1.17 // Due to the increasing number of solar panels, the energy network is burdened. This increase will cause problems at peak times in the future. By storing this energy locally, overloading is prevented. Currently supplying energy to the energy network is still subsidized. This makes local storage more important

Value proposition of the IE:

Check IE #1.1.17 // Make optimum use of locally sustainably generated energy and prevent overloading the energy grid // If feed-in of generated energy is no longer subsidized, it will become unattractive and in summary, lower energy costs and less CO_2 emissions.

How the IE can bring a market change and how market changes may affect the IE:

Check IE #1.1.17 // The use of batteries is a good solution to absorb peak moments in both production and use of electricity. It thus offers a flexible (and probably cheaper) alternative to grid reinforcement. There is only limited experience with this, which makes both investors and users reluctant to use it. The rollout of this stands or falls with proven applications. The project contributes to increasing practical experience. Increasing the flexibility in the grid also leads to more options for feeding in sustainably generated electricity into the grid.

How current and future market changes/challenges affect POCITYF's Objective:

Check IE #1.1.17

Negatively		**Neutral**	**X**	Positively	

Innovative Element (IE) #	**1.2.9**	**Description/Title**	**DC Lighting with EV charging**

Current market needs that the IE will address:

Check IE #1.2.1 // Alkmaar has a strong ambition regarding emission free mobility and car sharing. Integration with renewable generation is a key aspect // The market requests more and more charging poles for the increasing amount of electric driven vehicles in Alkmaar // The market requests public free entrance to internet everywhere // The market requests energy saving public lighting, with a good light quality and large area covered by the lamppost.

Value proposition of the IE:

These smart lampposts can offer more functionalities than an existing normal lamppost, which makes it a better offering compared to existing lamppost. Furthermore, useful data can be obtained to create energy positive and smart neighborhoods. The introduction of 5G network as from 2022 will cause a large increasement of antennas for mobile communication. This shall be done in a cost-efficient way. Furthermore, these antennas create a disturbing view in the (monumental) streets, which should be minimized as much as possible. The smart lampposts can create a solution for this matter. The same reasoning is valid for charging poles: Separate charging poles for electric vehicles won't be necessary when using the smart lampposts. This is cost-efficient and minimizes a disturbing view and extra required space for separate charging poles. Furthermore, this promotes the usage of electric driven vehicles.

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How the IE can bring a market change and how market changes may affect the IE:
Check IE #1.2.1 // This IE is very innovative and will alter the way how we look at lampposts, this technology can create a market change.
How current and future market changes/challenges affect POCITYF's Objective:
Check IE #1.2.1

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**1.2.10**	**Description/Title**	**Solar Roads**
Current market needs that the IE will address:			
Check IE #3.2.3			
Value proposition of the IE:			
Check IE #3.2.3			
How the IE can bring a market change and how market changes may affect the IE:			
Check IE #3.2.3			
How current and future market changes/challenges affect POCITYF's Objective:			
Check IE #3.2.3			

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**1.2.11**	**Description/Title**	**V2G**
Current market needs that the IE will address:			
Check IE #3.1.4			
Value proposition of the IE:			
Check IE #3.1.4			
How the IE can bring a market change and how market changes may affect the IE:			
Check IE #3.1.4			
How current and future market changes/challenges affect POCITYF's Objective:			
Check IE #3.1.4			

Negatively		Neutral		**Positively**	**X**

Table 8 Business models and innovation for IS-1.2

Innovative Element (IE) #	**1.2.1**	**Description/Title**	**Smart Lamps with EV Charging and 5G functionalities**
Business Models – capturing value from the IE:			
• Direct installation in districts. Financial revenues can emerge through the purchasing and installation of the solution. • Infrastructure as a Service (IaaS): The city can offer the lampposts infrastructure as a service creating revenues for the city • Platform as a Service (PaaS) Provide the environment to support the ability to build, test and deploy cloud services.			
Innovative Element (IE) #	**1.2.2**	**Description/Title**	**Energy Router**
Business Models – capturing value from the IE:			
Check IE #1.1.7			
Innovative Element (IE) #	**1.2.3**	**Description/Title**	**Smart Distribution Management System**
Business Models – capturing value from the IE:			
• Direct installation on a grid level. Financial revenues can emerge through the purchasing, installation and training of grid operators of the solution.			
Innovative Element (IE) #	**1.2.4**	**Description/Title**	**P2P Energy Trading Platform**
Business Models – capturing value from the IE:			
• Use the inter-relationships between stakeholders (facility-to-facility level, facility-to-DSO level, and facility-to-aggregator-to-DSO level) to promote energy trading schemes. Income generation can occur by applying a utilization fee and/or purchasing of the solution.			

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

Innovative Element (IE) #	1.2.5	Description/Title	Community Solar Farm
Business Models – capturing value from the IE:			
• Provide a virtual energy wallet composed by investments in solar panels outside the protected city area servicing also citizens that live in cultural heritage/protected areas. This energy wallet can be used in demand-response schemes, P2P trading schemes etc.			
Innovative Element (IE) #	**1.2.6**	**Description/Title**	**DHC (biomass, waste, geothermal)**
Business Models – capturing value from the IE:			
• Cost savings due to increased efficiency of DHC network operation.			
Innovative Element (IE) #	**1.2.7**	**Description/Title**	**Aquifer Thermal Energy Storage (ATES)**
Business Models – capturing value from the IE:			
• Direct installation in buildings (both new and renovated) that require energy efficiency improvements, coupled with RES integration. Financial revenues can emerge through the purchasing and installation of the solution. • Offer of renovation services as part of "integrated" renovation package solutions, including different innovative elements-set ups of POCITYF.			
Innovative Element (IE) #	**1.2.8**	**Description/Title**	**Li-ion/Li-metal Batteries**
Business Models – capturing value from the IE:			
Check IE #1.1.17 • In case citizens do not desire to physically own a battery system that would enable a future use or trading of this surplus energy, they should be able to buy virtual storage for this effect. This business model will assess the potential that a citizen-individual storage cloud and community-oriented virtual wallet could bring to the citizens.			
Innovative Element (IE) #	**1.2.9**	**Description/Title**	**DC Lighting with EV Charging**
Business Models – capturing value from the IE:			
Check IE #1.2.1			
Innovative Element (IE) #	**1.2.10**	**Description/Title**	**Solar Roads**
Business Models – capturing value from the IE:			
Check IE #3.2.3			
Innovative Element (IE) #	**1.2.11**	**Description/Title**	**V2G**
Business Models – capturing value from the IE:			
Check IE #3.1.4			

4.1.3 Integrated Solution 1.3: Feeding of PEDs with Waste Streams (heat/materials) promoting Symbiosis and Circular Economy

POCITYF aims to demonstrate and replicate success stories for waste streams (heat and 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.

The innovative elements which for the IS-1.3 are listed below while the following tables contain the progress relative to the three main pillars as described in the introduction of Section 4.

IS-1.3: Feeding of PEDs with Waste Streams (heat/materials) promoting Symbiosis and Circular Economy (2nd life residential batteries // Pay-As-You-Throw (PAYT) // Reverse collection of waste // Circular economy building practices // ATES (heat/cold storage) // PCM in the floor // Waste management tools)

Table 9 Technical and innovation progress for IS-1.3

Innovative Element (IE) #	1.3.1	Description/Title	2nd Life Residential Batteries

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

Innovative aspects of the IE:

Check IE #1.1.9

Advancement of TRL levels (TRL6→7/8):

Check IE #1.1.9

Innovative Element (IE) #	**1.3.2**	**Description/Title**	**Pay-As-You-Throw (PAYT)**

Innovative aspects of the IE:

POCITYF will demonstrate an end-to-end Pay-As-You-Throw (PAYT) system for waste production measurement. The key innovation of PAYT system is that it provides a ready-to-use solution that lets municipalities track their citizens' waste production levels. This makes more data available for the cities in order to efficiently implement policies to enforce sustainable behaviors. The technical innovative aspects include a smart locking mechanism that can be retrofitted into existing waste containers, making the installation and deployment of the system straightforward, and the use of volume and weight sensors that enable precise monitoring of waste production.

Advancement of TRL levels (TRL8→9):

Ubiwhere has implemented and tested the PAYT system in several use cases (one of them is in Aveiro). The pilot in Aveiro has run since late 2017, with 26 "smart" waste containers and aims to support municipalities adopting PAYT (pay-as-you-throw) waste fees, encouraging recycling, motivating the prevention and sorting of urban waste and contributing to a better management of the European resources and deployment of environmental strategies (TRL8). During POCITYF this system will be further proven in operational environment unlocking its wide scale roll-out (TRL9). More specifically, the municipal buildings of PEB1 in Evora, will leverage from the implementation of the PAYT system, which, by maintaining a tight control on the container's state, will increase the efficiency and efficacy of the urban waste team. A management platform will be developed, allowing the creation of multiple profiles and permission levels, optimizing the collection routes, configuring alerts and giving access to the collected data statistical analysis and gains measurement.

Innovative Element (IE) #	**1.3.3**	**Description/Title**	**Reverse Collection of Waste**

Innovative aspects of the IE:

This is a novel waste collection scheme, characterized by the separate collection of each re-usable commodity at different moments, instead of collecting mixed garbage by the garbage truck every week. These commodities are collected as followed: a) vegetables, fruit & garden waste (GFT); b) plastics, cans and drinking packages (PBD); c) paper and cardboard; d) The small amount of other waste material: this shall be brought by the consumers to underground containers in the vicinity of their homes. Other commodities like glass, cloths, electronic goods, batteries, paint, wood, bricks, metals, large waste, etc. shall be brought by the residents to the central waste collection station. Some commodities can also be thrown in local containers (glass, cloths) or brought to local collection points in stores (batteries), this is already a common procedure in The Netherlands and is not part of this IE.

Advancement of TRL levels (TRL8→9):

Currently, separation of the GFT and rest waste is already a common procedure for citizens in Alkmaar. The Municipality of Alkmaar has commissioned a study to assess the local opportunities for the circular economy in the region of Alkmaar identifying the largest waste streams in the region. This provides insight into which waste can be prevented and which waste streams can be recycled (TRL8). Additionally, Alkmaar has a 'waste hub' Sportive, in which the municipality and HVC are partner, consisting of collection, demolition and recycling companies. Opportunities for smarter collection and/or recycling of various waste streams will be tackled together with relevant companies in Alkmaar. Reverse collection of waste will be demonstrated during POCITYF in all households to encourage the production of as little residual waste as possible (TRL9). Specific targets for re-used/reusable/bio/modular materials will be set both for renovated and new buildings within Westrand.

Innovative Element (IE) #	**1.3.4**	**Description/Title**	**Circular Economy Building Practices**

Innovative aspects of the IE:

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

POCITYF aims to promote and apply as much as possible, building practices in accordance with the principles of circular economy. Innovative aspects of this IE are the combination of renovation, the usage of less surface and the application of circular practices within the renovation. It contains the renovation with / integration of an ATES-system with smart heating and cooling, a green roof, flexible demountable wall systems, ecological carpets, environmentally friendly rubber floor finish, solar panels on the roof, facade and bicycle part, energy efficient smart lighting and others.

Advancement of TRL levels (TRL7→9):

POCITYF will offer proven cases of success implementation of circular economy building practices in actual operational environment (TRL9). Duurzaam Bouwloket has already experience with the use of circular materials, as shown in IS 1-1. In terms of circular economy building practices Inholland has renovated their campus with an ATES system, a green roof, flexible demountable wall systems, ecological carpets and environmentally friendly rubber floor finish. Alliander has achieved one of the most circular renovations in the World (office in Duiven). The expertise and the outcomes of these Circular projects will be capitalized by POCITYF. Van Alckmaer at the Bloemwijk in Alkmaar will demolish and re-build 190 new residences, 55 of which will be built during POCITYF. In accordance with the principles of circular economy, as much of the building materials of the demolished buildings as possible, will be used during the new construction, such as wood and bricks.

Innovative Element (IE) #	**1.3.5**	**Description/Title**	**ATES**

Innovative aspects of the IE:

Check IE #1.2.7

Advancement of TRL levels (TRL7→8):

Check IE1.2.7

Innovative Element (IE) #	**1.3.6**	**Description/Title**	**PCM in the floor**

Innovative aspects of the IE:

Check IE #1.1.20

Advancement of TRL levels (TRL7→8):

Check IE #1.1.20

Innovative Element (IE) #	**1.3.7**	**Description/Title**	**Waste Management Tools**

Innovative aspects of the IE:

This IE puts Circular Economy in practice through mapping of the material steams by a material passport, for both demolition phase and construction phase of the re-build of the building. By mapping material streams, some of the waste materials can be reused. The materials passport will make it possible to see the real time value of all the materials in the building. When the buildings will reach the end of life cycle, these materials can be sold or recycled creating value as opposed to the event of disposal.

Advancement of TRL levels (TRL8→9):

Waste management tools (e.g. material passports) are already a mature solution (current level TRL8). Duurzaam Bouwloket has already experience with the use of circular materials, as shown in IS 1-1. In terms of circular economy building practices Inholland has renovated their campus with an ATES system, a green roof, flexible demountable wall systems, ecological carpets and environmentally friendly rubber floor finish. Alliander has achieved one of the most circular renovations in the World (office in Duiven). The expertise and the outcomes of these Circular projects will be capitalized by the POCITYF project. Several pilot projects (e.g. Beatrixsluis by Rijkswaterstaat) are experimenting with material passports. Within this project Van Alckmaer at the Bloemwijk in Alkmaar will demolish and re-build 190 new residences, 55 of which will be built during POCITYF. In accordance with the principles of circular economy, as much of the building materials of the demolished buildings as possible, will be used during the new construction, such as wood and bricks. Additionally, material streams will be mapped during the development utilizing relevant tools, along with materials passports utilizing the Madaster platform. The waste streams will be collected by Stadswerk 072 (department within the municipality of Alkmaar) and processed by consortium partner HVC and used to create energy. The outcome of the Bloemwijk renovation can be used to further advance the level of TRL of this IE (TRL9).

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Table 10 Market needs, changes and challenges for IS-1.3

Innovative Element (IE) #	**1.3.1**	**Description/Title**	**2nd Life Residential Batteries**		
Current market needs that the IE will address:					
Check IE #1.1.9					
Value proposition of the IE:					
Check IE #1.1.9					
How the IE can bring a market change and how market changes may affect the IE:					
Check IE #1.1.9					
How current and future market changes/challenges affect POCITYF's Objective:					
Check IE #1.1.9					
Negatively		Neutral		**Positively**	**X**
Innovative Element (IE) #	**1.3.2**	**Description/Title**	**Pay-As-You-Throw (PAYT)**		
Current market needs that the IE will address:					
489 kg of municipal waste per capita were generated in the EU in 2018, whereas 47% of municipal waste was recycled (material recycling and composting)[21]. For 2018, municipal waste generation totals vary considerably, ranging from 272 kg per capita in Romania to 766 kg per capita in Denmark. The variations reflect differences in consumption patterns and economic wealth, but also depend on how municipal waste is collected and managed. As population rises, more materials/products are consumed, and thus more waste is produced – making efficient waste management a necessity for sustainable development. EU waste management policies aim to reduce the environmental and health impacts of waste and to improve the EU's resource efficiency. The long-term aim of these policies is to reduce the amount of waste generated and when waste generation is unavoidable to promote it as a resource and achieve higher levels of recycling and the safe disposal of waste. To achieve these goals, there is a growing need for different, more efficient and dynamic waste collection systems and motivated people, knowing what, how and why it should be done. The growing awareness and pressure for changing our habits, so that they are increasingly sustainable, requires a change in the way we produce and treat the waste. In this sense, one of the ways to foster this awareness is through paying for the waste we produce. The more waste is produced, the higher the cost to the citizen. Solutions like PAYT are therefore increasingly requested by city decision-makers.					
Value proposition of the IE:					
A novel waste management system, including state-of-the-art technology applied to common municipal waste containers and a management platform, allowing the monitoring of the amount of urban waste deposited, the creation of multiple profiles and permission levels, optimizing the collection routes, configuring alerts and giving access to the collected data statistical analysis and gains measurement. The current model of undifferentiated payment for waste or based on water consumption is not realistic nor does it even promote sustainability by reducing waste or increasing recycling. With systems like PAYT, it is intended to change not only this functioning but also the behavior of citizens.					
How the IE can bring a market change and how market changes may affect the IE:					
Even though more waste is being generated in the EU-28, the total amount of municipal waste landfilled has diminished. In the reference period, the total municipal waste landfilled in the EU-28 fell by 88 million tones, or 61 % - from 145 million tones (302 kg per capita) in 1995 to 57 million tones (111 kg per capita) in 2018. This reduction can partly be attributed to the implementation of European legislation, for instance Directive 62/1994 on packaging and packaging waste. Waste prevention and the use of waste as a resource is becoming increasingly important, not only in environmental policy but also in industrial and raw materials policy. In December 2015, the European Commission published 'Closing the loop — An EU action plan for the circular economy' (EC, 2015), otherwise known as the Circular Economy Package. Unlike the traditional linear take–make–consume–dispose approach, a circular economy seeks to respect planetary boundaries by increasing the proportion of renewable or recyclable resources while reducing the					

[21] https://ec.europa.eu/eurostat/statistics-explained/index.php/Municipal_waste_statistics#Municipal_waste_generation

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consumption of raw materials. The Waste Framework Directive (EU, 2008) obliges EU Member States to adopt and implement waste prevention programs. The revised Waste Framework Directive (EU, 2018) strengthens this requirement but does not introduce binding quantified targets for waste prevention. As the requirements will becoming more ambitious and stricter for waste collection and treatment, market demand for relevant solutions will be increased. New ways of facing the problem of waste, improving the sustainability of cities, as well as the creation of new solutions similar to PAYT for a change in the paradigm of the production and treatment of waste are expected to gain higher attention.

How current and future market changes/challenges affect POCITYF's Objective:

Market changes relevant to this IE are indirectly contributing to Objective #1, since the generation of less waste is accompanied by significant energy savings (both in terms of resource efficiency-less raw materials need to be extracted and treatment). With encouraging recycling, motivating the prevention and sorting of urban waste POCITYF intends to contribute to better management of the European resources and deployment of environmental strategies.

Negatively		**Neutral**	**X**	Positively	

Innovative Element (IE) #	**1.3.3**	**Description/Title**	**Reverse Collection of Waste**

Current market needs that the IE will address:

Check IE #1.3.2 // Alkmaar aims to reach a 60% waste separation by the end of 2020. This means a reduction of 235 kg to 180 kg of other waste material per resident per year. The Dutch government aims to be fully circular in 2050 and all waste is to be re-used. The aim is to use as less new materials & products as possible by recycle the existing materials & products as much as possible.

Value proposition of the IE:

This is a novel waste collection scheme, where waste in no longer collected from homes, and residents have to bring residual waste to a dedicated container/facility making it easier to offer separated waste // Re-usable commodities can be used to create new products. Less raw material has to be used and/or less new material has to be fabricated (energy saving, environmental saving, emission saving, etc.) // Less garbage has to be burnt in the ovens of the waste plant // Less farmland is needed for the production of new wood, cotton, etc., more ground available for agriculture or nature purposes // Less waste creates a better environment. Less spillage in nature is better of wildlife and environment.

How the IE can bring a market change and how market changes may affect the IE:

Check IE #1.3.2 // This IE can change the way we deal with garbage. By forcing the separate collecting of the different re-usable commodities, residents are forced to separate the garbage at their homes, and hence the re-usable commodities will be separated from the beginning. Some governmental institutes (e.g. Rijksoverheid) already demand during the procurement phase that their clothing (for army, firemen, customs, police) contain a minimum percentage of recycled content.

How current and future market changes/challenges affect POCITYF's Objective:

Check IE #1.3.2

Negatively		**Neutral**	**X**	Positively	

Innovative Element (IE) #	**1.3.4**	**Description/Title**	**Circular Economy Building Practices**

Current market needs that the IE will address:

Check IE #1.1.12 // This IE shows the market that it is possible to make an existing, old building sustainable. It's an example for other buildings and a good alternative for building a new campus-building complexes (what would be easier with less complexity and sometimes cheaper choice).

Value proposition of the IE:

POCITYF will demonstrate circular economy building practices such as maximum reuse of building materials from demolition and the re-use of concrete offering proven cases of success in actual operational environment. The use of less surface for tertiary needs, combined with sustainable energy production and measures to reduce the energy consumption (save energy), lead to enormous energy efficiency. The energy costs are reduced substantially, and the lifespan of the building is extended.

How the IE can bring a market change and how market changes may affect the IE:

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

Check IE #1.1.12 // When more buildings will apply circular economy practices, the costs will be reduced changing the way we used to deal with our buildings (instead of demolishing or leaving the building for a new building, we choose for renovation)

How current and future market changes/challenges affect POCITYF's Objective:

Check IE #1.1.12

Negatively		**Neutral**	**X**	Positively	

Innovative Element (IE) #	**1.3.5**	**Description/Title**	**ATES**

Current market needs that the IE will address:

Check IE #1.2.7

Value proposition of the IE:

Check IE #1.2.7

How the IE can bring a market change and how market changes may affect the IE:

Check IE #1.2.7

How current and future market changes/challenges affect POCITYF's Objective:

Check IE #1.2.7

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**1.3.6**	**Description/Title**	**PCM in the floor**

Current market needs that the IE will address:

Check IE #1.1.20

Value proposition of the IE:

Check IE #1.1.20

How the IE can bring a market change and how market changes may affect the IE:

Check IE #1.1.20

How current and future market changes/challenges affect POCITYF's Objective:

Check IE #1.1.20

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**1.3.7**	**Description/Title**	**Waste Management Tools**

Current market needs that the IE will address:

Check IE #1.3.2 // Raw material are scarce. In order to keep materials available indefinitely, they need to be reused, and their use must be documented // Re-used material could offer financial and environmental benefits compared to newly bought materials, e.g. less transport movements, less use of water, electricity and other resources, CO2 reduction, job potential // Used materials can be sold, which adds value.

Value proposition of the IE:

A material passport gives insight into the materials used to create a building, and into their quantities. Additionally, the passport contains information on the quality of materials, their location, and their monetary and circular value. This way, it becomes a lot easier to reuse materials, minimize waste, and to reduce the cost of material consumption. Improved insight into the use of material will stimulate the circular economy, and will lead to better design solutions for the market.

How the IE can bring a market change and how market changes may affect the IE:

Check IE #1.3.2 // An increase of the price of raw or new material will strongly influence to need to re-use materials. The same applies for the availability of the raw / new materials. // Legislation can force the application of a material passport. // Legislation can force an extra tax or penalty for not re-using the material // Government can create opportunities by providing grants/tax deduction schemes for the use of recycled materials (proved by the material passports) // This IE can bring awareness to the market that used materials can have value and can be re-used.

How current and future market changes/challenges affect POCITYF's Objective:

Check IE #1.3.2 // Not all materials can be re-used, as the quality or quantity of the material can be poor after demolition. The chosen design solution highly affects the success rate of re-used materials.

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Negatively		Neutral	X	Positively	

Table 11 Business models and innovation for IS-1.3

Innovative Element (IE) #	1.3.1	Description/Title	2nd Life Residential Batteries
Business Models – capturing value from the IE:			
Check IE #1.1.9			
Innovative Element (IE) #	**1.3.2**	**Description/Title**	**Pay-As-You-Throw (PAYT)**
Business Models – capturing value from the IE:			
• The business model behind the PAYT system follows a mixed model with CAPEX. This model links the number of waste containers, waste lids and RFID cards, linked with OPEX, the cloud platform's hosting requirements and the mobile communications (to synchronize the access control whitelists and the readings about waste production) between the waste containers and the web platform. This business model incorporates circular inputs, product-service systems, and knowledge sharing platforms under the umbrella of Circular Economy Business Models (CEBM) • Support municipalities adopting waste fees, encouraging recycling, motivating the prevention and sorting of urban waste and contributing to a better management of the European resources and deployment of environmental strategies. • Direct installation of the hardware and the software system to monitor and inform on waste collection of containers in municipalities • Product as a service (PraaS) – provide the hardware and the software system to monitor and inform on the waste collection from containers			
Innovative Element (IE) #	**1.3.3**	**Description/Title**	**Reverse Collection of Waste**
Business Models – capturing value from the IE:			
• Support municipalities adopting waste fees, encouraging recycling, motivating the prevention and sorting of urban waste and contributing to a better management of the European resources and deployment of environmental strategies. In order to be able to develop a good business model for reversed collection of waste, it is important to have insight into the cost structure of waste collection, the processing of it and how this affects the cost price and the selling price of recycled materials. For a feasible business model it is important that the use of recycled building materials in terms of price level is comparable to that of new materials. Traditional industry (for instance raw material suppliers for the packaging industry) has a head start there, mainly due to economies of scale, which keeps the price per unit of virgin material or new product low. Government support, for example, in the form of subsidies or tax breaks for the use of recycled materials and / or taxing the use of new materials or the disposal of waste.			
Innovative Element (IE) #	**1.3.4**	**Description/Title**	**Circular Economy Building Practices**
Business Models – capturing value from the IE:			
• Resource recovery techniques from building waste, could be integrated to contribute to income generation, cost reduction, and adding value to the whole process. When the buildings will reach the end of life cycle, materials can be sold or recycled creating value as opposed to the event of disposal.			
Innovative Element (IE) #	**1.3.5**	**Description/Title**	**ATES**
Business Models – capturing value from the IE:			
Check IE #1.2.7			
Innovative Element (IE) #	**1.3.6**	**Description/Title**	**PCM in the floor**
Business Models – capturing value from the IE:			
Check IE #1.1.20			
Innovative Element (IE) #	**1.3.7**	**Description/Title**	**Waste Management Tools**
Business Models – capturing value from the IE:			
• By mapping materials streams, some of the waste materials can be reused. The materials passport will make it possible to see the real time value of all the materials in the building. When the buildings will reach the end of life cycle, these materials can be sold or recycled creating value as opposed to			

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the event of disposal. In order to be able to develop a good business model for waste management tools, it is important to have insight into the cost structure of waste processing and how this affects the cost price and the selling price of recycled building materials. For a feasible business model, it is important that the use of recycled building materials in terms of price level is comparable to that of new building materials. The traditional construction sector has a head start there, mainly due to economies of scale, which keeps the price per unit of new product low. Government support, for example, in the form of subsidies or tax breaks for the use of recycled materials and / or taxing the use of new building materials or the dumping of construction waste.

4.2 Progress related to Project Objective #2

Objective 2: Demonstrate P2P energy management and storage solutions supporting grid flexibility and curtailment reduction.

POCITYF will demonstrate how the solutions (TRL≥6) proposed for achieving flexible and energy efficient electricity, heating and cooling networks (**Obj. 1**) grouped in ETT#2 (coupled with ETT#1) portfolio of solutions can be adapted to the different climatic conditions and regional special characteristics (technical, financial, social and legal) of the cities involved. Most of those solutions have already been pre-piloted (see section 1.3.4). Solutions will further benefit from mature and innovative P2P energy management enabling the integration of service providers, energy exchange and storage. The storage solutions vary from short to seasonal ones, while the benefits gained from the utilization of low temperature waste heat and geothermal sources are expected to support the operation of flexible, sustainable and high-energy efficient networks. Special attention will be given on the use of 2nd life batteries (to promote circular economy) and V2G deployment (to support grid flexibility services and curtailment reduction).

Objective #2 is aligned with the activities under POCITYF Energy Transition Track #2: P2P Energy Management and Storage Solutions for Grid Flexibility. ETT#2 encompasses 2 Integrated Solutions (IS): IS-2.1 deals with Flexible and Sustainable Electricity Grid Networks with Innovative Storage Solutions while IS-2.2 deals with Flexible and Sustainable District Heating/Cooling with Innovative Heat Storage Solutions.

Tables 10-16, report on the three main pillars as described in the beginning of Section 4. As various innovative elements fall into multiple Objectives (or ETTs), duplication of information is avoided by pointing out the specific Obj. and IS where this IE has been detailed. The progress reporting is structured per Integrated Solution.

4.2.1 Integrated Solution 2.1: Flexible and Sustainable Electricity Grid Networks with Innovative Storage Solutions

As the share of RES will be increasing in the coming decades, the generation of energy will change drastically towards decentralized generation mostly by local household and block/district level RES systems operating in the level of micro-grids. Due to the intermittent nature of RES, grid stress is a challenge. Therefore, there is a need for more flexibility in the energy system and decreasing curtailment. Advances in technology can help linking resource efficiency and flexibility in energy supply and demand with innovative, inclusive and more efficient services for citizens and businesses. POCITYF will demonstrate innovative storage and grid flexibility solutions that understand and allow the effective management of the core issues of interwoven and interdependent energy sub-networks and sub-systems of sustainable district/city smart grid environments.

The innovative elements which for the IS-2.1 are listed below while the following tables contain the progress relative to the three main pillars as described in the introduction of Section 4.

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

IS-2.1: Flexible and Sustainable Electricity Grid Networks with Innovative Storage Solutions (2nd life residential batteries // Micro-grid controller platform // Control algorithms // LV and MV-connected storage systems // P2P energy trading platform // City Energy Management System // ReFlex (ex-PowerMatcher) (DSM platform) // Stationary batteries // Virtual Power Plant (VPP) // V2G // DC grid // Fuel cells(hydrogen)

Table 12 Technical and Innovation Progress for IS-2.1

Innovative Element (IE) #	**2.1.1**	**Description/Title**	**2nd life residential batteries**
Innovative aspects of the IE:			
Check IE #1.1.9			
Advancement of TRL levels:			
Check IE #1.1.9			
Innovative Element (IE) #	**2.1.2**	**Description/Title**	**Micro-grid controller platform**
Innovative aspects of the IE:			
The innovation of this IE lies on the make use of distributed management and control strategies to allow the provisioning of flexibility and market services using RES forecasting, Distributed Energy Resources (DER), energy models and load estimation tools. It offers improved flexibility and controllability of energy resources in distribution grids while its interface to DSO (Distributed System Operators) allows controlling of existing assets. This IE is subject to replacement. Info will be updated in following versions of the deliverable.			
Advancement of TRL levels (TRL6→7):			
The technology has been demonstrated in relevant environment (TRL 6) in the Sustainable and SENSIBLE projects, where these controllers were deployed in electric grids in Evora, to allow the integration of renewable and provide distributed voltage control capabilities to secondary distribution substation. The TRL increase to level 7 and beyond (8-9), will be performed via the system prototype demonstration in the operational environment of residential and commercial PEBs (Evora), performing software modules, extensive testing and pre-certification when applicable. This IE is subject to replacement. Info will be updated in following versions of the deliverable.			
Innovative Element (IE) #	**2.1.3**	**Description/Title**	**Control Algorithms**
Innovative aspects of the IE:			
Flexibility Control Algorithms for energy performance improvement at building and district levels, allow the characterization and use of the available energy flexibility, at building and district levels, to achieve different objectives as defined by the respective DSM measure. The operation of the controllable devices contributing to the referred energy flexibility (e.g. appliances and batteries) is defined by these algorithms taking into consideration the objectives of the enabled DSM measures (e.g. self-consumption improvement) and the comfort needs and preferences of the involved consumers.			
Advancement of TRL levels (TRL6→7):			
Flexibility Control Algorithms have been extensively studied, developed and demonstrated (TRL 6) under the International Energy Agency, within their Energy in Buildings and Communities program, working group Annex 67. During POCITYF Flexibility Control Algorithms will reach TRL 7 by having the energy flexibility characterization and use demonstrated in operational environment in order to achieve the objectives of the enabled DSM measures (e.g. self-consumption improvement).			
Innovative Element (IE) #	**2.1.4**	**Description/Title**	**LV and MV connected storage systems**
Innovative aspects of the IE:			
The specific IE refers to grid integrated Low-voltage and Medium-Voltage electric energy storage systems. These battery systems allow to deal with increasing Renewable Energy Sources (RES) and their inherent variability. The innovative nature of these systems can lead to a multitude of offered services , i.e., peak-shaving, reactive power compensation, RE self-consumption maximization, increased energy			

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dispatchability, power quality management and control (voltage sags or dips, interruptions, voltage spikes, harmonic distortion, voltage fluctuation), etc.

Advancement of TRL levels (TRL6→7):

The IE has been demonstrated in an operational level within the scope of H2020, SENSIBLE where four LV and one MV storage systems have been utilized in Valverde (TRL 6). During POCITYF, this IE will be further developed, and novel energy management strategies will be developed and customized according to the typology of the demonstration sites, resulting in a more complete and enhanced solution (increasing the TRL according to the technology of battery storage - TRL 7 and beyond).

Innovative Element (IE) #	**2.1.5**	**Description/Title**	**P2P energy trading platform**

Innovative aspects of the IE:

Check IE #1.2.4

Advancement of TRL levels (TRLX→Y):

Check IE #1.2.4

Innovative Element (IE) #	**2.1.6**	**Description/Title**	**City Energy Management System**

Innovative aspects of the IE:

The innovative character of this IE lies to its nature as a city-based energy management system (EMS), in the form of a computer-aided tool used by power system operators to monitor, control, and carry out optimal energy management. CEMS can be used to determine power generation or power demands that minimize a certain objective such as generation cost, power loss, or environmental effect, at a city level. The Energy Flexibility Interface (EFI) included in the CEMS will provide additional aid on Demand Side and Smart Grid Management. In particular, EFI, known also as S2 communication and prepared by the Technical Committee CENELEC TC 205, is a communication protocol utilizing Energy Flexibility from smart devices in an automated way. Instead of describing the device itself, EFI describes the potential behavior of the devices. EFI is also used to send control instructions to the device. In doing so, the control algorithm does not need to know any device-specific details in order to control it. EFI can work with any type of control algorithm or incentive that optimizes the Energy Flexibility of devices. EFI bridges the gap between smart energy devices and Demand-Side Management (DSM) solutions.

Advancement of TRL levels (TRL7→8):

The use of an Energy Management System in terms of a DSM system has been demonstrated in the operational environment of the Stad van de Zon (Sun City) pre-pilot in Heerhugowaard next to Alkmaar (TRL 7). EFI and architectural and operational elements of the ReFlex software tool have been included in the management system. The implementation of a holistic complete and qualified CEMS in roughly 400 dwellings from Bloemwijk area (Alkmaar) will lead to the envisioned TRL leap (TRL 8).

Innovative Element (IE) #	**2.1.7**	**Description/Title**	**ReFlex (previously PowerMatcher)**

Innovative aspects of the IE:

Check ICT solution #3

Advancement of TRL levels (TRL7→8):

Check ICT solution #3

Innovative Element (IE) #	**2.1.8**	**Description/Title**	**Stationary batteries**

Innovative aspects of the IE:

The IE deals with stationary lithium ion batteries to store electricity. Such innovative batteries can serve on-demand and emergency needs as they are typically infrequently discharged as well as contribute to electrical load balancing. When power quality on the grid is poor or even during blackouts, the battery can be used to guarantee power availability and power quality within the building (entirely or for vital functions only), improving comfort and prolonging the lifespan of indoor devices.
Check also IE #1.1.17 and IE #1.2.8.

Advancement of TRL levels (TRL8→9):

Home storage of electricity with Li-ion batteries has been pre-piloted in Amsterdam Nieuw West by Alliander with 25 home batteries and a capacity of 160kWh (TRL 8). The proof of the actual system in operational environment (TRL9) will be performed in the Alkmaar's demonstration sites.

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Check also IE #1.1.17 and IE #1.2.8.

Innovative Element (IE) #	2.1.9	Description/Title	Virtual Power Plant (VPP) @NEROA

Innovative aspects of the IE:

A Virtual Power Plant is a network of decentralized, medium-scale power generating units such as wind farms, solar parks, and Combined Heat and Power (CHP) units, as well as flexible power consumers and storage systems. The interconnected units are dispatched through the central control room of the Virtual Power Plant but nonetheless remain independent in their operation and ownership. The objective of a Virtual Power Plant is to relieve the load on the grid by smartly distributing the power generated by the individual units during periods of peak load. Additionally, the combined power generation and power consumption of the networked units in the Virtual Power Plant is traded on the energy exchange. VPPs are innovative by nature as they are a combination of diverse kinds of power plants and storage units, each one with its own innovative character. Furthermore, this combination requires innovative modular designs based on software communication technologies that can integrate and manage decentralized generation and storage. In POCITYF, the VPP can be considered as a cross-cutting IE across ETT#2 and ETT#3 as it will integrate batteries from electric vehicles (V2G) and fuel cells. The hydrogen needed for the fuel cells is produced by local wind energy.

Advancement of TRL levels (TRL8→9):

VPP technology has been proven to work in its final form and complete system development and qualified by testing and evaluating of the system under most operating conditions (during H2020 projects). Operational procedures have been successfully completed prior to the start of POCITYF (TRL8). During POCITYF, the VPP concept will be demonstrated and proven in an operational environment in Alkmaar resulting to the TRL increase (TRL 9).

Check also IE #3.1.4 and #2.1.12 as these elements are parts of the VPP.

Innovative Element (IE) #	2.1.10	Description/Title	V2G

Innovative aspects of the IE:

Check IE #3.1.4

Advancement of TRL levels (TRLX→Y):

Check IE #3.1.4

Innovative Element (IE) #	2.1.11	Description/Title	DC grid

Innovative aspects of the IE:

Direct Current (DC) grid is an innovative element with lower grid losses compared to AC for the facilitation of production, storage and distribution of solar electricity. When connected with intelligent control technology and the li-ion batteries (as planned in POCITYF), energy can be used more efficiently and zoned/distributed optimally in the buildings of interest.

Advancement of TRL levels (TRL7→8):

The Technology Readiness of DC grids have reached level 7 through a variety of projects. In the Netherlands, there are already 15 projects with public lighting on DC grids (City Tec) on +/- 350 VDC and a NEN1010 energy norm has been developed. Municipality of Alkmaar and Alliander were involved in this new regulation. Alliander has a public DC grid in an industrial district near Lelystad airport and runs a pilot with DC connected dwellings in Delft. Through demonstration activities in Alkmaar demo sites, the technology will be qualified in a complete system form (TRL 8) in conjunction with other innovative technologies.

Innovative Element (IE) #	2.1.12	Description/Title	Fuel cells (hydrogen)

Innovative aspects of the IE:

Hydrogen fuel cells are electrochemical power generators that combine hydrogen and oxygen to produce electricity, with water and heat as by-products. Fuel cells do not need to be periodically recharged like batteries, but instead continue to produce electricity as long as a fuel source is provided. They are clean, scalable, operate near-silently and present improved efficiency especially in CHP systems. Moreover, the specific technology in POCITYF includes the production of hydrogen from wind energy which creates and

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offers innovation as the energy carrier (hydrogen) can be used to stabilize the grid and serve as storage (Power to Fuel concept).

Advancement of TRL levels (TRL7→9):

While the technology has been demonstrated and operating in Sun City (where 2 fuel cells from BlueGen are utilized to generate electricity to match supply and demand), POCITYF aims to integrate hydrogen based fuel cells to supplement the grid and the hybrid heat system during longer periods of low energy yield from solar (e.g. in winter). The hydrogen needed for the fuel cell will be generated from wind energy in the Boekelermeer industrial area forming a complete system (TRL 8).

Table 13 Market needs, changes and challenges for IS 2.1

Innovative Element (IE) #	**2.1.1**	**Description/Title**	**2nd life residential batteries**		
Current market needs that the IE will address:					
Check IE #1.1.9					
Value proposition of the IE:					
Check IE #1.1.9					
How the IE can bring a market change and how market changes may affect the IE:					
Check IE #1.1.9					
How current and future market changes/challenges affect POCITYF's Objective:					
Check IE #1.1.9					
Negatively		Neutral		**Positively**	**X**
Innovative Element (IE) #	**2.1.2**	**Description/Title**	**Micro-grid controller platform**		
Current market needs that the IE will address:					
As the penetration of RES into the market is rising, the demand for controlling platforms to maintain power load stability and increase grid flexibility is following the same trend. The lack of distributed energy resources for controllability and the integration of resources controlled by end-consumers contribute greatly to the need. This IE is subject to replacement. Info will be updated in following versions of the deliverable.					
Value proposition of the IE:					
By using advanced distributed management and control strategies, the solution offers high level control authority allowing for optimal ES integration , operation and consequent energy savings. Moreover, the prosumers are offered a solution to support the grid operation. This IE is subject to replacement. Info will be updated in following versions of the deliverable.					
How the IE can bring a market change and how market changes may affect the IE:					
The IE can introduce into the market novel services for grid support applicable to energy communities. Security and privacy considerations are considerable in DSM network systems. Future regulations might influence the wide application and control authority of algorithms towards DSM thus narrowing the market. Moreover, the grid operation strategy can vary significantly, and the application of distributed control schemes may not be used. This IE is subject to replacement. Info will be updated in following versions of the deliverable.					
How current and future market changes/challenges affect POCITYF's Objective:					
Envisioned market changes related to grid operation strategy and considerations on security and privacy might affect negatively Objective 2. Such effects could be balanced by the novel services introduced due to this technology, contributing positively to Objective #2. This IE is subject to replacement. Info will be updated in following versions of the deliverable.					
Negatively		**Neutral**	**X**	Positively	
Innovative Element (IE) #	**2.1.3**	**Description/Title**	**Control algorithms**		

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Current market needs that the IE will address:

The time variability of renewable energy sources and the increasing electrification of energy demand are illustrative examples of the rising need to implement DSM measures at different levels of power systems. The need to modify energy consumption in real time can also be identified in other types of energy systems, where peak demand reduction in district heating is a common example.

Value proposition of the IE:

Flexibility Control Algorithms will characterize and use the energy flexibility provided by different types of controllable devices bringing benefits for both consumers (e.g. lower energy costs) and power systems operators (e.g. lower peak loads). In such way, the modification of buildings' energy demand profiles to implement the referred DSM measures can be assured, tackling the identified market needs while respecting users' comfort needs and preferences.

How the IE can bring a market change and how market changes may affect the IE:

Flexibility Control Algorithms will bring a market change by allowing the characterization and use of the energy flexibility provided by different types of controllable devices resulting in benefits for both consumers and power systems operators. Changes in regulation that restrict the deployment of the Flexibility Control Algorithms to existing or new controllable devices, although unlikely, can affect this IE.

How current and future market changes/challenges affect POCITYF's Objective:

Future regulation affecting the IE deployment being unlikely, market changes are expected to have a positive impact on Objective #2 as the use of energy flexibility based on controllable devices will increase.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**2.1.4**	**Description/Title**	**LV and MV connected storage systems**

Current market needs that the IE will address:

In different market segments, these solutions will respond to different needs of users. In the domestic residential market, it maximizes the energy use of the building's own photovoltaic systems is maximized, increasing the user's return on investment. In the industrial/services and large consumer market, the IE also provides backup and uninterrupted energy supply services, as well as implementing intelligent energy management strategies such as peak shaving or ramp rate control. For grid operators and utilities these solutions provide effective tools to manage and control power quality in the grid (MV).

Value proposition of the IE:

This IE offers easy scalability of power and capacity, allowing to offer products suited to the scale of different users and their needs. Being easy to implement and integrate into the existing electrical networks, it provides additional and complementary energy services to existing photovoltaic solar energy production systems in buildings.

How the IE can bring a market change and how market changes may affect the IE:

Electric energy storage solutions will induce a large market evolution, providing new services and smart interaction of users and the existing grid. The legal framework regarding this technology is still under development and largely inexistent in some European countries. The implementation of technical standards and a legal European framework will guide and restrict market solutions and functionalities.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#2, given that a strong expansion of these storage technologies is expected, with decreasing costs, accompanying the large-scale implementation of distributed renewable energy sources.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**2.1.5**	**Description/Title**	**P2P energy trading platform**

Current market needs that the IE will address:

Check IE #1.2.4

Value proposition of the IE:

Check IE #1.2.4

How the IE can bring a market change and how market changes may affect the IE:

Check IE #1.2.4

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How current and future market changes/challenges affect POCITYF's Objective:

Check IE #1.2.4

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**2.1.6**	**Description/Title**	**City Energy Management System**

Current market needs that the IE will address:

Opportunities of flexible energy management are great both for commercial and residential consumers. As RES and smart grids occupy larger shares of the market, such management is required in order to outperform centralized energy distribution and control.

Value proposition of the IE:

The solution, based on the Energy Flexibility Interface, allows end users to control various smart devices unlocking the opportunities of flexible energy. Its value proposition lies on EFI's key attributes : Being independent of Smart Grid Technology and equipment, ease of use and end users focus. As an integrated scheme under the City Energy Management System it ensures a smart global management through relevant manufacturers devices (Powermatcher etc.).

How the IE can bring a market change and how market changes may affect the IE:

The CEMS can introduce enhanced flexibility and controllability that will allow the further penetration of RES and smart grids into a city's energy ecosystem.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen changes are expected to greatly contribute towards Objective #2 in terms of enhanced grid flexibility.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**2.1.7**	**Description/Title**	**Reflex (previously Powermatcher)**

Current market needs that the IE will address:

Check ICT solution #3

Value proposition of the IE:

Check ICT solution #3

How the IE can bring a market change and how market changes may affect the IE:

Check ICT solution #3

How current and future market changes/challenges affect POCITYF's Objective:

Check ICT solution #3

Negatively		Neutral		Positively	

Innovative Element (IE) #	**2.1.8**	**Description/Title**	**Stationary batteries**

Current market needs that the IE will address:

Stationary batteries will play a crucial role in enabling the next phase of the international transition towards renewable energies. As more and more households have adopted PV systems stationary battery systems integration can provide self-sufficiency and reducing the monthly electricity bills. The economic benefit is thus the driving force of the technology in an expanding market.
Check also IE #1.1.17 and IE #1.2.8

Value proposition of the IE:

Novel Lithium-ion batteries with increased capacity and reduced cost enable a financially attractive investment. As the capacities of lithium-ion batteries has increased from around 6kWh in 2015 to over 8kWh in 2018, the continuation of this trend will attract more end-users. The stationary nature of these storage systems offers advanced load balancing and on-demand/emergency discharging capabilities.
Check also IE #1.1.17 and IE #1.2.8

How the IE can bring a market change and how market changes may affect the IE:

Check IE #1.1.17 and IE #1.2.8

How current and future market changes/challenges affect POCITYF's Objective:

Check IE #1.1.17 and IE #1.2.8

Negatively		Neutral		Positively	

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

Innovative Element (IE) #	2.1.9	Description/Title	Virtual Power Plant (VPP)
Current market needs that the IE will address:			
Rise in demand for RE in the power generation sector and the energy mix, changes in the dynamics of power grids from centralized to distributed, moderating costs and easy accessibility of energy storage are some of the factors driving the growth of the VPP market .as alternative sources of flexibility to the power systems are sought. Navigant Research forecasts that total annual VPP vendor revenue will grow from $1.1 billion in 2014 to $5.3 billion in 2023 under a base scenario, with installed capacity growing from 4,800 MW to nearly 28,000 MW[22].			
Value proposition of the IE:			
The market value of VPPs lies on their potential to provide a cost-effective alternative to complement the power mismatch due to intermittent RE generation and avoid expensive upgrades to the network infrastructure to meet peak demands. Their main premise is the non-physical (hence virtual) aggregation of several heterogeneous Distributed Renewable Energy Resources (DRERs), with the aim of providing performance that resembles a single, large power plant unit. The Virtual Power Plant to be formed in POCITYF (which includes batteries from electric vehicles (V2G) and hydrogen fuel cells) holds important market value as it provides grid flexibility while integrates individual assets to a central control system. Exploitation of the aggregated power limits the impact of electricity price fluctuations.			
How the IE can bring a market change and how market changes may affect the IE:			
VPPs can influence multiple markets simultaneously owing to their integrated character. They link decentralized units in a power network (such as solar, wind, CHP, biogas, hydro power plants, batteries, power-to-heat and power-to-gas) and operate as a single centralized control system where the power and flexibility of the aggregated assets can be traded collectively. Thus, even small units can get access to the lucrative markets that they would not be able to enter individually. On the contrary, the model of centralized electricity generation in power plants and operation by large utilities still stands, thus, legal and regulatory barriers must be overcome in order to be replaced by a mix of decentralized and RES power production in small facilities, owned by SMEs or even households that will have the ability to become prosumers paving the way for VPPs.			
How current and future market changes/challenges affect POCITYF's Objective:			
The foreseen changes and regulatory barriers are not expected to affect significantly Objective #2.			

Negatively		**Neutral**	**X**	Positively	

Innovative Element (IE) #	2.1.10	Description/Title	V2G
Current market needs that the IE will address:			
Check IE #3.1.4			
Value proposition of the IE:			
Check IE #3.1.4			
How the IE can bring a market change and how market changes may affect the IE:			
Check IE #3.1.4			
How current and future market changes/challenges affect POCITYF's Objective:			
Check IE #3.1.4			

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	2.1.11	Description/Title	DC grid
Current market needs that the IE will address:			
The electricity demand is expected to rise by more than a third by 2050 compared to 2000 levels, driven by the electrification of traditionally fossil-based sectors like transport and heating/cooling. Such growing demand and technological advances require measures from the EU level to control energy losses as well as to reduce the economic and ecological footprint of this transition. To this respect, the market needs for efficient, low cost and cleaner decentralized energy supply grids are substantial.			
Value proposition of the IE:			

[22] Navigant Research, Virtual Power Plants, Demand Response, Supply-Side, and Mixed Asset VPPs: Global Market Analysis and Forecasts, 99 pages, June 16, 2014.

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DC grids offer great potential for energy savings and consequently present high market value. Such grids when compared with more traditional AC networks, present low losses and high transmission capacity. Moreover, energy recovery as well as reduction of electronic waste render this innovative element an attractive investment.

How the IE can bring a market change and how market changes may affect the IE:

The IE can potentially impose a transition from an AC dominated grid market to a DC one. Through this transition, a cluster of related technologies would be promoted such as Energy efficiency and Energy management, Renewables, Storage and Low carbon applications (heat pumps etc.) boosting these markets and changing the market landscape. From the other hand, this transition requires regulation evolutions (e.g. new DC-ready buildings and appliances) which are imperative for the future of DC grids and distribution systems.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen changes are to facilitate the integration of DC grids into already existing infrastructure, promoting grid flexibility and more efficient energy storage and consequently contributing positively to Objective #2.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**2.1.12**	**Description/Title**	**Fuel cells (hydrogen)**

Current market needs that the IE will address:

The transition to an economy with reduced dependency on fossil fuels is of utmost importance not only for the EU but also worldwide. Government based regulations and initiatives towards this target, stimulate the energy market transition towards green technologies for electricity production. The need for such technologies is expected to boost the market for non-RES in the future.

Value proposition of the IE:

Hydrogen fuel cells are a ground-breaking technology generating electricity with zero emissions. The integration of such technology into local grids and hybrid heat systems provides means for increased energy efficiency and thus creates market value. Moreover, the generation of hydrogen through RES (wind energy) forms a complete clean system making the innovative element in POCITYF even more market attractive. Energy storage with hydrogen fuel cells can lead to substantial cost reduction through peak shaving.

How the IE can bring a market change and how market changes may affect the IE:

Globally, the technology has potential to revolutionize the energy sector and corresponding energy market as a whole. The demonstration of a complete hydrogen-based fuel cell system that can supplement the existing grid can open opportunities for a larger scale penetration of this technology to the existing energy market.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes/challenges related to this IE are expected to affect positively Objective #2.

Negatively		Neutral		**Positively**	**X**

Table 14 Business models and innovation for IS-2.1

Innovative Element (IE) #	**2.1.1**	**Description/Title**	**2nd life residential batteries**

Business Models – capturing value from the IE:

Check IE #1.1.9

Innovative Element (IE) #	**2.1.2**	**Description/Title**	**Micro-grid controller platform**

Business Models – capturing value from the IE:

- Energy as a Service (EaaS) - Control energy at neighborhood level integrating basic elements (e.g. generation sources, storage devices, street lighting), more complex units (e.g. buildings, malls) and the whole distribution grid
- Product licensing

Innovative Element (IE) #	**2.1.3**	**Description/Title**	**Control Algorithms**

Business Models – capturing value from the IE:

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UNINOVA as a research center does not envisage profit, however, has a close cooperation with Academia and Industry. A suitable business model could be based on the mass deployment of the Flexibility Control Algorithms. UNINOVA can use their links to industrial tissue to promote technology and knowledge transfer or support the creation of spin-offs associated to the exploitation of knowledge related with the Flexibility Control Algorithms. Relevant business models for the potential spin-off companies are Data management services (DaaS) that use the cloud to:

- lower contracted power agreements with grid operators
- lower upfront investments in grid (CAPEX)
- Offer flexibility services for optimizing self-consumption

Innovative Element (IE) #	**2.1.4**	**Description/Title**	**LV and MV connected storage systems**
Business Models – capturing value from the IE:			
Energy Storage as a service (EsaaS): • LV storage units will endow the users to maximize self-consumption and be proactive in demand side management • MV units could provide multiple services to the DSO, namely peak-shaving, reactive power compensation, increased energy dispatchability, power quality management and control (voltage sags or dips, interruptions, voltage spikes, harmonic distortion, voltage fluctuation).			
Innovative Element (IE) #	**2.1.5**	**Description/Title**	**P2P energy trading platform**
Business Models – capturing value from the IE:			
Check IE #1.2.4			
Innovative Element (IE) #	**2.1.6**	**Description/Title**	**City Energy Management System**
Business Models – capturing value from the IE:			
• Product as a service (PRaaS) – Provide a digital platform for city energy management services • Data As A Service (DaaS). Data management that uses the cloud to deliver data storage, integration, processing, and/or analytics services via a network connection to end users or companies that may use the data for the development of new products/ services • Platform as a Service (PaaS) – provide the environment to support the ability to build, test and deploy cloud energy services.			
Innovative Element (IE) #	**2.1.7**	**Description/Title**	**ReFlex (previously PowerMatcher)**
Business Models – capturing value from the IE:			
Check ICT Solution #3			
Innovative Element (IE) #	**2.1.8**	**Description/Title**	**Stationary batteries**
Business Models – capturing value from the IE:			
• Energy Storage as a service (EsaaS): Storage system solution in special/hazard events, in which the grid is subject to extreme conditions and some micro grids may arise to guarantee reliability of supply. Check also IE #1.1.17			
Innovative Element (IE) #	**2.1.9**	**Description/Title**	**Virtual Power Plant (VPP)**
Business Models – capturing value from the IE:			
• A first business case for a VPP consists of car batteries, fuel cells and stationary batteries. This business case will use the peer-to-peer energy trading, as well as the aggregated energy market, as possible sources of revenues. • Moreover, being the demonstration areas energetic positive, they will have flexibility to sell under two different perspectives: to the DSO – to enable an advanced local congestion management – and the TSO – which will be able to activate this flexibility to solve grid balancing issues. These two features will enable the creation of a business model addressing a technical (DSO, in a regulated environment) and commercial (TSO, in a non-regulated environment) VPP. The business model needs to assess which benefits this solution could bring to the two mentioned actors and the demo sites that compose the PEBs, which, as "shareholders" of the positive communities, will have new monetary revenue.			

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- Platform as a Service (PaaS) – provide the environment to support the ability to aggregate a number of different generation, storage and demand assets into one heterogeneous distributed energy source through the use of cloud-based services in order to perform as one in energy wholesale markets also in the electric mobility sector while also it uplifts ancillary mobility service markets and peer to peer trading.

Innovative Element (IE) #	**2.1.10**	**Description/Title**	**V2G**
Business Models – capturing value from the IE:			
Check IE #3.1.4			
Innovative Element (IE) #	**2.1.11**	**Description/Title**	**DC grid**
Business Models – capturing value from the IE:			
• Lamp posts powered by renewables, public Wi-Fi for citizen engagement and sensors for dynamic lighting are some of the envisioned business cases with DC infrastructure. • A coupled solution with energy storage devices (e.g. Li-ion batteries) and smart technologies providing reduce cost and peak shaving opportunities.			
Innovative Element (IE) #	**2.1.12**	**Description/Title**	**Fuel cells (hydrogen)**
Business Models – capturing value from the IE:			
• Combination of this technology with mobility challenges (fuel cell electric vehicles) – check also IE #3.2.2 • Leveraging storage and peak shaving to offer low cost storage and management services as well as trading opportunities			

4.2.2 Integrated Solution 2.2: Flexible and Sustainable District Heating/Cooling with Innovative Heat Storage Solutions

POCITYF will further demonstrate and replicate solutions that are able to advance the flexibility and environmental sustainability of district heating networks through the utilization of innovative technologies and the exploitation of waste heat and geothermy.

The innovative elements which for the IS-2.2 are listed below while the following tables contain the progress relative to the three main pillars as described in the introduction of Section 4.

IS-2.2: Flexible and Sustainable District Heating/Cooling with Innovative Heat Storage Solutions (Freezing storage in store // Market-oriented building flexibility services // low temperature heat grid // geothermal // low temperature waste heat // ATES (heat/cold storage) // HEAT matcher thermal grid controller // Heat Island concept)

Table 15 Technical and Innovation Progress for IS-2.2

Innovative Element (IE) #	**2.2.1**	**Description/Title**	**Freezing storage in store**
Innovative aspects of the IE:			
Freezing storage in retail store for improved energy consumption management and demand side flexibility takes advantage of the natural storage capacities of freezers, which are normally the responsible for the higher share of energy consumption in retail stores. The freezing storage IE has two main innovative aspects: • Regards the use and management of thermal storage, using building HVAC and industrial freezers, while complying to pre-established criteria of comfort and safety. With variation of energy price during the day it becomes relevant to manage properly the consumption of the facilities in order to reduce energy costs. Thus, thermal storage allows to shift and optimize energy consumption along the day, avoiding peak (high cost) periods. This poses a reasonable challenge that becomes even more complex when the facilities are equipped with PV generation for self-consumption. In short, the			

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innovative aspect regards the optimization of energy management having these three vectors into account: *daily consumption profile vs intraday energy cost variation vs PV generation*.

- Currently, grid flexibility is only provided from the generation side and not from the demand side. Thus, providing flexibility services to the grid by managing the energy consumption as detailed in a) is also a key innovative aspect.

Advancement of TRL levels (TRL8→9):

SONAE deploys the following method in a large part of its Portuguese retail stores to leverage from the thermal inertia of the freezers (TRL 8). During POCITYF, the solution will be put to actual operation by SONAE whose freezers thermal inertia will lead to monthly energy savings (TRL 9). Moreover, the timely management responsible for the performance of this method will be optimized, by being automated and added, as a module, to Schneider BMS that will be therein installed.

Innovative Element (IE) #	**2.2.2**	**Description/Title**	**Market-oriented building flexibility services**

Innovative aspects of the IE:

Market-oriented building flexibility services, allow retailers/aggregators to handle buildings' thermal flexibility as a replacement reserve product within the ancillary services or as an active to optimize its portfolio deviations.

Advancement of TRL levels (TRL6→7):

Flexibility of several MW has already been achieved under H2020 InteGrid and Sensible projects (TRL 6) while during POCITYF the complete set of 8 municipal buildings will target market-oriented flexibility services to improve their self-sufficiency, which can be used as an ancillary services market product or for the DSO (TRL 7).

Innovative Element (IE) #	**2.2.3**	**Description/Title**	**Low temperature heat grid**

Innovative aspects of the IE:

This IE focuses on the shifting of the High Temperature (110/100) Waste Heat Network to Low Temperature (80/85) geothermal Heat Network through applying 'indirect delivery sets' at costumers' homes. Large-scale waste heat networks are almost always designed as a system with "direct delivery sets" at the homes. The supply temperature at the customer (90° C /70 ° C) is dominated for a large part of the year by the minimum requirement to be able to make hot tap water. The use of heat exchangers ensures a higher required supply temperature in the primary network (minimum 110° C /80 ° C). The introduction of electronically controlled delivery sets with both hot tap water exchanger and CV (indirect delivery set) offers new possibilities. This makes it possible that the heat exchanger is moved from the control station to the home. This provides more flexibility in the network design. As a result, the heat exchanger in the control station can be dispensed with and with it also the temperature loss over the heat exchanger. The supply temperature in the primary network can be lower, which is favorable for applying low temperature renewable heat sources such as geothermal energy and collective heat pumps with energy from surface water. In addition, a heating line (higher supply in winter) can be used in the secondary network which offers the possibility of using smaller pipes.

This IE is linked to IE #2.2.4 and IE #1.2.6.

Advancement of TRL levels (TRL7→8):

Relevant system prototypes are already being used in operational environment but only on small scale and in one type, whereas every existing building has its own challenges and its own needs as with regard to the delivery sets needed. The project will therefore advance the IE from TRL 7 to TRL 8.

Innovative Element (IE) #	**2.2.4**	**Description/Title**	**Geothermal heat source**

Innovative aspects of the IE:

This innovative element deals with the use of geothermal energy to heat buildings through a distribution network. Geothermal heating capitalizes the near constant underground temperatures to create a heating system that offers clean heat through energy transfer from the earth. They typically require little maintenance and present high efficiency. The heating grid described in IE # 2.2.3 will be used to integrate the geothermal heat source.

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

Advancement of TRL levels (TRL8→9):

In Trias Westland project, a geothermal heat network which uses heat at 2.700m with a capacity of 23MW and a temperature of 85^{oC} is in operation (TRL 8) while CHESS is being used to optimize the heat network and reduce the investments of the heat network (TRL 8). In POCITYF, a geothermal heating project will be implemented in Woonwaard's buildings (TRL 9).

Innovative Element (IE) #	**2.2.5**	**Description/Title**	**Low temperature waste heat**

Innovative aspects of the IE:

The innovative aspect of this IE is the make use of waste heat recovery and integration of the residual heat in a local heat grid in order to reduce the energy consumed. This separate small-scale grid, overall leads to a local hybrid heating network, in which heat from different sources is transported to customers in the most optimal way. Waste heat recovery is performed through the residual heat from the Ice Rink De Meent.

Advancement of TRL levels (TRL8→9):

The technology has been demonstrated already in Amsterdam where heat from the Ice Rink has been used as a heat source for a heat network at the Jaap van Edenbaan (TRL 8). The TRL leap will be achieved via the implementation of the technology mainly in the Ice Rink PEB where heat resulting from the cooling machines will be inserted into a local (low temperature) heat grid, forming a local operating hybrid heating network (TRL 9).

Innovative Element (IE) #	**2.2.6**	**Description/Title**	**ATES**

Innovative aspects of the IE:

Check IE #1.2.7

Advancement of TRL levels:

Check IE #1.2.7

Innovative Element (IE) #	**2.2.7**	**Description/Title**	**HeatMatcher thermal grid controller**

Innovative aspects of the IE:

HeatMatcher is an innovative real-time matching solution for heating and cooling systems. It determines the optimal balance between producers (supply) and consumers (demand) of heat and cold. HeatMatcher is highly scalable, allowing systems of hundreds or thousands of producers and consumers to be controlled in an efficient way. It uses a multi-agent architecture and a market-based algorithm, where agents do biddings whenever they want to buy or sell heat or cold. HeatMatcher is strong in using the available buffer capacity and exploiting the flexibility the different heating system components offer.

Advancement of TRL levels (TRL7--> 8/9 – see in-text details):

HeatMatcher has been used in building context within 4 different multi-year pilots, saving energy for the building owner and lowering the energy bill with up to 20% while keeping comfort at the same level (TRL 7-8). Main innovation focus in this project will be on the HeatMatcher for District Heating and Cooling Networks and in connecting HeatMatcher to its electricity-counterpart ReFlex, proving if possible the complete system in operational conditions (TRL 8/9). As the technology in district level is not mature enough at the moment the TRL advancement is indicative at this stage.

Innovative Element (IE) #	**2.2.8**	**Description/Title**	**Heat Island concept**

Innovative aspects of the IE:

This IE is an innovative Energy Management System (EMS) for heat. The heat pumps will provide the basic heat load of a building or small group of buildings with individual small heating systems per apartment. PVT panels will be connected to a centrally fed buffer vessel. The ATES will also be arranged by the Heat Island. The main innovation lies on an algorithm which will align production and use of electricity between the several connected products (energy users and for instance PV panels). The Heat Island provides an optimum (related to energy household) energy management on a building level in stead of sub-optimum results on equipment/device level.

Advancement of TRL levels (TRL6→7):

The EMS technique (which is the core of the heat island concept) is currently on TRL 6 and during POCITYF this IE will be advance to TRL 7 and beyond through demonstration and usage in the heat island concept.

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

Table 16 Market needs, changes and challenges for IS-2.2

Innovative Element (IE) #	2.2.1	Description/Title	Freezing storage in store
Current market needs that the IE will address:			
Energy costs are critical in several economy sectors in an increasingly competitive world. With the proliferation of self-consumption generation through decentralized renewable energy plants, particularly PV, an efficient energy management as defined in 1.i (daily consumption profile vs intraday energy cost variation vs PV generation) leads to energy costs savings and more efficient use of energy answering clear market demand for more sustainability, energy efficiency associated to the ever-present energy cost reduction (particularly in large facilities where energy consumption is higher, thus its impact). Moreover, grid flexibility services are a direct answer to the grid operator needs. At periods where demand is higher than supply it of extreme relevance that consumers can shift, curtail or switch off energy demand.			
Value proposition of the IE:			
This innovative technology offers great potential for stores which want to reduce their energy consumption. More precisely, the innovative technology leveraging from the thermal inertia of the freezers along with the integrated BMS system offer increased market value as an optimal and efficient system towards energy savings.			
How the IE can bring a market change and how market changes may affect the IE:			
Expected retail store and freezer storage market growth is expected to further boost innovation in this technology. This IE, aims an energy cost reduction through use and management of thermal storage while grid flexibility inverts the traditional logic that has been driving grid management. Thus, this solution explores grid flexibility services, topic that is expected to become increasingly more relevant as penetration of renewable energy sources tend to increase in the upcoming years therefore additional fluctuation on energy generation is set to occur.			
How current and future market changes/challenges affect POCITYF's Objective:			
The market changes as described above are expected to positively affect Objective #2.			

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	2.2.2	Description/Title	Market-oriented building flexibility services
Current market needs that the IE will address:			
More and more RES are being integrated into the electrical and heating grids, leading to a growing need of energy flexibility. Such flexibility must provide a balance in the grids, adjusting the thermal or electrical output to the customers' needs at all times. Exploiting the thermal storage of buildings for example can lead to the desired flexibility which increases efficiency and reduces overall cost of buildings thermal management.			
Value proposition of the IE:			
The market-oriented nature of the innovative element is the key feature which adds market value. The flexibility services provide means for optimizing the thermal imbalances or act as a replacement reserve product leading to energy savings and increased efficiency. As an example, in H2020 SENSIBLE project, EDPL has simulated the market participation of 25 clients equipped with HEMS, smart plugs, 1.5 kWp 25 PV panels, 1.5 kW water heaters and a residential battery (3.3kW/3kW), resulting, for the residential clients, in a self-consumption increase of 26%, a socio-economic welfare growth of 27% and a flexibility increment from energy players of 45% (energy) and 14% (power).			
How the IE can bring a market change and how market changes may affect the IE:			
N/A at this stage			
How current and future market changes/challenges affect POCITYF's Objective:			
N/A at this stage			

Negatively		Neutral		Positively	

Innovative Element (IE) #	2.2.3	Description/Title	Low temperature heat grid
Current market needs that the IE will address:			

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As population and disposable income grows so do the heating demands of households and districts. The need for a green based economy along with various government initiatives towards this target, not only propels the growth of the district heating market but also imposes market related needs such as energy efficiency, reduced environmental impact and quick transition to RES.

Value proposition of the IE:

The technology of low temperature heat grid provides more cost-effective heating which is more evenly distributed in spaces while keeps the air cleaner. The indirect delivery set offers enhanced flexibility in the network design, lower heat losses while offering greater possibility for RES penetration into the heat grid (such as geothermal heat sources). The indirect delivery set also has other advantages, such as separating the indoor installation from the heat network, which is safer in the event of leaks, lower water pressure in the home, limit / arrange return temperature.

How the IE can bring a market change and how market changes may affect the IE:

The efficiency of the low temperature heat grid relies strongly to the insulation properties of the buildings concerned. Thus, future initiatives towards better insulation and a growing insulation market favors the further penetration of this innovative element into the market.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes and challenges are expected to positively affect POCITYF Objective #2, since they support the introduction of innovative technologies and products, while also enabling the high-to-low temperature heat grid transition. This IE is facilitating this transition which in conjunction with the utilization of geothermal sources is expected to support the operation of flexible, sustainable and high-energy efficient networks.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**2.2.4**	**Description/Title**	**Geothermal heat source**

Current market needs that the IE will address:

Similar to IE #2.2.3

Value proposition of the IE:

Geothermal heating has low environmental impact, it is highly efficient and presents excellent reliability. Adding a geothermal heat source to the heating network gives additional market value.

How the IE can bring a market change and how market changes may affect the IE:

The retrofitting of geothermal heat sources in existing buildings/districts (such as heritage buildings) requires large-scale interventions. On top of that, the higher upfront cost than other HVAC systems along with the low information of installers on its excellent (short) payback period may be seen as market challenges that can affect the IE market penetration. Focusing on newly built houses and a great information/promotion campaign greatly reduces this risk. In addition, as the foreseen market needs are expected to grow significantly the challenges are expected to be balanced.

How current and future market changes/challenges affect POCITYF's Objective:

Overall the expected changes will positively affect Objective #2, towards flexible and energy efficient heating networks. Check also IE #2.2.3

		Neutral		**Positively**	**X**

Innovative Element (IE) #	**2.2.5**	**Description/Title**	**Low temperature waste heat**

Current market needs that the IE will address:

Similar to IE #2.2.3

Value proposition of the IE:

Waste heat recovery and recirculation presents an evident value for customers as it has a direct impact to the total heating cost.

How the IE can bring a market change and how market changes may affect the IE:

Lack of knowledge and awareness among installers on hybrid heating networks along with low temperature waste heat might seen as a barrier and challenge for realizing this IE full market potential.

How current and future market changes/challenges affect POCITYF's Objective:

Similarly, to IE #2.2.3

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Negatively		Neutral		**Positively**	**X**
Innovative Element (IE) #	**2.2.6**	**Description/Title**	**ATES**		
Current market needs that the IE will address:					
Check IE #1.2.7					
Value proposition of the IE:					
Check IE #1.2.7					
How the IE can bring a market change and how market changes may affect the IE:					
Check IE #1.2.7					
How current and future market changes/challenges affect POCITYF's Objective:					
Check IE #1.2.7					

Negatively		Neutral		Positively	
Innovative Element (IE) #	**2.2.7**	**Description/Title**	**HeatMatcher thermal grid controller**		
Current market needs that the IE will address:					
Traditional heating installations are faced with several drawbacks, not least the fact that their control systems are often rule-based. This makes configuration and maintenance cumbersome, leading to operational bugs and flaws that result in malfunctioning, inefficiencies and economic losses throughout the lifetime of these installations, routinely spanning several decades. HeatMatcher is relatively easy to configure (and this becomes even easier with the current development of the automatic HeatMatcher configurator). With the introduction of 4th generation District Heating and Cooling Networks, designing an optimal (rule-based) control algorithm becomes very difficult. This increases the need for algorithms like HeatMatcher.					
Value proposition of the IE:					
With HeatMatcher the heating system owner saves operational costs. Next to this, the initial design and configuration process of the controller becomes a lot easier, with less manual effort. Designing a rule-based controller for larger systems becomes very cumbersome as the designer cannot grasp all system complexity and dynamics. HeatMatcher's provides a relatively easy solution to this aspect with high outcome value.					
How the IE can bring a market change and how market changes may affect the IE:					
The electrification of heat is driving efforts to better integrate and control the two energy networks. Indeed, the challenges of delivering heat electrification within a grid that increasingly absorbs intermittent and distributed renewable energy generation, strongly indicate the need for dynamic, real time demand-supply matching solutions where the interplay between heat and electricity is considered. Similarly, HeatMatcher can support the incorporation of heat storage and conversion to the existing networks along with the integration of low temperature (district) heating networks.					
How current and future market changes/challenges affect POCITYF's Objective:					
The characteristics of the energy system are dramatically changing as it increasingly depends on less controllable and geographically distributed energy sources. The energy system will be determined by local characteristics and will be a distributed system. Demand and supply no longer 'automatically' match. Electrification of energy demand will increase for industry, heating and mobility. Integration of flexibility into the energy system on a cost-effective way and resulting in a robust and resilience energy system is a major challenge that will drive both innovation and investments. To this respect, foreseen market changes are expected to positively contribute towards Objective #2.					

Negatively		Neutral		**Positively**	**X**
Innovative Element (IE) #	**2.2.8**	**Description/Title**	**Heat Island concept**		
Current market needs that the IE will address:					
Similar to IE #2.2.3 and #2.2.7					
Value proposition of the IE:					
The innovative algorithm of energy management between these several components renders the Heat Island a unique heating concept with optimal energy distribution allowing for increased heating efficiency and energy savings for buildings owners.					

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How the IE can bring a market change and how market changes may affect the IE:

The inclusion of several innovative components into the Heat Island concept can boost the development of each, further promoting these technologies. In reverse, the IE will be strongly affected by the further development of each component. As devices and equipment are expected to be included into an EMS extensively in the future, the Heat Island importance will increase.

How current and future market changes/challenges affect POCITYF's Objective:

The future market changes are expected to positively affect Objective #2 as they relate to increased grid flexibility through energy management.

Negatively		Neutral		**Positively**	**X**

Table 17 Business models and innovation for IS-2.2

Innovative Element (IE) #	**2.2.1**	**Description/Title**	**Freezing storage in store**
Business Models – capturing value from the IE:			
• Energy Storage as a service (EsaaS): • Reduce energy costs and provide flexibility services to the grid.			
Innovative Element (IE) #	**2.2.2**	**Description/Title**	**Market-oriented building flexibility services**
Business Models – capturing value from the IE:			
N/A at this stage			
Innovative Element (IE) #	**2.2.3**	**Description/Title**	**Low temperature heat grid**
Business Models – capturing value from the IE:			
• Thermal Energy as a Service (ThEaaS): Production, storage, distribution and supply of thermal energy based on low thermal heat grid. By sharing cost of investments with other partners such as the municipality and the DSO, the cost for the heating district can be diminished. With the integration of a geothermal source the heat network will be more sustainable including elements of Product as a Service (PRaaS) and Circular Economy based Business Models (CEBM) making the solution attractive for the operator of the heat grid, incumbent suppliers, alternative producers of heat and customers.			
Innovative Element (IE) #	**2.2.4**	**Description/Title**	**Geothermal heat source**
Business Models – capturing value from the IE:			
Check IE #2.2.3			
Innovative Element (IE) #	**2.2.5**	**Description/Title**	**Low temperature waste heat**
Business Models – capturing value from the IE:			
• Thermal Energy as a Service (ThEaaS): Production, storage, distribution and supply of thermal energy based on waste heat recovery			
Innovative Element (IE) #	**2.2.6**	**Description/Title**	**ATES**
Business Models – capturing value from the IE:			
Check IE #1.2.7			
Innovative Element (IE) #	**2.2.7**	**Description/Title**	**HeatMatcher thermal grid controller**
Business Models – capturing value from the IE:			
The CHESS and HeatMatcher technology can support heating system owners and operators to: • Offer Demand – Response heating services (for heating flexibility) • Control of heating assets The technology can also be used as a tool for design and consultancy services for heating flexibility to reduce investments and operational costs in the district heating and cooling networks.			
Innovative Element (IE) #	**2.2.8**	**Description/Title**	**Heat Island concept**
Business Models – capturing value from the IE:			
• Installation of heat pumps working together with PVT as a heating system for buildings • Maintenance of the heating network • Subscription and consumption fee per used $kWht_h$			

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4.3 Progress related to Project Objective #3

Objective 3: Demonstrate the integration of electro-mobility solutions as an enabler to grid flexibility

POCITYF will implement the solutions identified in the ETT#3 (TRL≥6), encompassing both the technological improvements for the integration of RES and electro mobility linked services in the cities' energy system and planning. Most of those solutions have already been pre-piloted (see section 1.3.4). RES integrated e-mobility promotes significantly the use of e-bicycles, e-cars and e-buses, thus decreasing the conventional mobility environmental footprint and creating an environmentally friendly infrastructure for the participating cities. This objective works in parallel with **Obj. 2**. Proposed mobility services will further contribute to the decarbonization of the transportation sector, while fostering collective mobility creating new business opportunities. The various elements have been integrated in the two Integrated Solutions of the ETT#3 and will be demonstrated in the urban environments.

Objective #3 is aligned with the activities under POCITYF Energy Transition Track #3: E-mobility Integration into Smart Grid and City Planning. ETT#3 encompasses 2 Integrated Solutions (IS) : IS-3.1 deals with Smart V2G EVs Charging while IS-3.2 deals with E-mobility Services for Citizens and Auxiliary EV Technologies.

Tables 17-23, report on the three main pillars as described in the beginning of Section 4. As various innovative elements fall into multiple Objectives (or ETTs), duplication of information is avoided by pointing out the specific Obj. and IS where this IE has been detailed. The progress reporting is structured per Integrated Solution.

4.3.1 Integrated Solution 3.1 - Smart V2G EVs Charging

POCITYF aims to demonstrate and perform replication studies for the idea of **V2G** and **smart solar power**-driven charging stations in order to support the demand-supply energy management (with a scheme of **smart charging management**) at district level, while increasing their large-scale energy **storage** capacity and promotion of more environmentally friendly mobility solutions. From the citizen perspective, this solution is the linking pin between ETT#1 and ETT#2, but addresses as well e-mobility aspects. As a result, the added value for citizens is the lower and stable energy bills, higher comfort and a more livable and safer district resulting from ETT#1 and ETT#2 solutions, as well as affordable e-mobility thanks to this solution.

The innovative elements which for the IS-3.1 are listed below while the following tables contain the progress relative to the three main pillars as described in the introduction of Section 4.

IS-3.1: Smart V2G EVs Charging (EV charging management platform // EV charger prototype with PV integration // Bidirectional smart inverters // V2G // Smart Lamp posts with EV charging and 5G functionalities // Intelligent and optimal control algorithms // Smart solar charging // Virtual Power Plant (VPP) // DC lighting with EV charging)

Table 18 Technical and Innovation Progress for IS-3.1

Innovative Element (IE) #	3.1.1	Description/Title	EV charging management platform
Innovative aspects of the IE:			
This IE refers to an integration of an EV charging management platform with an energy management system. The platform for EV charging is supported by open ICT interconnection and performance monitoring which is a fully smart and innovative package due to its capabilities and potentiality for data management and information services for aggregators, grid operators, municipality and citizens and also a multi-level planning that offers operational efficiency and the highest performance of EV charging infrastructure. Integration of EV charging management platforms with energy management systems (BMS			

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or others) is a key enabler for an effective management and efficient use of energy. The movement towards decentralized energy generation, with increasing penetration of renewable energy sources and liberalized energy markets makes the integration of different systems of great relevance. Thus, the use of EV charging platforms integrated with a wider energy management system potentially allows to shift or curtail energy consumption at EV chargers during the day, avoiding peak (high cost) periods. In short, the innovative aspect regarding the optimization of energy management takes four vectors into account: *a) daily consumption profile, b) intraday energy cost variation, c) PV generation, d) EV charging management*. Additionally, grid flexibility is typically provided from the generation side and not from the demand side. Thus, providing flexibility services to the grid by managing/curtailing the energy consumption on demand side is another innovative aspect of this IE.

Advancement of TRL levels (TRL6→7):

The engineering development of the EV charging management platform is already done with the demonstration of the prototype platform in relevant environment. The platform was tested for its design parameters and inputs in a relevant engineering environment close to the actual operating area, hence current EV charging management platform is TRL6. The platform is capable of performing all the functions that will be required in field, and fine-tuned to a variety of operating conditions. Right now, manufacturing standard issues are addressed, before the final design system will be tested. As discussions between all parties are still ongoing, it is not possible at this stage, to give a clear answer regarding the advances to be made and the role of each partner, either providing relevant data and information from the full-scale analysis on the test environment. Nevertheless, it is clear that, the upgrade from TR6 to TRL7 will be acquired during POCITYF, when the platform will be installed in the LH districts by verifying that is well connected and integrated with the other collateral and ancillary energy systems. The indicative energy management platform for EV charging will operate using an appropriate communication protocol for EV charging with grid flexibility and peak shaving functionalities.

Innovative Element (IE) #	**3.1.2**	**Description/Title**	**EV charger prototype with PV integration**

Innovative aspects of the IE:

This IE refers to the use of smart bidirectional EV chargers in conjunction with solar PVs in order to support V2G applications. Key innovative aspects of the indicative solution can be considered:

- Improved flexibility and controllability of electric vehicles and fleets.
- Rich user interface (stand-alone or using HEMS platform).
- Intelligent techniques to optimize energy usage and cost.
- Providing added value services for electric grid.

Advancement of TRL levels (TRL6→7):

The EV Charger Prototype System with PV integration has been already built and demonstrated. The functionalities and tools of the prototype system have been tested extensively from our company and a first pilot-scale product with all necessary prototype materials will now be implemented in the daily operations in relevant environments within the LH city of Evora. Within this context, with the aid of POCITYF project, the EV chargers integrated with PV technology will be enlarged to a full-scale system demonstrated in field. In order to achieve TRL7, the behavior of the PV with different natural solar irradiation and under various conditions will be investigated and analyzed, while the performance of the EV charger will be validated in the operational environment of the district. The expected efficiency of the whole system should be verified, the reliability of the EV charging system will be tested and the stability under long-term real-time outdoor conditions will be confirmed leading to next readiness level (TRL7). The aim is to increase technology readiness level to the highest (TRL 8-9) by performing hardware or firmware optimizations, extensive testing and pre-certification when applicable.

Innovative Element (IE) #	**3.1.3**	**Description/Title**	**Bidirectional smart inverters for EV smart charging and V2G applications**

Innovative aspects of the IE:

Smart inverters constitute a novel, innovative and sophisticated tool that not only can make autonomous decisions to keep the grid stable and reliable as more distributed energy resources (DERs) come online, but also, they can support smart EV charging and V2G applications. In other words, their available field of

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offers deals also with electric mobility applications making them very innovative and novel systems. Instead of just feeding power into the grid, bidirectional smart inverters are capable of a two-way communication, and thanks to advanced software, they can perform specific grid-supportive functionalities related to voltage, frequency, communications, responses and controls.
Check also IE #1.1.6

Advancement of TRL levels (TRL6→7):

Currently, output of the IE has been fully demonstrated and most engineering subsystems have been tested in industrial environment (TRL6). Prototyping implementation of standards for advanced smart inverter functions has been created to test, verify and certify smart inverters in operational environment. To this end, during POCITYF, the bidirectional smart inverters will provide location-specific grid services for EV charging and V2G in order to address e-mobility system constraints or needs and enable every customer-sited smart charging conditions at district level, leading to a system prototype application in field (TRL7).
Check also IE #1.1.6

Innovative Element (IE) #	**3.1.4**	**Description/Title**	**V2G**

Innovative aspects of the IE:

The term vehicle-to-grid (V2G) refers to the concept of using vehicle batteries to provide services to the electrical grid. V2G can either be managed as stand-alone unit or in local clusters. The specific IE is a Vehicle-to-Grid application for public transport buses being highly innovative because it can provide sustainable results and can fit-in marketable product-service combinations for various types of areas, such as production of renewable energy with V2G, smart charging and EV sharing systems.
Key points for the IE are considered:

- A battery of an electric bus is used to supply energy to the Alkmaar grid.
- A study is planned about feasibility, impacts, risk and opportunities when implementing V2G strategies into public transport operations. For instance, with bus OEM, grid operator, and public transport operator.
- A test of V2G services in practice, when applicable.

Advancement of TRL levels (TRL6→7):

This vehicle-to-grid (V2G) technology is deployed in an industrially relevant environment, where all key factors and operating conditions for EV charging and grid flexibility have been determined and tested (TRL6). The V2G application within POCITYF will be demonstrated as a prototype system in the district of the LHs and will be configured to serve as a mobile power plant generating electricity to the grid when necessary, controlling the charging rate of EVs, demonstrating efficiency and interoperability with the other technologies of the grid and improving also grid reliability. As a result, the IE will move to the next readiness level (TRL7).

Innovative Element (IE) #	**3.1.5**	**Description/Title**	**Smart lamp posts with EV charging and 5G functionalities**

Innovative aspects of the IE:

This element is a fully innovative product which offers smart lighting, EV charging, traffic and air quality monitoring, mobile network (5G) connectivity and many more capabilities by using IoT and allowing new cloud services like edge computing.
Check also IE #1.2.1

Advancement of TRL levels (TRL7→8):

The Smart Lamppost solution can be classified with TRL7. The offered technology has been connected within the network and tested by Ubiwhere in one operational environment as a system prototype on a pilot scale, with the installation in the city of Guimarães, as one contribution to the initiative "Guimarães 5G Ready", demonstrating operational capabilities for 5G connectivity and EV charging in field (TRL7). Within POCITYF, smart lampposts will be embedded in the various points of the district in order to prove all system functionalities and final purposes in working conditions. With the integration of different hardware providers in the Évora demonstration pilot, in particular, new EV chargers with V2G capabilities,

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the IE is expected to upgrade to TRL8, closing the principal developments and start the commercial activities to install the solution in a large-scale market (TRL8).
Check also IE #1.2.1

Innovative Element (IE) #	**3.1.6**	**Description/Title**	**Intelligent and optimal control algorithms**
Innovative aspects of the IE:			
The intelligent and optimal control algorithms were built based on an agile approach of R&D and innovation taking into account intelligent and optimal charge control for a smart charging depot. Connections to the grid need to be as small as possible to lower upfront assets costs, and to lower energy transition costs in general. These new smaller available energy volumes from grid operators are a new parameter when developing and operating charging schedules. When buses are in operation, software need to be able to monitor and control chargers to prevent these grid connections overruns. This is not new, however, smart charging or load balancing solutions mainly are build one-sided, from grid perspective point of view, and they are not yet to be combined with the real-time charging data of public transport operators. Consequently, combining these two topics could lead to new innovative insights and strategies in the utility of chargers.			
Advancement of TRL levels (TRL6→7):			
The algorithms have been developed with inputs and parameters already tested at laboratory and engineering level (TRL6). Relevant prototype systems of these algorithms will be demonstrated within POCITYF implementation for specific building blocks of the district to calculate the solar power supply highest levels and the charging demand rates, properly interconnected with other key energy and mobility technologies (i.e. where EVs are charged) in order to operate towards grid flexibility on a pilot scale. Compliancy with relevant environment conditions and local standards for the demo site will be verified and readiness level 7 will be achieved (TRL7).			

Innovative Element (IE) #	**3.1.7**	**Description/Title**	**Smart solar charging**
Innovative aspects of the IE:			
Smart solar charging is a fully innovative solution adapting the charging cycle of EVs to both the conditions of the power system and the needs of vehicle users. In addition, the IE facilitates the integration of EVs while meeting mobility needs.			
Advancement of TRL levels (TRL7→8):			
The prototype is in demonstration phase and has been tested with commercial EVs in terms of local solar energy production and storage (TRL7). By learning from these practices and experimental results, smart solar charging is prepared for large-scale transition to RES use. The charging technology is mature, but not yet in series production. For POCITYF needs, the sustainable energy system will be complete and qualified for working in operating conditions at district level (TRL8).			

Innovative Element (IE) #	**3.1.8**	**Description/Title**	**Virtual Power Plant (VPP)**
Innovative aspects of the IE:			
Check IE #2.1.9			
Advancement of TRL levels (TRL8→9):			
Check IE #2.1.9			

Innovative Element (IE) #	**3.1.9**	**Description/Title**	**DC lighting with EV charging**
Innovative aspects of the IE:			
This IE consists of a Direct Current (DC) infrastructure with 82 smart lampposts, public 5G for citizen engagement, sensors for dynamic lighting and with integrated e-storage. Five of the lampposts will be linked with EV charging points. The DC grid will have the possibility for direct feeding in solar energy. Considering the following operational characteristics, the indicative DC system is an innovative solution for smart cities: • Providing integrated smart solutions for a lamppost: public 5G/Wi-Fi for citizen engagement, sensors for dynamic lighting, integrated e-storage and EV changing point • Promoting increase of large-scale local e-storage capacity.			

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

- Promoting more environmentally friendly, emission free & energy saving mobility and public lightning solutions
- Successful introduction of demand-supply energy management at district-level, in combination with the solar road and feeding of the DC grid by PV panels.
- In case of malfunctioning, the lamppost could report this itself by using smart sensors. Citizens reporting or regular inspection rounds won't be necessary anymore.

Advancement of TRL levels (TRL7→8):

The proposed solution has been demonstrated on a pilot/prototype scale. In the Netherlands, there are already +15 projects with public lighting on DC grids on +/- 350 VDC. Also, pilots with lampposts with integrated EV charging poles are done, for example in Zeist and The Hague. In particular, unified standards, comprehensive testing and certification has been conducted to ensure data safety, reliability of results, connection issues and system resilience (TRL7). Currently, with the implementation of POCITYF, the innovative element will be customized to operate in grid-connected mode, the stability of DC voltage will be supported by the storage of EVs and the system will be upgraded one level and verified for market conditions and applications (TRL8).

Table 19 Market needs, changes and challenges for IS-3.1

Innovative Element (IE) #	3.1.1	Description/Title	EV charging management platform

Current market needs that the IE will address:

Nowadays, key enabling technologies linked to the use of ICT energy platforms (smart charging, V2G) are under development. With the movement towards electrification, an efficient energy management leads to energy costs savings through a more efficient use of energy, addressing the ever-increasing demand for sustainability, energy efficiency as well as the ever-present demand for cost reduction[23]. The specific market needs that will be covered with the respective platform and system are but not limited to:

- Cloud-based and easily integrated system with other smart energy management and mobility systems or software for charging control (grid operators, energy companies, service providers, apps and end-users)
- Transparency, data and information about locations and tariffs of charging points
- Grid flexibility services which are a direct answer to the grid flexibility needs. At periods where demand is higher than supply, consumers can shift, curtail or switch off energy demand.
- Current EV charging network is limited, thus the success of this IE may help widen the existing EV charging network available to EV users, fostering the transition to e-mobility.

Value proposition of the IE:

The EV Charging Management Platform was developed based on a versatile and market-based approach called TEC4ENERGY offering capabilities to address real world challenges and performance levels that adopt energy saving, grid load optimization and smart management for EV charging. The charging points are configured from a multi-level planning and management interface that offers operational efficiency and the highest performance of EV charging infrastructure. Except for controlling charging levels and administration of the electricity grid, it can also provide ancillary services to transmission system operators. The IE is customizable and adaptable to the requirements of each district, area or city, enhances grid safety and enables flexible control of demand to match available supply, providing also outputs of the charging points by analyzing information based on monitoring and comparative analysis.

How the IE can bring a market change and how market changes may affect the IE:

Market expansion will be enhanced by the further cooperation of car manufacturers and charging hardware and software suppliers. The advancements in science and technology will enable science-based innovation through the transfer of new knowledge and ICT solutions for mobility in smart cities. The IE induces a market pull drive into R&D and production of relevant ICT solutions used in the energy and transport sector.

[23] Global Energy Transformation- A Roadmap to 2050, IRENA (2018)

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The IE aims to an energy cost reduction through a better integrated energy management solution on one hand, while on the other hand it inverts the traditional logic that has been driving grid management by enabling grid flexibility services - topic that is expected to become increasingly more relevant as penetration of renewable energy sources tend to increase in the upcoming years therefore additional fluctuation on energy generation is set to occur. Furthermore, the adoption of such controlling solutions in cities, may lead to the reinforcement of EV charging stations network and broadness of the available offer to EV users increasing competition in the market and therefore potentially lowering the charging costs for EV users.

How current and future market changes/challenges affect POCITYF's Objective:

Global energy markets and demand patterns are strongly shaped by EV adoption and charging infrastructure which also influence the practices and the development of urban smart grid and ICT management systems. In that respect, future market challenges are expected to have a positive impact on POCITYF Objective#3, since they support electric mobility in city planning while enabling ICT systems integration for better monitoring, management, communication and control.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**3.1.2**	**Description/Title**	**EV charger prototype with PV integration**

Current market needs that the IE will address:

Climate neutrality and decarbonization of the electric sector constitute one of the main goals in Europe and globally[24]. As the adoption of EVs increases, the demand for charging stations is rising and the EV charging industry is transforming drastically[25]. Furthermore, location constraints for the installation of EV charging systems generate a need for highly customizable and integrated solutions. The integration of PVs is gaining popularity in construction and transportation sectors as they are energy-efficient, and their increased aesthetics facilitates their acceptance especially when installed in public spaces. Finally, the convergence of energy and transportation sectors is growing because is creating value for both parties.

Value proposition of the IE:

The EV Charger can combine the production of renewable energy with PV and distribution with V2G. The IE was designed to provide electricity charging with regard to every own user profile, type of customer application, specific market and pilot area. As a result, it gives the opportunity for implementation of local and community based EV charging profiles. In addition, the EV charger combined with PV energy, can also reduce carbon footprint in a more meaningful way and provide a solution for prosumers with EVs to optimize self-consumption, energy usage and cost.

How the IE can bring a market change and how market changes may affect the IE:

Electro-mobility is an emerging global trend that will open a world of new and exciting opportunities also for solar energy applications[26]. E-mobility market is rising and the same is projected with charging systems and services. In this context, the massification of EVs can increase the demand for such IE. From the technology side, smart charging can have a positive effect in planning various mobility cases. European smart cities pioneer the development of solar powered offers, like in the Netherlands, and most probably the proliferation of such solutions could expand the possible size of the solar and self-consumption market in a big way. However, the global offer and cost of storage elements (batteries) can decrease the proliferation of EVs and relevant solutions such as EV chargers.

How current and future market changes/challenges affect POCITYF's Objective:

There are multiple market changes in favor of going solar along with EVs uptake, such as lowering ongoing energy costs, becoming more energy independent, and reducing the carbon footprint at both the individual and national level. In this context, due to the fact that the market is shifting towards electric mobility and grid flexibility, POCITYF objective#3 is going to be influenced considerably.

Negatively		Neutral		**Positively**	**X**

[24] The European Green Deal, European Commission (2019)
[25] Global EV Outlook 2019, IEA: https://www.iea.org/reports/global-ev-outlook-2019
[26] Innovation Outlook-Smart Charging for Electric Vehicles, IRENA (2019)

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

Innovative Element (IE) #	3.1.3	Description/Title	Bidirectional smart inverters for EV smart charging and V2G applications

Current market needs that the IE will address:

Smart inverters will play a pivotal role in redefining the relationship between DERs and utilities[27]. Technical complexity makes difficult to ensure that the electricity sourced effectively corresponding to injected electricity demand and grid flexibility. Thus, Smart inverters and distributed energy systems (DERs) are beginning to replace the centralized grid. Moreover, key enabling technologies linked to the use of smart inverters and higher RES share (smart charging, V2G) are under development and growing continuously, leading to an increase in the need of smart inverter solutions.
Check also IE #1.1.6

Value proposition of the IE:

This IE adds value to the grid by providing direct response when needed for critical grid distribution services and also supports grid safety and reliability by ensuring performance requirements and best voltage management services along with smart charging and V2G connectivity. Moreover, this IE gives the opportunity for prosumers with EVs to maximize their own generation and optimize self-consumption.
Check also IE #1.1.6

How the IE can bring a market change and how market changes may affect the IE:

Given the fact that EVs and electric mobility market is rising and its interlinked relation with grid flexibility, the adoption of smart inverter solutions will most probably notice an upward trend in the near future. Nevertheless, a related challenge to smart inverter market penetration is the ability to deploy new smart inverter enabled DERs or retrofit existing DERs with smart inverters in a targeted function, which may be necessary as localized grid needs are identified. The development of a new market design that takes environmental aspects of power generation sources into account, will play a key role for the deployment of smart inverters. Large power companies and governments in cooperation with science and technology providers and R&D organizations are trying to identify economic and market mechanisms to enable flexible grid-services. Smart Inverters appear to hold great potential as key components of the overall grid modernization effort enabling EV charging and higher RES penetration in a safe and more reliable manner.
Check also IE #1.1.6

How current and future market changes/challenges affect POCITYF's Objective:

The specific market is trying to combine charging infrastructure with locally installed DERs and stationary energy storage, because it can lead to augmented flexibility for the charging stations and the grid. In this context, taking into account EVs predicted uptake and V2G development in the upcoming years, Objective#3 will most probably positively affected by the related market changes to this IE.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	3.1.4	Description/Title	V2G

Current market needs that the IE will address:

Demand for V2G and smart charging stations is increasing rapidly as countries move towards an electric transport sector. V2G and EVs (powered by V2G) can spawn widespread benefits for the grid while also for the city, with an expected positive impact on energy saving, environmental preservation, traffic management and urban planning of public spaces. All market players could take advantage of the potential of V2G integration in order to become sustainable, resilient and competitive. This IE is associated with electric buses and will assist the markets of public transport and power grid sectors in the following:

- Levelling of the energy grid could be expanded with new assets (buses). Buses have a relative stable consumption need and are predictable. This could allow grid operators to effectively manage the energy flows.
- This could also allow public transport operators to buy and sell energy when energy prices are low and high respectively.
- Integrating IT solutions among bus OEM, public transport operators and energy grid operators or other solution providers.

[27] Smart inverters redefine relationship between DERs and the grid, Solar Road (March 2019)

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

Value proposition of the IE:

The main thing that makes the IE a unique innovation with extra added value, from a holistic perspective, is that not only is developed as a grid flexibility and energy storage solution for the power sector, but also addresses and serves mobility needs. V2G is based on a symbiotic relationship work, in which three components are required, namely: an electric vehicle, a bidirectional charging capability, and software to facilitate the interplay among the vehicle, the charger and revenue-generating opportunities. V2G enables EVs to store and discharge electricity generated from RES. It capitalizes at scheduled times on charging or discharging of an EV battery to provide flexibility services such as frequency regulation and spinning reserves to system operators (DSOs and ISOs). It is an innovative technology that promotes environmental sustainability while achieving energy cost reduction. Providing flexibility at national level by facilitating balancing in the wholesale market, while also at district level by reducing the costs associated with reinforcing local electricity grids and control or adjust charging in order to decrease simultaneously and lowers peaks in demand makes it have an outstanding high market value. The indicative V2G for buses allows public transport operators to access the energy markets for trading options, facilitates city authorities to incorporate public services into their energy strategies, utilizing the produced and available energy as efficient as possible and offers many choices for informed and sustainability-minded customers by enabling user experience.

How the IE can bring a market change and how market changes may affect the IE:

V2G along with EVs uptake can change substantially the global power and mobility market (especially on an EU level) because require use cases that should align best for both energy (power) and transport (mobility) sectors[28]. Therefore, it can help in achieving higher RES penetration in the market, more emerging innovative storage solutions, circular economy driven mechanisms and recycling materials used in manufacturing sector along with decarbonization of above two sectors. Decreasing prices of EVs and new models with bigger batteries are accelerating the market growth, making V2G an attractive flexibility solution for the power system. In this context, V2G technologies will seize the market, accelerating the convergence of mobility and energy. Consequently, by entering energy markets V2G for e-buses could result in lower costs for public transport in general.

On the other hand, the majority of investments in infrastructure development comes from large utilities and large private energy companies. Additionally, emerging innovations in smart charging for EVs and V2G span not just technologies but business models and regulatory frameworks that need to be taken into account, which are continuously built and updated and should grow fast to facilitate electric mobility in the near future.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#3, since they enable the launch of innovative charging technologies and systems and extensive V2G projects/rollouts and ensure also higher RES penetration, EVs uptake and sustainable urban mobility development through better policies, reliable services and cooperation between energy and mobility sector.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**3.1.5**	**Description/Title**	**Smart lamp posts with EV charging and 5G functionalities**

Current market needs that the IE will address:

Increasing adoption and decreasing cost of LEDs and smart lamps are driving the market// The rising trend of integrating the technology with the lighting system is gaining momentum[29]// Smart buildings and smart mobility focus on efficiency, lifecycle assessment and performance generating the need for new monitoring and IoT technologies in the cities// Traffic management, environmental sustainability and city safety-data monitoring are three key sectors in favor of smart lamp posts proliferation.

Check also IE #1.2.1

Value proposition of the IE:

[28] Electric-Vehicle Smart Charging – Innovation Landscape Brief, IRENA (2019)

[29] https://www.led-professional.com/resources-1/articles/smart-lighting-market-and-technology-trends

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The IE is a future-proof solution with bleeding edge technology, that is changing the manner cities evolve in a flexible and cost-effective way, tackling current e-mobility, connectivity and communication needs.
Check also IE #1.2.1

How the IE can bring a market change and how market changes may affect the IE:

The development of smart buildings, smart urban mobility and increase in government initiatives for relevant mobility services, actions and applications about smart city projects are boosting the adoption of smart lighting, thereby impacting the market's growth positively. On the other hand, the very high cost of installation and maintenance is restraining the market to grow.
Check also IE #1.2.1

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes will most probably contribute positively to POCITYF Objective#3, since they trigger further introduction of relevant ICT systems in smart buildings and urban public spaces that give noticeable added value for mobility, connectivity, sustainability and safety in cities.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**3.1.6**	**Description/Title**	**Intelligent and optimal control algorithms**

Current market needs that the IE will address:

Adjustment to energy peak demand of a depot when charging // Development of new, flexible charging strategies or options to lower energy peaks and better usage of the available chargers.

Value proposition of the IE:

The value of the IE can be summarized in the main following points:

- Lowering contracted power agreements with grid operators
- Lower upfront investments in grid connection and number of chargers (CAPEX)
- Providing insights, data and information and ability to adjust to operational issues and needs.
- Reducing energy costs even further.

How the IE can bring a market change and how market changes may affect the IE:

This IE can allow public transport operators and grid operators to reduce upfront costs. In this context, the IE can bring an upward trend to the market of relevant optimization solutions. With this IE also, energy demand response could be planned more efficiently and result in another use of chargers, which could finally lead to a lower usage of the number of chargers needed.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes may positively affect POCITYF Objective#3, because these intelligent tools support the shift towards electric mobility in smart cities through digitalization, energy transition and operational control of the transportation network.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**3.1.7**	**Description/Title**	**Smart solar charging**

Current market needs that the IE will address:

In many countries solar is the lowest cost power option today – both in residential and commercial applications, but also increasingly in the utility-scale field[30]. Overall, Solar PV capacity is projected to grow 2.5-fold over the next 5 years[31] //The uptake of EVs is gaining pace due to the urgent need for decarbonization and its resulting global market changes in automobile industry, while EV charging industry is transforming also drastically// In PV markets where increased self-consumption is the goal, charging EVs using solar energy is yet another way to help achieve energy independence[32]. Hence, energy consumption and efficiency and performance rates of renewable power self-consumption for clients could be managed by their own // Distribution System Operators cannot manage congestion and ensure grid reliability

Value proposition of the IE:

[30] PV Status Report 2019, European Commission: https://ec.europa.eu/jrc/sites/jrcsh/files/kjna29938enn_1.pdf
[31] Renewables 2019 - Market analysis and forecast from 2019 to 2024, IEA (2019)
[32] FUTURE OF SOLAR PHOTOVOLTAIC: Deployment, investment, technology, grid integration and socio-economic aspects, IRENA (2019)

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

This IE offers charging of EVs along with significant additional grid flexibility from solar energy in terms of energy efficiency, environmental sustainability and cost reduction, resulting in a fully valuable product at all levels of use. In addition, when EVs can be charged using solar energy, it helps reduce the pressure from the grid, and can potentially accelerate charging time.

How the IE can bring a market change and how market changes may affect the IE:

Smart solar charging technology will accelerate the sustainable charging of EVs and DC grids (Market PUSH). Smart charging could provide flexibility at both the national system (system level) and regional network (local level). Considering also the e-mobility global rising trend, opportunities for solar energy applications charging systems and services is going to increase. European smart cities pioneer the development of novel solar powered solutions for transport, e.g. in the Netherlands (Market PULL).

How current and future market changes/challenges affect POCITYF's Objective:

Due to the emergence of totally new mobility services tailored to smart city needs in terms of resilience, sustainability and multi-modality, the market changes in the electric mobility and power sectors align well with the increase in the level of service of the transportation system, most probably affecting positively the objective#3 of the project.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**3.1.8**	**Description/Title**	**Virtual Power Plant (VPP)**

Current market needs that the IE will address:

Check IE #2.1.9

Value proposition of the IE:

Check IE #2.1.9

How the IE can bring a market change and how market changes may affect the IE:

Check IE #2.1.9

How current and future market changes/challenges affect POCITYF's Objective:

Check IE #2.1.9

Negatively		Neutral		Positively	

Innovative Element (IE) #	**3.1.9**	**Description/Title**	**DC lighting with EV charging**

Current market needs that the IE will address:

As EVs gain popularity in the EU and worldwide, the EV charging industry is transforming drastically offering also new smart services, capabilities for interconnection and operation with other intelligent systems and the potential to radically change public areas of cities. The integration of these technologies enabling higher RES penetration is a key aspect in order to achieve climate targets and decarbonization. Alkmaar has a strong ambition regarding emission free mobility, safety and car sharing services and initiatives. The local market needs that will be addressed are:

- Alternative of more and more EV charging poles for the increasing amount of EVs in Alkmaar.
- Energy saving and public lighting with good light quality and large area coverage by the lamppost.
- public free/5G entrance to internet everywhere

Value proposition of the IE:

Within this DC lighting system, these smart lampposts can offer more functionalities than an existing normal lamppost, which makes it a better offering compared to existing lamppost. Furthermore, useful data can be obtained to create energy positive and smart neighborhoods.

The introduction of 5G network as from 2022 will cause a large increase in the demand for installation of antennas for mobile communication. This shall be done in a cost-efficient way. Furthermore, these antennas create a disturbing view in the (monumental) streets, which should be minimized as much as possible, therefore these smart lampposts can be a solution for this matter.

The same reasoning is valid for charging poles. Separate charging poles for electric vehicles won't be necessary when using the smart lampposts. This is cost-efficient and minimizes disturbing view and extra required space for separate charging poles. Furthermore, this promotes the usage of electric vehicles.

How the IE can bring a market change and how market changes may affect the IE:

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

The market brings the potential for further IE evolution in the near future, since some key driving forces such as stricter regulations for emissions, not enough space for charging infrastructure and increased need for safety in the cities, are shaping the market.

How current and future market changes/challenges affect POCITYF's Objective:

The specific market will bring up many changes in smart mobility and energy management related applications, that will play a crucial role in order to achieve entirely the implementation needs of POCITYF Objective#3, from this point forward. If market evolution proven successful, the DC public lighting grid with EV charging points can be implemented for all big renovations in the districts of Alkmaar.

Negatively		Neutral		**Positively**	**X**

Table 20 Business models and innovation for IS-3.1

Innovative Element (IE) #	**3.1.1**	**Description/Title**	**EV charging management platform**
Business Models – capturing value from the IE:			
• Platform as a Service (PaaS) – provide the environment to support the ability to build, test and deploy cloud services for EV charging management • b. Data as a Service (DaaS). Data management that uses the cloud to deliver data storage, integration, processing, and/or analytics services via a network connection to end users or companies that may use the data for the development of new products/ services enabling a distributed, renewable energy management system.			
Innovative Element (IE) #	**3.1.2**	**Description/Title**	**EV charger prototype with PV integration**
Business Models – capturing value from the IE:			
• Install EV charger with PV integration Network • Infrastructure as a Service (IaaS). Provide integration of data collection with platforms or engines that perform data analytics and provide visualizations. • Demonstrate the product benefits in field • License the product/technology			
Innovative Element (IE) #	**3.1.3**	**Description/Title**	**Bidirectional smart inverters for EV smart charging and V2G applications**
Business Models – capturing value from the IE:			
• Sales of bidirectional smart inverters for EV smart charging and V2G applications • Product as a service (PaaS) - Provide data-based understanding of grid conditions and performance at the edge, and integrate inverter performance scenarios with that data offering optimization analytics. Check also IE #1.1.6			
Innovative Element (IE) #	**3.1.4**	**Description/Title**	**V2G**
Business Models – capturing value from the IE:			
• Infrastructure as a Service (IaaS): Use public transport batteries to provide short term energy storage when there is a large supply of energy. • b. Energy as a Service: Offer ancillary services, trading local flexibility, industrial peak saving and savings of network distribution fees.			
Innovative Element (IE) #	**3.1.5**	**Description/Title**	**Smart lamp posts with EV charging and 5G functionalities**
Business Models – capturing value from the IE:			
Check IE #1.2.1			
Innovative Element (IE) #	**3.1.6**	**Description/Title**	**Intelligent and optimal control algorithms**
Business Models – capturing value from the IE:			
• Data As A Service (DaaS): Data management that uses the cloud to lower contracted power agreements with grid operators and upfront investments in grid connection and number of chargers (CAPEX).			
Innovative Element (IE) #	**3.1.7**	**Description/Title**	**Smart solar charging**

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Business Models – capturing value from the IE:			
• Infrastructure as a Service (IaaS): Use smart charging technology in V2G infrastructure to provide short term energy storage in EVs when there is a large supply of energy • b. Energy as a Service (EaaS): Offer ancillary services, trading local flexibility, industrial peak saving and savings of network distribution fees with smart solar charging for EVs			
Innovative Element (IE) #	**3.1.8**	**Description/Title**	**Virtual Power Plant (VPP)**
Business Models – capturing value from the IE:			
Check IE #2.1.9			
Innovative Element (IE) #	**3.1.9**	**Description/Title**	**DC lighting with EV charging**
Business Models – capturing value from the IE:			
Check IE #1.2.1 and IE #3.1.7			

4.3.2 Integrated Solution 3.2 - E-mobility Services for Citizens and Auxiliary EV technologies

POCITYF foresees the demonstration and replication of the idea of integrating V2G EVs, operated in an e-car sharing system, within the urban mobility system. On top of that POCITYF will demonstrate innovative EV and hydrogen related technologies that can further promote cleaner mobility, while reducing impact on the local energy system and RES local production.

The innovative elements which for the IS-3.2 are listed below while the following tables contain the progress relative to the three main pillars as described in the introduction of Section 4.

IS-3.2: E-mobility Services for Citizens and Auxiliary EV technologies (EV sharing // Hydrogen powered HD vehicles // Solar Roads)

Table 21 Technical and Innovation Progress for IS-3.2

Innovative Element (IE) #	**3.2.1**	**Description/Title**	**EV sharing**
Innovative aspects of the IE:			
This IE is a highly innovative car-sharing electrification scheme that facilitates EVs to be placed into shared mobility applications and services aiming to accelerate the adoption of EVs and to establish best practices that can be used by other cities (e.g. FCs) in the EU, in order to meet climate targets and reduce traffic and emissions.			
Advancement of TRL levels (TRL8→9):			
This EV sharing scheme is considered a complete and qualified, environmentally friendly customer service, based on a specific vehicle pool of an e-car (EV) and developed with pre-defined criteria that have been already tested to meet transport network requirements, energy grid characteristics, and vehicle operational conditions (TRL8). Through POCITYF, car sharing of EVs will be fully rolled-out in the LH city of Alkmaar and will be advanced to the highest level of technology readiness (TRL9), by using commercial cars available in the market.			
Innovative Element (IE) #	**3.2.2**	**Description/Title**	**Hydrogen Powered HD Vehicles**
Innovative aspects of the IE:			
The IE refers to a green hydrogen powered garbage truck, which is highly innovative considering sustainable hydrogen fuel source as an application in heavy duty transport vehicles (HDV). Key innovative aspects of the hydrogen powered vehicle are the commercial use of a zero-emission, zero air pollution and low-noise technology.			
Advancement of TRL levels (TRL8→9):			
Current IE level of innovation is TRL8. A commercial vehicle is already present and will be demonstrated in the LH city of Alkmaar aiming to evaluate and analyze the performance of this new fuel and expand sustainable market of heavy-duty transport vehicles (HDV). Several municipalities in the Netherlands are			

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already experimenting and using hydrogen powered garbage trucks. Examples can be found at projects i.e. "Life 'N Grab Hy" (www.lifeandgrabhy.eu), Project HECTOR (http://hyer.eu/eu-projects/hector).
The municipality of Alkmaar and Energy Valley are participating in the hydrogen-program DUWAAL under which long distance heavy transport hydrogen powered vehicles are fed by hydrogen generated by wind energy. The cities of Groningen and Amsterdam already have hydrogen-powered garbage trucks.
The level of TRL can be advanced from TRL8 to TRL9 by:

- Encouraging the production of hydrogen powered HD transport vehicles by manufacturers, thereby bringing down the price and contributing to the commercialization of fuel cell HD transport vehicles in Europe.
- Creating a fixed demand for hydrogen in the region of Alkmaar, thereby enabling the production of green hydrogen on a commercial scale.
- Developing a framework for further deployment of fuel cell HD transport vehicles.
- Assessing the technical and environmental performance of a hydrogen powered garbage truck compared to a conventional diesel truck.

Innovative Element (IE) #	**3.2.3**	**Description/Title**	**SolarRoads**
Innovative aspects of the IE:			
This IE element is a 20-meter solar bike-path that will utilize integrated solar panels in pre-made road segments which will power 5 'Smart DC public light posts with charging points for Electric Vehicles'. • Panels are strong enough to incidental support heavy (12-tonne) fire trucks without any damage. • Each individual panel connects to smart meters, which optimize their output and feed their electricity straight into 5 smart DC public light posts with EV charging points. In this way, vehicles will be fed using locally generated energy; using batteries as a buffer. • The top coating of the panels shall be robust enough to deal with the traffic loads and fluctuations in temperature but also give traction to the vehicles passing by • panels to not only let in as much light as possible, but also to last at least 20 years - a similar lifespan to rooftop solar panels (20-year life cycle)			
Advancement of TRL levels (TRL7→8):			
A prototype system of the energy harvesting bike path paved with glass-coated solar panels has been already demonstrated, to analyze and estimate its efficiency, function, durability and operational characteristics. The solar prototype at Krommnenie has experienced several problems with the top-layer coating. Detachments of the top-layer coating from the glass layer and cracks may cause malfunctioning of the panels. More experience to an optimized top-layer coating must be gained to uplift this technology to level 8. The engineering team spent the period of the last year improving the system of solar roads to be durable, testing the system in its final configuration under the range of environmental conditions in which it will be expected to operate during POCITYF and carrying out assessments to determine whether it will meet its design specifications and operational requirements for this purpose and reach next TRL level (TRL8).			

Table 22 Market needs, changes and challenges for IS-3.2

Innovative Element (IE) #	**3.2.1**	**Description/Title**	**EV sharing**
Current market needs that the IE will address:			
There is an urgent need for congestion mitigation, effective use of inner-city space and better air quality/pollution reduction in cities. The EV revolution has been growing rapidly over the past ten years and is accelerating, with the global stock of electric passenger cars passing 5 million in 2018, an increase of 63% from the previous year with a percentage of 24% in Europe[33]. Special attention will be given to (electric) car/bike sharing in new urban planning strategies. As shared mobility grows in popularity, electrification in the shared use market will help cities and EU countries to meet their climate goals, and			

[33] Global EV Outlook 2019, IEA: https://www.iea.org/reports/global-ev-outlook-2019

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reduce GHG emissions[34]. Car sharing and carpooling are changing the habits of consumers. For the new generation the focus is more on car use; car ownership may be less important. Alkmaar has a strong ambition regarding emission free mobility and car-sharing. To this end, an EV sharing scheme helps to increase the effective use of inner-city space and reduce pollution. In addition, residents want fewer cars and a neighborhood with more green. In a city center, this means that there will be more space available, less emissions, whereby the quality of the historic city center will be better reflected.

Value proposition of the IE:

This EV sharing system represents the new frontier of sustainable urban mobility based on a robust charging network and supportive policies of EVs combining key areas of interest such as shared mobility, low environmental impact and carbon dioxide emissions, energy savings offering shared use services, and additional benefits and deals for consumers (i.e. experiences and photos exchange, navigation systems), and most significantly alleviating upfront costs, creating lower-density neighborhoods (decreasing the amount of parking spaces needed), increasing air quality and bringing people into familiarization with EVs. As a specific added value, less emissions of exhaust gases and particulate matter will be observed within the (historic) city center of Alkmaar, leading to a better living environment.

How the IE can bring a market change and how market changes may affect the IE:

The market of EV sharing services will face two major challenges that will drive the market evolution or not. The first is the regulatory and policy framework development and the second is customer demand. It is an indisputable fact that most of the EU countries have not yet adopted solid car sharing strategies and initiatives, while also citizens are not confident with this type of services at this time (demand is not high). However, there is a common belief that shifting away from vehicle ownership to shared mobility and to mobility-as-a-service (MaaS) is expected to continue progressively with digitalization and decarbonization. Moreover, this IE is fully dependent and affected from the markets of electric vehicle production, charging infrastructure deployment and battery material development. In this context, concerning that the other markets grow, the demand for EV sharing schemes will most probably be increased, but there is much that must be done in the regulatory and policy domain.

How current and future market changes/challenges affect POCITYF's Objective:

Due to the fact that mobility needs for smart cities is one of the main issues to be addressed, the foreseen market changes will most probably positively affect POCITYF objective#3, since they support the cleaner energy and mobility targets through the demonstration of V2G and EV charging, operating in an e-car sharing system, within the urban mobility system.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**3.2.2**	**Description/Title**	**Hydrogen Powered HD Vehicles**

Current market needs that the IE will address:

The hydrogen fuel cell vehicle market size is projected to grow at a CAGR of 66.9% from 2019 to 2026[35]. An increase of government initiatives for development of hydrogen fuel cell infrastructure and improvement of international industry cooperation is observed (e.g. Hydrogen Europe & H2KOREA)[36]. Key factors impact the growth of the global market such as surge in environmental-climate change concerns, rapid R&D and technological advancements in energy efficiency and storage[37]. In parallel, an eminent recognition of fuel cell and hydrogen technologies in European energy policy (SET-Plan3.2 2007 & Clean Energy package 2016) is a positive expansion parameter of hydrogen sector.

In this context, regarding the global market needs, the IE will enable a smooth introduction of a zero-emission technology in the conventional fleet of inner-city sweepers and garbage collection trucks and

[34] "Agora Energiewende (2019): European Energy Transition 2030: The Big Picture. Ten Priorities for the next European Commission to meet the EU's 2030 targets and accelerate towards 2050."

[35] Hydrogen Fuel Cell Vehicle Market Statistics: https://www.alliedmarketresearch.com/hydrogen-fuel-cell-vehicle-market

[36] Hydrogen Europe: https://hydrogeneurope.eu/news/hydrogen-europe-signs-mou-h2korea

[37] FUEL CELL AND HYDROGEN TECHNOLOGY: EUROPE'S JOURNEY TO A GREENER WORLD, 10th Stakeholder Forum I Fuel Cells and Hydrogen Joint Undertaking (2017)

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other heavy-duty transport vehicles, thereby laying the foundation for upscaling and further deployment of fuel cell heavy-duty transport vehicles in the future. Stadswerk072 has 30 conventional garbage collection trucks and HVC has more than 100 garbage trucks, operating in the wide region of Alkmaar. The introduction of a hydrogen fueled garbage truck will create high publicity towards the society as the truck drives through many different residential areas.

Value proposition of the IE:

This IE is a sustainable and highly energy efficient vehicle with a quiet and reliable fuel-cell engine that does not emit CO_2. The functional needs of the targeted market are zero-emission, low-noise and zero air pollution heavy-duty transport vehicles, while having similar performance compared to conventional diesel trucks and a reliable and commercial competitive availability of green hydrogen sources.

How the IE can bring a market change and how market changes may affect the IE:

Regarding the changes in the regulatory framework related to air pollution targets and emission targets, the commercialization of hydrogen fuel cell technologies is considered a key EU technology challenge for the next 10 years till 2030. In this context, various technologies will be launched in the market to support smart city concept and eco-friendly development to sustain the environment. The increased citizen awareness toward the consequences of air pollution, carbon footprint and traffic level rise drive also the market to the adoption of hydrogen fuel cell powered transport vehicles. As a result, the market changes will affect essentially the evolution of this technology. On the other hand, the unavailability of a reliable, safe and sufficient supply of hydrogen tanking facilities and a negative public opinion towards hydrogen, may affect the deployment of such IEs.

How current and future market changes/challenges affect POCITYF's Objective:

Government policies and global markets in the energy and transport sector put in a lot of effort to adopt more hydrogen technologies and expand hydrogen energy supply in the future, and as a consequence the forthcoming hydrogen market growth may be partly held as an obstacle for POCITYF Objective #3.

Negatively	**X**	Neutral		Positively	

Innovative Element (IE) #	**3.2.3**	**Description/Title**	**SolaRoads**

Current market needs that the IE will address:

Solar is quickly becoming the cheapest source of electricity – the lowest cost power option nowadays in many countries, both in residential and commercial applications, but also increasingly in the utility-scale field. Given the fact that, the integration of PVs is gaining popularity in construction and transportation sectors. The solar capacities of PVs that are installed globally are greater than any other power generation technology[38]. In The Netherlands there is 600 km² of road surfacing, which is more than the available roof surface. Solar roads can, therefore, provide extra capacity for generating green electricity without claiming extra space in densely populated areas and without being an eyesore.

Value proposition of the IE:

"SolaRoads" comprise a Dutch innovative solution for bike paths, paved with glass-coated solar panels which are connected to smart meters that optimize their output and feed their electricity straight into street lighting or the local grid, resulting in energy harvesting of more than 70Kwh per sq.m. per year. The solar panels are embedded between glass, silicon rubber and concrete, appropriate to every road material characteristics and conditions and strong enough to support 12-tonne load without any damage. The potential of solar roads is huge, because not only could the roads generate enough electricity to power local households, electric powered vehicles and/or street lighting, but they can also provide some amazing lighting opportunities during the night.

How the IE can bring a market change and how market changes may affect the IE:

This IE looks very innovative and attractive and has the potential to push the specific market, as it will be installed on public roads, it will be highly visible for the general public (Market PUSH). The boost in solar energy solutions is going to thrive to a larger extent as a result of its spectacular lower cost development

[38] FUTURE OF SOLAR PHOTOVOLTAIC: Deployment, investment, technology, grid integration and socio-economic aspects, IRENA (2019)

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and prices. European smart cities pioneer the development of solar powered innovative elements, like in the Netherlands. In this context, the solar market development will have a positive impact on solar roads (Market PULL). The problem is that the public opinion is not familiarized yet with solar roads due to safety incidents (danger of skidding, risks related to electricity, risks related to glass panels), narrowing the market.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#3, since they enable the convergence of energy and mobility sector through innovative solar technologies, smart metering systems and sustainable materials.

Negatively		Neutral		**Positively**	**X**

Table 23 Business models and innovation for IS-3.2

Innovative Element (IE) #	**3.2.1**	**Description/Title**	**EV sharing**
Business Models – capturing value from the IE:			
Mobility as a Service (MaaS): • a. Offering mobility packages that include EV-sharing and bike-sharing and specific services such as parking, car-pooling, peer-to-peer. Providing also customer classification and information for booking & payment, including two types of payment options: subscription or pay-as-you-go; • b. E-mobility service driven by property owners: EV sharing concepts i.e. P2P (peer-to-peer) by increasing utilization of privately-owned vehicles that are idle over 90% of the day			
Innovative Element (IE) #	**3.2.2**	**Description/Title**	**Hydrogen Powered HD Vehicles**
Business Models – capturing value from the IE:			
• a. Hydrogen refueling stations (incl. sufficient storage) at nodes (as well as along main shipping routes) • b. Maintenance centers at key nodes / truck depots • c. High safety standards for FCH components, permitting and licensing of commercial operation • d. Similar business cases for other applications i.e. trains - hydrails, buses			
Innovative Element (IE) #	**3.2.3**	**Description/Title**	**SolaRoads**
Business Models – capturing value from the IE:			
• a. Panels for solar roads • b. Maintenance of solar roads • c. High safety standards for permitting and licensing of commercial operation			

4.4 Progress related to Project Objective #4

Objective 4: Demonstrate the integration of the latest generation of ICT solutions within existing city platforms over open and standardized interfaces enabling data exchange/monitoring for the development of new innovative services

POCITYF will cover this aspect of the call (see **Section 1.2)** integrating already existing Cross-Functional Modular open specifications CIP platforms with tools/mechanisms and services (e.g. Connect with Energy, GRIDS energyCity, PowerMatcher). The demonstration of them is realized in all four PEBs of the LHs. POCITYF will deliver a set of Optimized Mechanisms and Methodologies for improved control and automation of the distribution network (e.g. Energy/Mobility System Modelling). Topology Analysis, Demand & Supply Matching are going to be performed achieving Grid Balancing & Stability Engine, Day Ahead Topology Optimization achieving as well as Supervisory Monitoring Services, Data Analytics Services and Energy-Network Management Schemes (**WP2, WP6, WP7**).

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Tables 23-25, report on the three main pillars as described in the beginning of Section 4. As some ICT solutions are already described under other Objectives (or ETTs), duplication of information is avoided by pointing out the specific Obj. and IS where this solution has been detailed.

Table 24 Technical and Innovation Progress for ICT solutions

ICT Solution #	1	Description/Title	Connect with Energy
Innovative aspects of the IE:			
Check IE #4.1.1			
Advancement of TRL levels (TRL6→7):			
Check IE #4.1.1			
ICT Solution (IE) #	**2**	**Description/Title**	**GRIDS energyCity**
Innovative aspects of the IE:			
GRIDS energyCity digital platform acts as the digital twin of the building sector, integrating measurement data to monitor and analyze the energy consumption and CO2 emissions of building. GRIDS energyCity provides energy-relevant information for cities, municipalities or regions in an easy to understand way. It allows easy monitoring and simulation of energy efficiency measures over a longer period as well as the digital planning and effective implementation of different strategic investments supporting decision making. The solution presents important KPIs in a geographic context and can be considered a digital energy concept which is up to date at any time. Local or regional energy strategies can not only be planned digitally but also implemented effectively and visualized in an appealing way. GRIDS energyCity is an innovative platform for internal and external communication providing transparency to all stakeholders of a region (e.g. citizens, politicians, utilities, local companies). Main features: • In a compact overview, decision makers receive essential KPIs about the buildings in their community, the development of CO2 emissions and as well as the comparison of different districts and building types. • Furthermore, decision makers can compare different measures with each other in order to identify, for example, which measures in historical buildings lead most efficiently to a CO2 reduction. • In addition to CO2 emissions, primary and final energy consumption by energy source is also displayed. • A further feature is that various packages of measures can be defined for the future. • The CO2 reductions to be achieved by these measures will also be displayed. • Thus, different scenarios can be run through and finally be compared with each other according to their effectiveness in terms of CO2 emissions. • Additionally, the solar potential of the roof is displayed.			
Advancement of TRL levels (TRL6→7):			
The GRIDS energyCity platform is already tested in an operational environment in three municipalities in Switzerland (TRL 6). The IE will be connected to Evora's CIP taking local conditions into account and with customized software bridges and APIs, These adaptations essentially comprise the following points: • Data-availability • Building stock characteristics • Customized user-stories The GRIDS energyCity will use the data monitored to contribute to the energy infrastructure planning of the city up to 2050. Enersis will support the project in defining and deploying necessary information for data platforms to ensure the interconnectivity with existing City Information Platforms.			
ICT Solution #	**3**	**Description/Title**	**Reflex (previously PowerMatcher)**
Innovative aspects of the IE:			
ReFlex is a software for aggregating and monetizing Energy Flexibility through value stacking. There are multiple energy and balancing markets that an Aggregator could use to capture the value of flexible assets (e.g. batteries, EV charging, HVAC, curtailing PV panels). Typically, one asset is used for optimizing for one energy or balancing market. However, it can be profitable for Aggregators to utilize the flexible assets			

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dynamically and for multiple markets simultaneously. However, this is very complex, since actions on one market affect the possibilities for another market. This is especially complicated when dealing with a heterogeneous portfolio of flexible assets. ReFlex is a tool which can inform the Aggregator exactly what type of flexibility there is available within the portfolio, and what the consequences of a potential dispatch are. It aligns the positions on different markets. In order to do this, it incorporates live asset information and forecasts.

Advancement of TRL levels (TRL7→8):

Currently ReFlex is validated in a demonstration environment. The current TRL level is 7 In this project the TRL level will be increased to 8. Reflex (previously known as PowerMatcher) is an IT solution that combines IT, electrical engineering, economics and control. This platform is currently available (TRL 7), as part of the Flexible power Alliance Network (FAN) and was designed to coordinate and manage a large number of small and medium-sized energy-demanding services, allowing control over its ever-increasing load of the grid and the distributed generators that create it, from rooftop PV panels to massive wind parks. The PowerMatcher will be connected to the heat and cold storage system, allowing the DHC grid to operate as a power to heat/cold (hybrid) system. To optimize the operation of it, and before its connection, TNO (in close collaboration with HVC) will a) simulate the existing heat network in CHESS (quantitative model to support the developing of new, integrated energy concepts and associated business models), b) simulate the new innovative elements and c) add control algorithms in its model (TRL 8). PowerMatcher will be adapted to be applied in: CEMS (IS2.1) for VPPs, in residential buildings, in storage with EVs, in heat and cold storage systems for balancing the grid. The design is based on multi-agents' systems, which makes it highly scalable and able to ensure user privacy at all times.

Table 25 Market needs, changes and challenges for ICT solutions

ICT Solution #	**1**	**Description/Title**	**Connect with Energy**		
Current market needs that the IE will address:					
Rise in demand for RE in the power generation sector and the energy mix, changes in the dynamics of power grids from centralized to distributed, moderating costs and easy accessibility of energy storage are some of the factors driving the growth of P2P energy trading. Furthermore, continuous policy interventions[39,40] are calling for: a) universal access to affordable, fairly priced and abundant energy, and b) the choice to take control and responsibility for the self-provision of their energy needs allowing the possibility to produce and sell own electricity creating investment opportunities[41], which can enhance energy equity[42,43] in EU. Check IE #4.1.1					
Value proposition of the IE:					
Check IE #4.1.1					
How the IE can bring a market change and how market changes may affect the IE:					
Check IE #4.1.1					
How current and future market changes/challenges affect POCITYF's Objective:					
Check IE #4.1.1					
Negatively		Neutral		**Positively**	**X**
ICT Solution #	**2**	**Description/Title**	**GRIDS energyCity**		
Current market needs that the IE will address:					

[39] SET-Plan Action 3.2, Implementation Plan, Europe to become a global role model in integrated, innovative solutions for the planning, deployment, and replication of Positive Energy Districts, June 2018

[40] https://ec.europa.eu/energy/en/topics/energy-strategy/clean-energy-all-europeans

[41] European Commission. In-depth analysis in support of the Commission. COM (2018) 773

[42] According to World Energy Council (WEC) https://www.worldenergy.org/transition-toolkit/world-energy-trilemma-index

[43] 'The 'energy trilemma' is a term used to describe the policy challenge of simultaneously responding to the potentially competing goals of energy security, energy affordability and low carbon energy supply'. Source: 'Rinkinen, Jenny, and Elizabeth Shove. "THE ENERGY TRILEMMA." Energy Fables: Challenging Ideas in the Energy Sector (2019): 91.'

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Both municipal energy planners and policy makers need to have an up-to-date and comprehensive understanding of the impact of the municipal building stock in terms of CO2 emissions and energy status. This is important in order to determine the need for action and identify measures to achieve the targets. Climate targets include greenhouse gas emissions and energy status. The aim is to be able to compare suitable measures with each other and thus to identify the best measures more quickly, to reduce the time required for reporting through automation and to present the status quo of climate- and energy-relevant topics in a transparent manner.

The transitioning to more sustainable energy systems and building the necessary data infrastructure to monitor and reduce consumption is increasingly becoming a serious challenge to cities (both large and smaller). This poses a need for increased operational and planning efficiency of local / regional authorities for achieving energy transitioning requiring tools/systems with which cities can monitor energy city data and plan future energy systems' interventions increasing their effectiveness.

Value proposition of the IE:

A city's energy and climate data analytics engine, with energy simulation and climate planning tools, in which:

- The municipality is shown as a map with the complete building stock.
- In a compact overview, essential KPIs about the buildings in the community, the development of CO2 emissions and energy consumption are visible. Different districts and building types can be compared in terms of these KPIs.
- Furthermore, heating type is displayed for each building and, if measures have been implemented, the year of implementation is also shown.
- Different measures can be compared with each other in order to identify, for example, which measures in historical buildings lead most efficiently to a CO2 reduction.
- A further feature is that various packages of measures can be defined for the future.
- The CO2 reductions to be achieved by these measures will also be displayed.
- Thus, different scenarios can be run through and finally be compared with each other according to their effectiveness in terms of CO2 emissions.
- Additionally, the solar potential of the roof and the heat demand density for district heating planning is displayed.

How the IE can bring a market change and how market changes may affect the IE:

The growing awareness of the threat of climate change is increasing the pressure on federal and local politicians and decision-makers to implement appropriate measures and legislative changes to reduce greenhouse gas emissions. Since emissions from buildings represent a very high proportion of total emissions and because building stocks have to take local characteristics into account, it will become increasingly important for local decision makers and energy planners to have a deep understanding of the status quo in order to define appropriate measures. Therefore, it can be assumed that the demand for platforms that communicate the influence of buildings in a comprehensible way will increase in the future. GRIDS energyCity can help local/regional authorities increase their capacity to implement efficient energy transition measures though visualising the current status of the city energy data understanding its patterns and plan future investments based on real data gathered.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#4, since the introduction of innovative technologies and products i.e. the GRIDS energyCity into the CIPs are supported rendering them into a holistic toolbox for monitoring and managing energy and energy related behaviors and needs increasing the capacity of local/regional/national authorities to plan energy efficiency investments.

Negatively		Neutral		**Positively**	**X**
ICT Solution #	**3**	**Description/Title**	**Reflex (previously PowerMatcher)**		

Current market needs that the IE will address:

Flexibility has strategic value in the energy transition process. Every single stakeholder we consulted is afraid of missing the boat and lose their competitive edge. Here we identify Fear Of Missing Out as a key driver; however, timing is crucial and most importantly not similar for every stakeholder.

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The electricity demand is expected to rise by more than a third by 2050 compared to 2000 levels, driven by the electrification of traditionally fossil-based sectors like transport and heating/cooling. Energy storage will play a crucial role to ensure a stable energy supply. The forecasted investments in the electricity grid in the lapse 2011-2050 are between €1.5 and €2.2 trillion, according to the EC[44]. At the same time the IEA estimates an increase of energy storage capacity from 140 GW in 2014 to 450 GW in 205045 with the cost of all major components of stationary system storage declining. The market of energy storage will achieve at least $250 billion by 204046. In addition, the power sector is leading the ongoing energy transition, driven by the rapid decline in renewable electricity costs, particularly for wind and solar generation. Between 2009 and 2018 the price of solar photovoltaic modules dropped more than 80%, and the cost of electricity from solar PV fell nearly 75%. The price per unit of wind power fell by about 50% (depending on the market) over the same period, and the costs of onshore wind power dropped nearly 25% between 2010 and 2018, with further dramatic declines expected in the coming decade[47]. The above market changes are expected to increase the penetration of RES into the energy system and this will be accompanied by the need to tools and systems to match efficiently demand and supply. The PowerMatcher addresses this need for coordinating and managing the supply of a large number of small and medium-sized energy-demanding services, allowing control over its ever-increasing load of the grid and the distributed generators that create it.

Value proposition of the IE:

Maximizing the value, reliability and utilization of flexible assets, through asset pooling and simultaneous value stacking on multiple energy markets.

PowerMatcher is the missing link to face the market challenges described. It serves as a communication and coordination protocol for Smart Grids, as part of a complete system architecture. It is an innovative software that optimizes the potential for aggregated individual electricity producing and consuming devices to adjust their operation in order to increase the overall match between electricity production and consumption. It is consumer/prosumer based, highly scalable, cost effective even at small scale and provides local congestion management.

How the IE can bring a market change and how market changes may affect the IE:

ReFlex allows aggregators to increase the profits of utilizing flexibility. This way, the value of connecting and unlocking the flexibility increases, making it cost-effective to unlock more flexible assets. Using ReFlex (or similar technology) gives aggregators a competitive edge over aggregators that cannot handle pooling and value stacking. Pooling a set of heterogenous assets makes it easier for aggregators to enter multiple markets of assets (e.g. EV charging, controlling batteries and utilizing flexibility of industrial processes).

Furthermore, the foreseen market changes are expected to positively affect POCITYF Objective#4, since the introduction of innovative technologies and products towards increasing variable and dispatchable RES into the energy mix and providing Demand Response services for achieving energy efficiency and energy affordability are supported with Reflex.

How current and future market changes/challenges affect POCITYF's Objective:

- Currently the value of energy flexibility is not high enough to justify connecting medium and small flexibility assets. We expect this to change in the near future:
- Due to the increase of intermittent renewable energy sources, balancing the power grid will become more difficult in the future, increasing the need for energy flexibility and (due to market principles) increasing the value of energy flexibility.
- Due to advances in IoT technology and standardization, connecting flexible assets becomes cheaper, making it cost-effective to connect smaller flexible assets.

Negatively		Neutral		**Positively**	**X**

[44] European Commission: Energy Roadmap 2050, 2011. http://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A52011DC0885

[45] IEA: Technology Roadmap Energy Storage, 2014. https://www.iea.org/publications/freepublications/publication/TechnologyRoadmapEnergystorage.pdf

[46] Bloomberg New Energy Finance: New Energy Outlook 2016, 2016. https://www.bloomberg.com/company/new-energy-outlook/

[47] International Renewable Energy Agency, 2018

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Table 26 Business models and innovation for ICT solutions

ICT Solution #	1	Description/Title	Connect with Energy
Business Models – capturing value from the IE:			
Check IE #4.1.1			
ICT Solution #	**2**	**Description/Title**	**GRIDS energyCity**
Business Models – capturing value from the IE:			
• Data As A Service (DaaS). Data management that uses the cloud to deliver data storage, integration, processing, and/or analytics services via a network connection to end users or companies that may use the data for the development of new products/ services • Offer consultancy services on smart cities projects strategic planning • Onboarding new municipalities and gaining an income through licenses • In the case of individualized solutions, the costs for further development of the platform are also charged.			
ICT Solution #	**3**	**Description/Title**	**Reflex (previously PowerMatcher)**
Business Models – capturing value from the IE:			
Since TNO is a Research institute, is not capable of operationalizing ReFlex itself. Therefore, TNO wants to be in the Technology Provider role, and license the technology to a Solution Provider. This would be an (independent) ICT company which can further develop, maintain and support the technology. They can deliver it to multiple end users (Aggregators/Energy Suppliers). Alternatively, TNO could license the technology directly to Aggregators (or Energy Suppliers), which will have to maintain the technology themselves. Business models for Aggregators (or Energy Suppliers) might include: • Offer Demand – Response services (for flexibility, load shifting, etc.) • Offer Control and dispatch assets services			

4.5 Progress related to Project Objective #5

Objective 5: Demonstrate active citizen engagement services and solutions providing an open innovation ecosystem for citizens to participate in co-creation, decision making, planning and problem solving within the Smart Cities

4.5.1 Integrated Solution 4.1: Social Innovation Mechanisms towards Citizen Engagement

The energy transition to positive buildings, districts and communities shall be pursued through a close relationship with citizens, encompassing a bottom-up approach (from city to solution providers and local authorities), in which co-creation, co-development and co-implementation processes play a central role, aiming to prevent the disconnection that, may arise from the deployment of non-tailored solutions, agnostic to the culture and history of the local citizens. This approach has been demonstrated by INESC TEC in the development of the Portuguese Electronic Health Record (EHR) with the Portuguese Ministry of Health, which has been developed through co-design and co-creation approaches. The EHR was launched in 2012 and is currently used (2018) by 1,8 million Portuguese citizens and 650 healthcare institutions. These innovative social engagement strategies will be designed to boost and motivate the citizens to participate and create solutions along with the industry and policy makers. A focus on disadvantaged communities will be given, in order to provide inclusive technology capable of improving local life conditions, while promoting sustainable tourism, innocuous for the city infrastructures and historical buildings.

The innovative elements which for the IS-4.1 are listed below while the following tables contain the progress relative to the three main pillars as described in the introduction of Section 4.

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IS-4.1: Social Innovation Mechanisms towards Citizen Engagement (Digital transformation in Social Innovation // Gamification platform // Tourist apps // Cultural experiences market (mobile app) // Mobile apps on energy consumption // Value based design // InnoFest concept)

Table 27 Technical and Innovation Progress for IS-4.1

Innovative Element (IE) #	**4.1.1**	**Description/Title**	**Digital transformation in Social Innovation**
Innovative aspects of the IE:			
This IE refers to a digital fundraising platform for social innovation in energy poverty and underserved communities. A state-of-the-art cloud platform for energy donations provides a digital tool for electric/gas/water utilities and cities to enhance low income customer assistance programs and reduce unpaid bills. The cloud platform for P2P energy transactions empowers the users of the network with the ability to debit and credit their energy wallets with kWh or equivalent euro amounts. Following recent advances of the banking sector, the mission is to directly connect prosumers of the energy network so they can exchange energy (or equivalent monetary amounts) with just a few clicks. If a user has a surplus of energy it is not possible to credit the account of a friend and family member with an energy amount of his/her choice. The P2P digital platform also empowers users/utilities to publish campaigns and donate energy in euros or tokens – enabling the donations to be based on sustainable energy consumption behaviors. The platform enables the implementation of fundraising, performs transactions using credit/debit cards or tokenizes energy over blockchain and monitor analytics on projects and transactions. The platform also offers a great variety of features to engage the users: 1. Ambassador Feature: users can create their own personalized campaigns to help support existing programs in the platform, 2. Save and Donate: users can learn how to save the amount of their contribution by following personalized energy saving tips, 3. Smart Giving: users with smart thermostats can learn how to save the amount of their contribution by simply adjusting their heating/cooling needs, 4. Solar Sharing: users with solar panels can learn about their solar production and bill savings, select a percentage and share it. Transactions can be performed using credit/debit card. In addition, the platform can support integration with the billing system of the utility partner or even use blockchain to tokenize the transaction (e.g. ERC20). Check also IE #1.2.4 & IE #2.1.5			
Advancement of TRL levels (TRL6→8):			
Wireframes, Designs and user flow has been conceptualized as well as the proof of concept. The technology has already been tested with energy utilities in EU and USA. (TRL 6). During POCITYF the platform will be customized to meet the needs of the pilot community. Next steps include the appropriate integrations with external parties and databases of the consortium such as PowerMatcher, Meter Data Management Systems, Billing system. During POCITYF, this IE will be customized according to the needs of the network resulting in a qualified system targeting TRL8 and above. More specifically, the Connect with Energy P2P platform will be integrated with the Community Solar Farm (existing or new PV plants) and the City Information Platform of Evora to enable citizens watch their energy wallet also from RES assets and provide the possibility to trade and exchange for tokens the energy generated in the solar farms providing cheaper energy for those in need. Check also IE #1.2.4 & IE #2.1.5			
Innovative Element (IE) #	**4.1.2**	**Description/Title**	**Gamification platform**
Innovative aspects of the IE:			
Developed by INESC TEC the Gamification platform aims to change the behavior of the end-users through their involvement in games that are in accordance with the energy efficiency goals designed for the building. The platform includes serious games which enable competition between building users and small communities, through interconnecting users with mobile apps and with metering and automation platforms. Up to 70% of participants are expected to use the gamification platform increasing user acceptance rates.			
Advancement of TRL levels (TRL6→7):			

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

A technology pilot has been tested in relevant environment **(TRL6)** during projects FEEdBACk and GREsBAS and the final development strategy has been defined. The Gamification Platform concept will be demonstrated and validated **(TRL7)** in Evora's PEB1 and PEB2 to promote behavioral changes towards EE (energy savings around 15%), increasing citizens' engagement rates by rewarding with tokens that can be exchanged for those that perform better. The gamification platform will be connected to the data acquisition system at the City Information Platform of Evora.

Innovative Element (IE) #	**4.1.3**	**Description/Title**	**Tourist apps**

Innovative aspects of the IE:

The tourist mobile apps allow the management of crowd flows in heritage areas, which includes heritage buildings, districts, regions, etc. The innovative element is the capacity of providing intelligent alternative routes scheduling/destinations/timings/waiting times and be linked with property energy status in order to minimize not only crowd stress over heritage places, but also energy consumption.

Advancement of TRL levels (TRL6→7):

The tourist mobile app was developed in the framework of Smart Heritage City Project (SHCity), program Interreg Sudoe, and was demonstrated in Ávila, a world heritage Spanish city thus reached TRL 6. The tourist overcrowding in Avila was reduced by 20%. During POCITYF, the tourist app will reach TRL 7 by having a prototype demonstration in Évora environment, including the monitoring/management of several heritage places, in accordance to Évora's operational conditions and provide citizens and tourists with real-time data and information in order to enable them to make the best choices in what concerns energy efficiency-oriented behaviors.

Innovative Element (IE) #	**4.1.4**	**Description/Title**	**Cultural experiences market (mobile app)**

Innovative aspects of the IE:

A mobile app aiming to promote touristic experiences and cultural activities in specific regions facilitating dissemination and publicity both at a national and international levels.

Advancement of TRL levels (TRL6→7):

The **Cultural experiences marketplace** has been tested and validated in relevant environments **(TRL6)** such as different municipalities/museums in Portugal, such as WINES of Portugal, the Ethnographic Museum from Vouga Region, the Monastery of Emotions from Cabeceira de Bastos as well as in São João da Madeira (Industrial Tourism) and in GeoPark Terras de Cavaleiros. The **Cultural experiences marketplace** will be further demonstrated as a system integrated with the gamification platform and the CIP and validated **(TRL7)** in operational environment in the PEB1 of Evora aiming to promote user/tourist behavior change and engagement towards changing their routines to follow environmentally friendly practices and sustainable tourism especially in areas with cultural heritage sites.

Innovative Element (IE) #	**4.1.5**	**Description/Title**	**Mobile apps on energy consumption**

Innovative aspects of the IE:

The main innovative aspect of this IE results from the integration of diverse information, from different systems (PV generation, EV charges, energy consumption, energy price, …). Mobile apps associated to a rich and diverse data pool provide the ability to monitor data, get warnings based on predefined criteria, run analytics, create / access reports virtually in real time. Such mobile apps on energy consumption will allow interaction with sensing and control devices available within buildings, enabling information exchange with local or cloud-based energy management systems, providing feedback as well as relevant information to end-users and energy managers.

Advancement of TRL levels (TRL6→7):

Current web-based platform focused on energy consumption / generation monitoring is in commercial use. **Mobile apps on energy consumption** have been tested and validated **(TRL6)** in several projects, like AnyPLACE, FEEdBACk and InteGrid, where more than 200 households have participated as testing environment achieving energy savings up to 10% and up to 20% renewable integration. With a vast experience in many fields of expertise related to POCITYF, from PV, e-mobility, decentralized energy generation, energy markets, thermal storage and others, it is identified that the challenge now lies in the integration of all these technologies, and the ability to manage them efficiently with easy access to relevant data in a single platform. **M**obile apps will be integrated with other POCITYF solutions (i.e. gamification platform) for monitoring the campus

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energy consumption. The Mobile apps together with the gamification platform will be tested and operated as a system in operational environment in Evora University Campus (PEB2) **(TRL7).** Combined with the gamification platform, it will be interesting to understand those solutions together alter the consumption taking into account the competition between different buildings and departments or among students.

Innovative Element (IE) #	**4.1.6**	**Description/Title**	**Design based Value Mapping for Communities**

Innovative aspects of the IE:

The **innovative value-based methodology** targets citizens' willingness and ability to change. The rationale is to co-create with all involved stakeholders a network of lead users, both in pre-pilots and in replication and follow-up projects. These lead-users help to strengthen the initial acceptance and support for the project, accelerating it, but also the effectuation towards the majority of citizens in the follow-up phases. Content wise, the early adopter network can vary from users **(1)** with a high technical and do-it-yourself technical profile helping others with smart grid ICT applications, home energy management etc.; **(2)** users with excellent communication skills and sustainability motivation, prepared to function as practical organizers of -extra- neighborhood or street group meetings, making use of existing apps; **(3)** users with natural, informal leadership skills in the user-network who mobilize the users and other stakeholders for certain issues regarding -installation, use, costs, service of the new systems, who co-determine the agenda for discussion with the management of the pilots in Alkmaar

Advancement of TRL levels (TRL5 →6):

Project partner Energy Valley will advance its Design based Value Mapping for Communities (DBVC) method, based on previous research on value capturing of TU Delft (2015) applied amongst others as a pilot in a community test case on Texel island **(TRL5)**, located on top of Alkmaar, for the development and implementation of the Netherlands' most advanced sustainable public lighting system (2016). The method is based on design thinking and can help to create opportunities for new energy and circular product/services projects and business in neighborhoods emerging during the execution of POCITYF. During POCITYF, the community engagement approach of TNO (Alkmaar's ecosystem) will be enriched with recent methods and tools from design-based value creation, which also can lead to increased citizen and other stakeholder engagement via new local services and business creation within the project. Both methodologies, of TNO and Energy Valley, will be aligned in one systematic POCITYF community-oriented value-based development process and as a system will be demonstrated in real operational environment in Alkmaar **(TRL6).**

Innovative Element (IE) #	**4.1.7**	**Description/Title**	**POCIFEST (formerly INNOFEST)**

Innovative aspects of the IE:

- INNOFEST is both a brand name and generic approach to facilitate and accelerate new sustainable product design and business development via festivals. INNOFEST oriented festivals give start-ups from higher education institutes, new business proposals from SMEs and from other agency the opportunity to demonstrate and test their concepts during the festival, creating user feedback from thousands of potential users in a few days, accelerating the innovation process. In most cases, local incubators are engaged in the process, as well as special festival innovation brokers, who stimulate the business and product proposal submissions and give early guidance. For the POCITYF project, a variant of the original INNOFEST Methodology will be applied, that includes the experiences of the likewise EU InnoQuarter project as well. For reasons of brand rights, in the POCITYF project the approach will be coined as the POCIFEST approach from now on, building on INNOFEST and InnoQuarter expertise, but with a focus on energy transition innovations.
- So far, the average outcome, in terms of successfully kicked off new sustainable businesses, are ca. 3-5 per festival, based on the experiences from eight Dutch INNOFEST festivals over a four-year period and five European InnoQuarter festivals over a two-year period.
- POCIFEST should be considered as a design thinking oriented methodology which creates, tests and facilitates various, additional new product and business proposals, within the context of the POCITYF transition trajectories.

Advancement of TRL levels (TRL6 →7):

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- POCIFEST typically is testing TRL4 sustainable products, services and technologies, to bring them to TR5 level. In some cases, when the festival special conditions are close to a 'mini-society' context, a quick through-development to TR6 and TRL7 levels are possible. The precise levels not only depend on the proposed product-market innovations but also on the type of festivals, with usually lower TRL-start-levels for more high-tech festivals, and higher ones for the more generic, applied ones
- The TRL level of the POCIFEST methodology itself is at TRL6 level, to be further developed to TRL7.

Table 28 Market needs, changes and challenges for IS-4.1

Innovative Element (IE) #	4.1.1	Description/Title	Digital transformation in Social Innovation
Current market needs that the IE will address:			
The energy grid market is evolving and the cost for residential renewable energy sources as well as energy storage is decreasing, and this increases the population of energy prosumers (producers and prosumers of energy). In addition, with the evolution of Electric Vehicles, it is expected that a large portion of the energy consumption of a metered user will occur outside his/her meter domain. For example, car parks, friends' homes, or in general where the electric chargers will be placed. In this market, the need for a platform to enable P2P energy transactions will always be increasing. We address this issue with an innovative P2P energy transaction platform. Rise in demand for RE in the power generation sector and the energy mix, changes in the dynamics of power grids from centralized to distributed, moderating costs and easy accessibility of energy storage are some of the factors driving the growth of P2P energy trading. Furthermore, continuous policy interventions[48,49] are calling for: a) universal access to affordable, fairly priced and abundant energy, and b) the choice to take control and responsibility for the self-provision of their energy needs allowing the possibility to produce and sell own electricity creating investment opportunities[50], which can **enhance energy equity**[51,52] in EU.			
Value proposition of the IE:			
The P2P energy transaction platform enables more energy services for the end user and makes the renewable energy sources and energy storage more attractive to end users. For cultural heritage communities where solar power at residential level may not be an option, the proposed platform will enable the concept of solar sharing and community solar.			
How the IE can bring a market change and how market changes may affect the IE:			
The P2P energy transaction platform creates new business models for increased channels of revenues similar to the sharing economy. Prosumers who have excess of energy can decide what to do with their surplus. The expected reduction of the costs for residential off-grid installations may affect the need of such a platform but this addresses only a specific small number of homeowners and not cultural heritage communities. The Connect with Energy P2P trading platform can alleviate energy poverty by providing energy to those in need through donations. It can promote further the decentralization in energy production and can also contribute to grid stability, and balancing needs through demand response programs adapted to it. Existing grid infrastructure capacity can be a barrier for integrating RES and applying the Connect with Energy Platform, but this can be overcome with novel microgrid technologies of automation, management and control. The Connect with Energy platform can foster citizen engagement to adopt energy efficiency practices and provoke energy consumption behavior changes.			
How current and future market changes/challenges affect POCITYF's Objective:			

[48] SET-Plan Action 3.2, Implementation Plan, Europe to become a global role model in integrated, innovative solutions for the planning, deployment, and replication of Positive Energy Districts, June 2018
[49] https://ec.europa.eu/energy/en/topics/energy-strategy/clean-energy-all-europeans
[50] European Commission. In-depth analysis in support of the Commission. COM (2018) 773
[51] According to World Energy Council (WEC) https://www.worldenergy.org/transition-toolkit/world-energy-trilemma-index
[52] 'The 'energy trilemma' is a term used to describe the policy challenge of simultaneously responding to the potentially competing goals of energy security, energy affordability and low carbon energy supply'. Source: 'Rinkinen, Jenny, and Elizabeth Shove. "THE ENERGY TRILEMMA." Energy Fables: Challenging Ideas in the Energy Sector (2019): 91.'

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The foreseen market changes are expected to positively affect POCITYF Objective#5, since the introduction of innovative technologies and products into the CIPs are supported i.e. the Connect with Energy Platform renders the CIP into a more holistic toolbox for monitoring and managing energy and energy related behaviors and needs.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**4.1.2**	**Description/Title**	**Gamification platform**

Current market needs that the IE will address:

The market for flexibility requires a change in the behavior of end-users. Solutions are adopted more easily when they are citizen-centric by means of citizens' taking personal and collective responsibility for how they 'use' their city, changing their mindset, behaviors and actions. Bottom-up urban regeneration requires multi directional information flows (i.e. city-to-citizen, citizen-to-citizen, citizen-to-city53) and co-creation tools (i.e. hackathons, urban living labs, crowd sourcing), for citizens to be involved in designing the city in which they live in. Citizen participation and adoption of solutions is also enhanced through the use of technologies and digitization. Understanding the motivations and motives of citizens correctly leads to a more effective participation policy. One of the instruments to increase civic engagement is now through gamification. By bringing a more competitive and fun character to the use of novel technologies, the engagement rate can be significantly higher.

Value proposition of the IE:

A serious game platform for engaging citizens and users in energy related technologies and services enabling competition between building users and small communities. The Gamification platform interconnects users with mobile apps and with smart metering and automation platforms.

How the IE can bring a market change and how market changes may affect the IE:

Gamification could change the engagement approaches and the way the end-users/consumers take the energy efficiency measures. In that sense, the evolvement of such platforms and approaches with a proven track of increased engagement rate will change the market and its acceptance towards this technology. On the other hand, the improved procedure for integration of demand response programs and inclusion of flexibility in the energy efficiency measures could affect the market and increase its need for such IE.

How current and future market changes/challenges affect POCITYF's Objective:

End-user engagement and behavioral demand response has always been a challenge in the field. As one of the main objectives of the project is to make positive blocks of energy through citizen engagement, it could be a challenge to provide enough acceptance rate for the IE among the target users. Moreover, with the privacy issues on collected data and consent of the users on deploying their measured data, the integration of gamification approaches would be at risk and thus could be considered a risk for the project objective.

Negatively		Neutral	X	**Positively**	**X**

Innovative Element (IE) #	**4.1.3**	**Description/Title**	**Tourist apps**

Current market needs that the IE will address:

Travel-based mobile apps are the seventh most-downloaded app category and almost 60% Smartphone users regularly use travel apps while planning trips. Gone are the days when travelers relied on travel agents for making travel arrangements. With digital tools at hand, people now prefer to make their own travel arrangements through portable and user-friendly mobile apps.

Digital tools with energy related functionalities addressed to tourists can provide information on waiting-duration times of public transport, innovative intelligent route scheduling, property energy status, information gathering on the tourist occupancy, essential to establish tourist's scattering city mapping etc. These tools can facilitate tourist's engagement and increased awareness towards sustainable energy behavior especially in areas where population faces massive increase during touristic periods. In specific, the fast growing of tourist flows in heritage places (including Évora) raise a huge need of intelligent management of these flows. In this sense, a mobile app capable to, for one side, collect information from

[53] PwC. Creating the smart cities of the future – A three tier development model for digital transformation of citizen services, May 2019.

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region/city/building and, for other side, suggest good practices/options to optimize the tourist experience in heritage places will fulfil a need, but also a mandatory request of most heritage municipalities/managers.

Value proposition of the IE:

The tourist app will contribute to decrease waiting times, to improve quality of visits and to reduce energy consumption in heritage places through the intelligent management of crowd flows. At the same time, the app will be easy to access and easy to use in order to potentiate tourist's adhesion.

How the IE can bring a market change and how market changes may affect the IE:

Digital literacy advances in all age groups and tourists regardless of age seek smart solutions to facilitate their traveling/ living. The increasing number of Air B&B customers who need structured information (in absence of a hotel reception) fosters wider use of digital tools i.e. tourist apps. Tourist apps with energy related functionalities can foster wide adoption rates towards energy sustainable behaviors. An innovative element of a tourist app dedicated to managing people flows in heritage places will contribute to decrease the overcrowd of these places. Thus, it will improve the quality of touristic visits and satisfaction of tourists, will promote visits to less visible places, will reduce energy consumption related to tourism flows resulting from a better distribution of people and, will improve local citizens quality of life which usually suffer several constraints related to a huge number of tourists.

How current and future market changes/challenges affect POCITYF's Objective:

Current and future market changes/challenges are unlikely, nevertheless the constraints, if exist, could be related to data protection and privacy. To avoid this, the data collected by the tourist app should not allow personal identification.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**4.1.4**	**Description/Title**	**Cultural experiences market (mobile app)**

Current market needs that the IE will address:

The energy sector is currently looking to capture the potential value from the integration of energy and non-energy related services (e.g. energy consumption monitoring with waste management, assisted living, tourist cultural experience marketplace) offering solutions for energy efficient behaviors. Combining non-energy services to energy related services enable widen participation, awareness and adoption rates.

Value proposition of the IE:

Cultural experiences app marketplace, for promoting touristic experiences and cultural activities in specific regions facilitating dissemination and publicity at a national/ international level

How the IE can bring a market change and how market changes may affect the IE:

Digital literacy advances in all age groups and tourists regardless of age seek smart solutions to facilitate their traveling/ living. The increasing number of Air B&B customers who need structured information (in absence of a hotel reception) may make wide use of digital tools i.e. through a cultural experience marketplace. A cultural experience marketplace with energy related information on the promoted activities and activity scheduling can foster wide adoption rates on energy sustainable behaviors.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#5 by increasing the number of citizens engaged in pilot services and solutions.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**4.1.5**	**Description/Title**	**Mobile apps on energy consumption**

Current market needs that the IE will address:

Reducing energy bills at a building, household or industry level is becoming a necessity towards reaching energy efficiency and reducing carbon emissions. Digital tools that monitor, control and automate energy consumption are of increased importance to enable the realization of this goal. This trend coincides with the utility and energy analytics market which was valued at USD 292.25 million in 2019 and is expected to reach USD 1088.38 million by 2025, at a CAGR of 25% over the forecast period 2020 - 2025. With the increase in the usage of the microgrids control system and other smart grid systems, which enables companies to monitor, control, and analyze grid functioning from a central control center, there is a vast

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untapped potential of advanced analytics tools and techniques, such as the big data platform and cloud computing. Favorable EU and government regulations promoting smart grid solutions and exponentially increasing adoption of smart meters are also expected to drive the demand for big data analytics among utility vendors where mobile apps measuring energy consumption are also part of the solutions to be developed.

The need of real time information in a single platform, where relevant data regarding generation, consumption (partial, global, at device, building or portfolio level) can be consulted and analyzed by consumers (citizens, companies) enables a faster and easier interaction between consumer and its device, building or portfolio.

Value proposition of the IE:

Mobile apps for energy consumption/generation monitoring and analytics

How the IE can bring a market change and how market changes may affect the IE:

Monitoring energy consumption, coupled with control and automation functionalities can reduce energy bills and alleviate energy poverty while it can render citizens with sustainable consumption behavior.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#5 by increasing the number of citizens engaged in pilot services and solutions and those with energy sustainable behaviors.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**4.1.6**	**Description/Title**	**Design based Value Mapping for Communities**

Current market needs that the IE will address:

Transition to a circular economy – reduce the negative impacts of the linear economy

Value proposition of the IE:

A decision support tool with design thinking methods for creating opportunities for new energy and circular product/services emerging during the execution of POCITYF

How the IE can bring a market change and how market changes may affect the IE:

- Decoupling economic activity from the consumption of finite resources, and designing waste out of the system
- Transition to renewable energy sources, the circular model builds economic, natural, and social capital
- Keep products and materials in use
- Regenerate natural systems.

How current and future market changes/challenges affect POCITYF's Objective:

Increased number of citizens engaged in pilot services and solutions // increased citizens with changed behavior.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**4.1.7**	**Description/Title**	**POCIFEST (formerly INNOFEST)**

Current market needs that the IE will address:

POCIFEST typically will develop new product-services combinations for energy self-sufficiency and smart energy services for households, small businesses, outlets, service buildings etc. as well as new circular economy -reuse and upcycle- business by startups and new ventures from the own POCITYF region. Particularly, the market for (re-)design based circular products and services is growing fast, to be aligned with the energy transition process where possible, keeping energy and product fluxes as local as possible.

Value proposition of the IE:

By incorporating the POCIFEST Method and thereby one or two design-oriented Festivals in the innovation eco-system the chances on the successful development of own, local new businesses are significantly increased. Thus, new value propositions by startups and new ventures are facilitated and accelerated, making use of as well as contributing of the POCITYF momentum.

How the IE can bring a market change and how market changes may affect the IE:

- Startups and new ventures will create new, attractive product-services-market combinations within the energy transition process, including circular economy options, using the POCITYF momentum.

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- A new subnetwork will be created within the local innovation-ecosystem, combining design creativity, entrepreneurship, sustainable energy and circularity within a local stakeholder group of festivals, incubators, SMEs, Higher Education Institutes, NGOs and -facilitating- government.

How current and future market changes/challenges affect POCITYF's Objective:

- POCIFEST will contribute via new businesses to Objective #1 ETT1 (local production and reuse) and Objective 5 of ETT4 (citizen's participation in joint business development, sharing concepts etc.).

Negatively		Neutral		**Positively**	**X**

Table 29 Business models and innovation for IS-4.1

Innovative Element (IE) #	**4.1.1**	**Description/Title**	**Digital transformation in Social Innovation**
Business Models – capturing value from the IE:			
• Platform as a Service (PaaS) – provide the environment to support the ability to build, test and deploy cloud P2P energy trading services based on distributed ledgers ('blockchain') • Product As A Service models (PRaaS) with P2P trading/donations of energy units or campaigning to attract private financing to fund green projects			
Innovative Element (IE) #	**4.1.2**	**Description/Title**	**Gamification platform**
Business Models – capturing value from the IE:			
• Product as a service – Create and offer gaming material adjusted for different energy transition related needs			
Innovative Element (IE) #	**4.1.3**	**Description/Title**	**Tourist apps**
Business Models – capturing value from the IE:			
UNINOVA as a research center does not envisage profit, however, has a close cooperation with Academia and Industry. A suitable business model could be based on the mass deployment of the tourist mobile app. UNINOVA can use their links to promote technology and knowledge transfer or support the creation of spin-offs associated to the exploitation of knowledge related with this app. Business models relevant to a spin off operation may include: • Enable marketing campaigns of third parties • Platform as a service – Provide a platform for service providers to obtain customer acquisition			
Innovative Element (IE) #	**4.1.4**	**Description/Title**	**Cultural experiences market (mobile app)**
Business Models – capturing value from the IE:			
• Platform as a service – Provide a platform for service providers to obtain customer acquisition			
Innovative Element (IE) #	**4.1.5**	**Description/Title**	**Mobile apps on energy consumption**
Business Models – capturing value from the IE:			
• Product as a service – Provide apps integrated with other energy and non-energy services to attract clients.			
Innovative Element (IE) #	**4.1.6**	**Description/Title**	**Design based Value Mapping for Communities**
Business Models – capturing value from the IE:			
• Product as a service – Consultancy services for city planning			
Innovative Element (IE) #	**4.1.7**	**Description/Title**	**POCIFEST (formerly INNOFEST)**
Business Models – capturing value from the IE:			
POCIFEST will contribute via new businesses to Objective #1 ETT1 (local production and reuse) and Objective 5 of ETT4 (citizen's participation in joint business development, sharing concepts etc.).			

4.5.2 Integrated Solution 4.2: Open Innovation for Policy Makers and Managers

Next to citizens and networks of citizens, communities involve various other types of stakeholders. Policy makers and local government managers fulfil a crucial role in the energy and circular transition of cities and their residential, commercial and industrial zones. They have the unique position, in the beginning of a change process like in the implementation of Sustainable Development Goals, to bring the transition actors

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together. Within the Quadruple Helix –the industry-government-knowledge institutes-public relations and actors interact- in a region or city and contribute to the required change process.

The innovative elements which for the IS-4.2 are listed below while the following tables contain the progress relative to the three main pillars as described in the introduction of Section 4.

IS-4.2: Open Innovation for Policy Makers and Managers (TIPPING approach // Eco-Acupuncture)

Table 30 Technical and Innovation Progress for IS-4.2

Innovative Element (IE) #	**4.2.1**	**Description/Title**	**TIPPING approach**
Innovative aspects of the IE:			
TIPPING Approach for Governance Innovation and Co-development. The TIPPING (The Innovation Perspective for New Governance on Islands) Approach is a methodology for sustainable transition trajectories, aimed at program and capacity building as well as learning by local governments involved in quadruple-helix based regional innovation. Its goal is to involve and train local government employees to become pro-active and co-responsible members of the transition teams and to formulate and to lead supportive projects and programs. TIPPING brings design -and islands' resilience- thinking into the field of socio-technical system change, thereby increasing the chances of unorthodox solutions. The central element of the approach, the TIPPING Wheel, includes eight governance strategies, mainly build on best practices from different transition fields, like from Samsoe (DK) on energy, Madeira (PT) on seafood, Vlieland (NL) on innovation via festivals etc. Applying the TIPPING Approach leads to transition supportive projects and extra, trained staff capacity for local governments, and thereby to a higher success rate of energy transition projects. The Eco-Acupuncture based Vision Development is part of the TIPPING Tool. Check IE #4.2.2.			
Advancement of TRL levels (TRL6→7):			
The TRL level of TIPPING is TRL6, since its working has been demonstrated in the fairly isolated environment of seven islands belonging to the EU Islands-of-Innovation program. By testing the approach in a more complicated medium sized city environment the TRL will be advanced to TRL7 level. The challenge is to adapt the TIPPING Approach and Strategy Wheel in such a way that on the one hand the strengths of the island culture (self-sufficiency, community spirit, resilience, bricolage, entrepreneurship) are kept, while new elements and resources (educational institutes, large companies, a strong local government in the urban area) are channeled in, all contributing to energy transition success. However, some elements of the approach such as the Eco Acupuncture Vision Development for advancement of a sustainable future have already been tested in urban areas in various parts of the world and are already at TRL7 level.			
Innovative Element (IE) #	**4.2.2**	**Description/Title**	**Eco-Acupuncture**
Innovative aspects of the IE:			
The Eco-Acupuncture tool is a holistic decision-making approach that can help communities, towns and cities as they prepare their energy transition. It helps visualize future possibilities and design a series of interventions towards a resilient urban environment, putting extra emphasis on mobilizing stakeholders for co-developing solutions. The Eco-Acupuncture based Vision Development is part of the TIPPING Tool. Check IE #4.2.1.			
Advancement of TRL levels (TRL7→8):			
The Eco-Acupuncture back casting tool has been tested and validated in an operational environment **(TRL 7)** and has successfully developed a future vision on the development of deprived areas of Rotterdam (2016) and Leeuwarden (2017-2019). In POCITYF the Eco – Acupuncture tool will be demonstrated combined with the TIPPING approach together **(TRL8)** to foster novel ideas in the energy sector and to maximize results for the case of the city of Alkmaar. The Eco-Acupuncture tool will be applied per demo area, per replication area and per sector, in order to formulate challenging long-term visions and trajectories already from the early stages of POCITYF.			

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

Table 31 Market needs, changes and challenges for IS-4.2

Innovative Element (IE) #	4.2.1	Description/Title	TIPPING approach
Current market needs that the IE will address:			
Within energy transition projects often a lack exists with respect to a pro-active and leading contribution of employees from local governments. The hiring of external consultants can deliver the necessary temporary manpower and expertise but has the disadvantage of the local loss of expertise once the project is over and the consultants gone. In this respect, TIPPING helps to build own expertise and manpower within local governments by co-creating energy transition supportive projects, in cooperation with local stakeholders all over the quadruple helix. Municipalities and other types of local and regional governments become active partners, co-leaders and facilitators in the energy transition, upskill their staff and accumulate their transition process knowhow and experience in this way. Check also IE #4.2.2			
Value proposition of the IE:			
By creating a more active and experienced local government, facilitating the energy transition process, TIPPING facilitates and increases the opportunities for own, local innovations and new business development. TIPPING Wheel Strategies, such as the involvement of start-ups from local applied science institutes, the stimulation of out-of-the-box solutions generated by the design & art sector, the co-development of projects with the population and involvement of crowd-funding as well as aiming at 'next practices' together lead to a region or urban area where the eco-innovation system will flourish better. So the Value to be gained is not only expressed in terms of a more successful and efficient energy transition process, but also in terms of: more own, local and long-term expertise building, more sustainable energy products and services innovation creation and business development, more engagement from higher education institutes staff and students, in short a quadruple helix overall value increase in the selected urban area			
How the IE can bring a market change and how market changes may affect the IE:			
• By a -through TIPPING- facilitating government, leading to a stronger energy transition relevant local eco-innovation system; • Via a -TIPPING facilitated- jointly formulated regional innovation strategy, as well as program and projects, who increase the potential for the testing of local start-ups, green services and new business development by SMEs within the framework of energy transitions; • By inviting local knowledge institutes, their staff and students from all disciplines and departments, to engage themselves in multidisciplinary teams and project groups in the energy transition program, take co-responsibility, and roll out applied research and education for longer term engagement (5-10 years). This is one of the TIPPING Strategies.			
How current and future market changes/challenges affect POCITYF's Objective:			
TIPPING increases the opportunities for own, local innovations and new business development. TIPPING Strategies, such as the involvement of start-ups from local applied science institutes, the stimulation of out-of-the-box solutions generated by the design & art sector, the co-development of projects with the population and involvement of crowd-funding as well as aiming at 'next practices' together lead to a region or urban area where the eco-innovation system will flourish better. So the Value to be gained is not only expressed in terms of a more successful and efficient energy transition process, but also in terms of: more own, local and long-term expertise building, more sustainable energy products and services innovation creation and business development, more engagement from higher education institutes staff and students, more citizen participation, in short a quadruple helix overall value increase in the urban area. In this way, TIPPING contributes to Objective #1 of ETT1 (increasing sustainable energy services, also via student start-ups and new business development) and Objective 5 of ETT4 (citizens co-creation).			

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	4.2.2	Description/Title	Eco-Acupuncture
Current market needs that the IE will address:			
Citizen adoption along with citizen participation and co-creation practices offer an excellent opportunity to speed up the metabolism of city governments and cities Governance structures, giving agencies the			

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ability to watch events as they unfold, understand how demand patterns are changing, and respond with faster and often lower-cost solutions. The Eco-Acupuncture approach offers the opportunity for more innovative solutions to be generated collectively and adopted towards more energy consumption cautious behaviors. Check also IE #4.2.1

Value proposition of the IE:

A framework developed to deliver new locally specific starting points for urban transformation including a process to involve academic researchers and professional designers, students, representatives of local government, business and the wider community.

How the IE can bring a market change and how market changes may affect the IE:

The Eco-Acupuncture approach can help realize potential outcomes from exploiting collective intelligence and provide methods / tools to harvest them.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#5, through increasing mobilization and participation of stakeholders and citizens.

Negatively		Neutral		**Positively**	**X**

Table 32 Business models and innovation for IS-4.2

Innovative Element (IE) #	**4.2.1**	**Description/Title**	**TIPPING approach**

Business Models – capturing value from the IE:

- A joint regional innovation process, aligned with the planned energy transition measures, to create extra value via innovations and new business development that give extra support for and impact on the energy transition process;
- By building own expertise at the local government level, by engaging higher education staff and students in a systematic way in the process, a more attractive urban area for young talent and for reskill and upskill potential emerges for medium-sized cities;
- By new ways of engaging citizens, the potential of energy transition 'prosumerism' is increased

Innovative Element (IE) #	**4.2.2**	**Description/Title**	**Eco-Acupuncture**

Business Models – capturing value from the IE:

- Offering consultancy services for mobilizing local ecosystem players and harvesting collective intelligence for city level solutions in the energy sector

4.5.3 Integrated Solution 4.3: Interoperable, Modular and Interconnected City Ecosystem

This IS and all its related elements cover not only the monitoring needs of the demonstration areas at building and district-level, but also pave the way for the transition to an interconnected ecosystem that will underpin the effectiveness of the three previous transition tracks, while enabling the conception of new solutions on top of the data that will be retrieved and centralized at a city-level platform. From this vibrant smart city environment, a set of new tools emerging from local technological hubs and academia will arise, laying the ground for the attainment of an economically viable green economy and more efficient citizen engagement. Since LHs' CIPs are not the specific focus of this call, any activities related to their development and maintenance will be own-funded. The development of necessary interfaces for their link and integration with the innovative ones is co-funded by POCITYF.

The innovative elements which for the IS-4.3 are listed below while the following tables contain the progress relative to the three main pillars as described in the introduction of Section 4.

IS-4.3: Interoperable, Modular and Interconnected City Ecosystem (City Urban Platform // Wi-fi data acquisition systems // Data lake intelligence for positive communities // Smart-cloud for innovative Startups // Citizen Information Platform // Data acquisition systems // City Data Hub)

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Table 33 Technical and Innovation Progress for IS-4.3

Innovative Element (IE) #	4.3.1	Description/Title	City Urban Platform (CIP extension)
Innovative aspects of the IE:			
Traditionally, smart cities platform tends to be siloed according to the operating verticals (i.e., parking management, traffic monitoring, etc.). The Urban Platform takes an innovative approach by centralizing city information in a single management platform, letting cities take more value out of their data by correlating it between different verticals. Furthermore, the standards-based approach for communication protocols and data models (e.g. NGSI, Fiware Data models) ensures that data can be easily obtained from existing data sources and is not locked inside the platform.			
Advancement of TRL levels (TRL7→8):			
The City Information Platform (CIP) has already been tested in operational environment i.e. in the city of Guimarães **(TRL7).** POCITYF will offer municipalities a holistic view of their cities, combining more holistically insights based on the cross-domain data from different fields (traffic, air quality, waste collection, among others) processed in a unified way and combined into a single and customizable dashboard that is complete and qualified for operation **(TRL8).** Consequently, all the three PEBs (and the enclosed participants) will largely benefit from the CIP solutions, allowing not only the holistic monitoring of Evora demonstration areas, but also the conceival of innovation boosted by the project, for this ecosystem, that will happen during POCITYF on top of its advanced infrastructures with which the three demonstration areas will be endowed. The data acquisition systems will be installed both in PEB1 and PEB2 (more specifically, in University of Evora college campus), allowing the measurement of environmental indicators such as noise, temperature and air quality. An **Interconnected City Ecosystem** will be demonstrated in the three Positive Energy Blocks, in order to enable all demonstration areas to be linked to the holistic city urban platform and connect commercial and industrial clients with the life of the citizens, providing them with the capacity to increase their social responsibility. The CIP, the data lake intelligence for positive communities and the smart-cloud for innovative Startups, given its inherent nature, will be for residential, commercial, industrial, cultural use, and even for the PV park owners, as a way to monitor their social responsibility commitment impacts in the area where they are investing on.			
Innovative Element (IE) #	**4.3.2**	**Description/Title**	**Wi-fi data acquisition systems**
Innovative aspects of the IE:			
The autonomous Wi-Fi Data Acquisition Systems for real-time measurement of multiple environmental variables is based on a low-cost autonomous sensor network that measures multiple environmental variables, provides real-time information on temperature, humidity, atmospheric pressure, UV radiation, harmful gases, luminosity and noise, and also correlates its historical data in order to establish a map of the organic behavior of a specific area (street, square, city).			
Advancement of TRL levels (TRL6→7):			
The Wi-fi data acquisition system is currently being tested and validated **(TRL 6)** in the city of Lisbon, where several plug-and-play units are deployed in order to help city decision makers to make well-supported decisions regarding the planning of new infrastructures and traffic control (where not only atmospheric but also noise pollution is crucial). The wi-fi data acquisition systems will be integrated and interconnected to the City Information Platform to provide data, that will attract the interest of commercial and industrial clients providing access to city data in order to improve services and products During POCITYF, 10 additional units will be installed in Evora and TRL 7 will be achieved by consolidating the system demonstration in operational environment **(TRL7).**			
Innovative Element (IE) #	**4.3.3**	**Description/Title**	**Data lake intelligence for positive communities**
Innovative aspects of the IE:			
The ICT architecture behind the data lake intelligence is defined in terms of semantic models and ontologies and that will provide the city of Evora open data sharing tools and information to better manage energy blocks and stakeholders.			
Advancement of TRL levels (TRL6→7):			

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Data lake intelligence for positive communities, has been tested in cases such as DBPedia, YAGO, ConceptNet, Linguistic Linked Open Data, BabelNet, and NASARI, in order to further enrich the metadata-related processes **(TRL6).** Advanced cognitive and semantic analysis will be deployed in order to produce contextualized and focused knowledge. Automatic collection of unstructured, external (online) content from several sources (media, social networks), clustering and topic classification will be used and demonstrated in an operational environment at the city Evora **(TRL7).**

Innovative Element (IE) #	**4.3.4**	**Description/Title**	**Smart cloud for innovative startups**

Innovative aspects of the IE:

Increase local entrepreneurial ecosystem participation in City innovation using a common smart cloud framework. Smart cloud for innovative Startups developments will be based in FIWARE, which is a mature non-commercial sandbox environment where innovation and experimentation takes place. AGILE coding frameworks (Devops like Outsystems) and established Big Data analytics frameworks will be available for innovative Startups in order to enable the design and implementation of computing, storage and application framework for local SMEs and promote intelligent solutions to the PEBs. DECSIS will make available a datacenter local cloud resources framework and a deployment framework for projecting stakeholder's spin-off initiatives and the local Startup ecosystem. This will allow the participation of local SMEs and entrepreneurs to provide new solutions, during and after the project development. The innovative and participatory model is focused on collaboration between City decision makers, project partners but specially with entrepreneurial ecosystem, incubation centers and tech-providers, mentors and regional funding program.

Advancement of TRL levels (TRL7→8):

The DECSIS data center (**TRL7**), will enable startups to develop and test solutions in a real-world context (living lab) - solutions in TRL-7 are expected to be showcased. Startups with lab solutions or prototypes of future applications can test them in an applied and living lab environment to upgrade them to TRL-8. Further discussion and details after framework development. The DECSIS solution will set-up cloud resources for project stakeholders' innovation, and mobilize the local Startup Ecosystem. This will allow the participation of local SMEs and entrepreneurs to provide new solutions, during and after the project development. The big data analytics framework will be tested for innovative solution that are energy related and focused on POCITYF main topics **(TRL8).**

Innovative Element (IE) #	**4.3.5**	**Description/Title**	**Citizen Information Platform**

Innovative aspects of the IE:

The Smart City Platform will provide information for citizens and policy makers to ensure a futureproof and livable city. It refers to the automated data collection and exchange, which will serve as enabler of smart solutions. Due to the Smart City Platform it will be possible to combine and manage multiple data sources, for example open source data, data provided by the H2020 partners and data provided by Alkmaar based companies. In this way the platform facilitates: a) the exploitation of city data; b) intelligent monitoring and control of infrastructure and assets in the cities and, c) new and improved services, adopting an open approach and the design principle of a "System of Systems". The Citizen Information Platform will a) provide insight to inhabitants of Alkmaar to *collect*/view energy related data in their neighborhood; b) offer insights for companies that want to utilize data to develop smart propositions for new products/services; c) form the basis for ample operational and decision-making improvements. Yearly IoT challenges for schools, universities and/or companies will be organized to encourage citizens co-creation and participation. IE #4.3.5 along with IE #4.3.6 and IE #4.3.7 form the Smart City Platform

Advancement of TRL levels from level 7 to level 8 (TRL7→8):

The new Smart City Platform builds upon the existing Platform that is already online, by extending the services that are already available. In the current state open data and GA 'data is collected and managed. For citizens it is possible to extract pieces of information from a public website, for example information about the location of sport facilities, parking areas and the location of charging stations for electric vehicles (TLR7).

In collaboration with a tech partner the platform will be further developed to make it possible for citizens, local companies and the partners of the POCITYF project to deliver data through open and standard–based

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IT platform architecture rules and programing interfaces (APIs) to the platform. Moreover, to ensure citizens, business and communities are more likely to be engaged with POCITYF solutions, the services provided to them are extended in the Smart City Platform, as they are able to assess in detail the technical advancements achieved The Citizen Information platform will be advanced to integrate the City Data Hub and the Data acquisition system (TLR 8).

The existing Citizen Information Platform will integrate data from the City Data Hub, which stores data from the Data Acquisition System, and provide insight to a) inhabitants of Alkmaar i.e. view data related to their neighborhood, and also b) companies that may use this data for developing novel products.

Innovative Element (IE) #	**4.3.6**	**Description/Title**	**Data acquisition system**
Innovative aspects of the IE:			
Sensors will be deployed for the city of Alkmaar to collect and monitor environmental, traffic and waste collection data. This data acquisition system will feed the Energy Data Hub where the data will be stored and analyzed to provide visualizations. The Energy Data Hub will then feed the Citizen Information Platform. IE #4.3.6 along with IE #4.3.5 and IE #4.3.7 form the Smart City Platform The latest version of underground waste containers is equipped with sensors to analyze the amount of waste and this way the waste collection department can react more precisely when to empty these containers. This trail will start in 2020. Also, several city sweepers have sensors which can be monitored.			
Advancement of TRL levels (TRL6→7):			
Environmental, traffic and waste collection data from the sensor network together with the energy data collected from the PEBs will feed the City Data Hub (TRL7). Data will be harmonized to ensure that it can be used for cross functional purposes.			
Innovative Element (IE) #	**4.3.7**	**Description/Title**	**City Data Hub**
Innovative aspects of the IE:			
The **energy data hub** collects and stores data from the data acquisition system in a secure and open way, and in line with GDPR and with the data ownership belonging to the energy prosumer. The City Data Hub will serve as a source for the CIP. IE #4.3.7 along with IE #4.3.6 and IE #4.3.5 form the Smart City Platform			
Advancement of TRL levels (TRL7→8):			
Alkmaar has demonstrated an **energy data hub** and also a Data lab, another initiative of the Municipality. Both collect data and provides visualizations to citizens. In POCITYF, environmental, traffic and waste collection data from the sensor network together with the energy data collected from the PEBs, will be integrated to feed the **City Data Hub**. The information in the Hub will be used for monitoring, and optimizing business models. It will also be used as a source for the CIP and the Citizen Information Platform. The integration process of the data from the data acquisition system will be performed in order to ensure harmonization of data typology and allow for cross utilization. The whole system will be tested in operational environment in Evora **(TRL8).**			

Table 34 Market needs, changes and challenges for IS-4.3

Innovative Element (IE) #	**4.3.1**	**Description/Title**	**City Urban Platform (CIP extension)**
Current market needs that the IE will address:			
Cities are beginning to go digital both for internal workflow processes and for new ways to engage with citizens. There is also an increasing need for regional and local authorities to make informed decisions regarding the planning and investments at the city level. At the same time citizens are increasingly interested in being informed about various issues among others, traffic, air quality, waste collection, energy and environmental aspects City information platforms that are integrated with sensor networks, data lakes and designed with functionalities that allow for cross functional operation can enable an advance information and interaction framework that help cities perform more efficiently and engage citizens. This IE aims to meet the needs of management and operationalization of smart cities, integrating multiple verticals and increasingly oriented towards the sustainable management of cities.			
Value proposition of the IE:			
An integrated and standards-based management platform for interoperable smart cities. The unifying platform for all information / verticals in cities, facilitates quick analysis and decision support.			

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How the IE can bring a market change and how market changes may affect the IE:

City platforms will support and interconnect all the digital functionality the city needs to serve internal operating requirements and to engage with citizens. The advanced CIP can change the way citizens and business are informed about what is happening in their cities providing useful insights to various areas of interest in Evora. Through CIP citizens will be able to collect/view data in their neighborhood, and business may use the data to develop smart products/services. The CIP may unfold opportunities for developing services in other energy and non-energy services for citizens. The market and cities already have platforms for one or more verticals that can compete directly with this IE. In this sense, the market itself can affect the dissemination of this IE.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#5, since CIPs support the introduction of innovative technologies and products that enable the increase in efficiency and effectiveness of the cities and the engagement with the citizens. The growing concern for the sustainability of cities and the alignment with ISO 37120 and ISO 37122 may positively affect the challenges of Project Objective #5

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**4.3.2**	**Description/Title**	**Wi-fi data acquisition systems**

Current market needs that the IE will address:

There is a need to gather real-time information about different environmental variables in order to e.g. help city decision makers to make well-supported decisions regarding the planning of new infrastructures and traffic control (where not only atmospheric but also noise pollution is crucial). Additionally, systems responsible for this data acquisition must not increase burden over existing power distribution grids and should be easy to install by local not specialized workers. In practice, there must be numbers of acquisition spots scattered throughout large areas that are mostly enduring harsh environment. The use of phone lines or cables in these areas for data transfer would get half the result with twice the effort. While wireless networks could cover all the data acquisition points with much lower cost and less effort for installation and maintenance than wired networks.

Value proposition of the IE:

While ensuring the measurement of environmental variables, providing real-time information on temperature, humidity, atmospheric pressure, UV radiation, harmful gases, luminosity and noise, and also correlates its historical data in order to establish a map of the organic behavior of a specific area (street, square, city). The Wi-Fi Data Acquisition Systems are completely independent from local power distribution grids, being their power supply guaranteed by the integrated PV module and battery. These autonomous systems follow a modular approach and can be installed by non-specialized workers according to the data measurement needs of the respective areas

How the IE can bring a market change and how market changes may affect the IE:

The wi-fi data acquisition systems modernize data acquisition so that users can focus more on the data itself rather than the data collection process. When compared to other solutions, the Wi-Fi Data Acquisition Systems have lower cost and benefit from easier installation, which can be ensured by local not specialized workers. Despite the relatively small size of the involved hardware, the deployment of the Wi-Fi Data Acquisition Systems can be impacted by existing (and future) space use restrictions associated to e.g. historical protected areas. Current DAQs on the market are clunky, hard to configure, and have not user-friendly interfaces. During POCITYF powerful yet user friendly and intuitive DAQ will be created to facilitate data collection.

How current and future market changes/challenges affect POCITYF's Objective:

Constrains related with the deployment of the Wi-Fi Data Acquisition Systems may reduce the amount of environmental data for specific areas, which may negatively impact citizen engagement. If possible, in this scenario the Wi-Fi Data Acquisition Systems would be adapted to comply with existing (and future) restrictions.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**4.3.3**	**Description/Title**	**Data lake intelligence for positive communities**

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

Current market needs that the IE will address:

Data is poised to grow fast the coming years. And with that growth indeed comes more data or better: data is what we are after with the Internet of Things, in order to gain big insights and drive relevant actions and operations to achieve whatever outcome: big data analytics with a purpose; smart data for smart applications – and inevitably artificial intelligence to make sense of all that data. All these sectors are growing exponentially having data and data intelligence at the core.

Value proposition of the IE:

Data lake intelligence with advanced cognitive and semantic analysis for positive communities, providing open data and information to better manage energy blocks and players.

How the IE can bring a market change and how market changes may affect the IE:

Data lakes are seen as a way to end data silos in a fast growing and increasingly unstructured big data universe. In POCITYF data lake advancements will include intelligence integration into the data lakes and visualization which may lead to informed decision making and action and machine learning.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#5 since data lakes support the CIP and provide data analytics and visualizations for both local and regional authorities but also for citizens

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**4.3.4**	**Description/Title**	**Smart cloud for innovative startups**

Current market needs that the IE will address:

A vibrant start up ecosystem needs structured approaches in order to be supported effectively. Cloud services that enables the experimentation, design and implementation of new products especially in today's digital era is becoming a necessity. Especially local markets need to increase technology solutions integrated with city management in order to build a holistic vision over city operations. Innovative solutions requirements and specification should be developed together between city partners and involved Startups. Experimental solutions deployed in this integrated living lab can be scaled-up to other cities. This will boost local innovation to deploy new solutions to the market making Évora a more competitive ecosystem. Taking in consideration many solutions available the main progress will be the availability of a local framework for application development.

Value proposition of the IE:

Cloud resources for mobilizing the local Startup Ecosystem providing big data analytics frameworks and agile coding frameworks for startups.

The IE will select, develop and deploy a framework supported on agile solutions in order to deploy new solutions to the Évora ecosystem, integrated with municipal operations. Building a bottom-up entrepreneurial ecosystem with local developed solutions at city level, benefits from the innovation introduced by the technology and the collaborative model of solutions development based on open data and open innovation framework. Follower cities can then deploy similar programs. Using open source technologies but also using partnerships with software vendors for agile development platforms smart cloud

How the IE can bring a market change and how market changes may affect the IE:

The smart cloud for innovative startups will extend the capabilities of the cloud to serve new market opportunities and new business ideas. Cloud services will enable and accelerate the creation and development of new products and services. The IE can make a change in local tech to improve participation and development model, integrating political decision makers and solution providers. The impact is in mostly in the local ecosystem, but the example and good practices can be scaled-up and transferred to other cities. The goal is to facilitate connection and collaboration between city needs and Startups or students or SME that can take the challenge.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#5 as the Smart Cloud will enable participatory citizen/business engagement and co-creation practices for developing new

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products/services. Market is evolving very rapidly and not always in the same direction. Big tech companies that set the pace often change their roadmap and the paradigm of development. Still under some discussion what can be the right frameworks to support the CityOS. The IE will create open innovation between city gov and citizens/entrepreneurs, allowing collaborative co-creation of solutions to solve city problems.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**4.3.5**	**Description/Title**	**Citizen Information Platform**

Current market needs that the IE will address:

The expansion of cities and increasing urbanization are the biggest drivers for implementing intelligent and smart solutions. This leads to an increasing demand for technologies that make it possible to manage expanding cities. Cities are beginning to go digital both for internal workflow processes and for new ways to engage with citizens as a means to manage expanding cities. There is also an increasing need for regional and local authorities to make informed decisions regarding the planning and investments at the city level. With a Smart City Platform, it is possible to monitor city infrastructures, and manage everything from parking, traffic flows to air and water quality using generated data and in this way tackle decision-making issues. At the same time citizens are increasingly interested in being informed about various issues among others, traffic, air quality, waste collection, energy and environmental aspects. City information platforms that are integrated with sensor networks, data lakes and designed with functionalities that allow for cross functional operation can enable an advanced information and interaction framework that help cities perform more efficiently and engage with citizens.

Value proposition of the IE:

This IE offers multiple functionalities under one product, since it provides a data acquisition hub, and information for policy makers as well as general information for citizens. Moreover, it creates engagement for the POCITYF projects among citizens, business and communities as they are involved in value co-creation and have a feeling of co-ownership.

How the IE can bring a market change and how market changes may affect the IE:

The advanced Citizen Information Platform can change the way citizens are informed about what is happening in their cities providing useful insights to various areas of interest in Alkmaar. Through CIP citizens will be able to collect/view data in their neighborhood, and business may use the data to develop smart products/services. The CIP may unfold opportunities for developing services in other energy and non-energy services for citizens. Furthermore, the Smart City Platform can change the way of strategic planning for companies and governments, as the platform makes data-driven decision-making possible. It makes it possible to make decision based on facts instead of a gut feeling or trial and error.

How current and future market changes/challenges affect POCITYF's Objective:

Foreseen market changes are expected to positively affect POCITYF Objective#5, since CIPs support the introduction of innovative technologies and products that enable the increase in efficiency and effectiveness of the cities and the engagement with the citizens. The Smart City Market has already witnessed substantial growth in the past few years. The foreseen market changes are expected to positively affect Objective #4 because the demand for these smart city solutions is expected to rise due to a number of factors: the increasing urban population, the need for better management of scarce natural resources, the demand for a clean and safe environment, and the growing adaptation rate of cloud and IoT. This will most likely lead to a growing adaptation of new technologies that complement future cities.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**4.3.6**	**Description/Title**	**Data acquisition system**

Current market needs that the IE will address:

Real-time data acquisition is commonly required in a diversity of areas such as power grid, healthcare, industrial production, water conservancy, meteorology and agriculture. In practice, there must be numbers of acquisition spots scattered throughout large areas that are mostly enduring harsh environment. The use of phone lines or cables in these areas for data transfer would get half the result with twice the effort. Wireless networks can nowadays cover all the data acquisition points with much lower cost and less effort for installation and maintenance than wired networks.

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Value proposition of the IE:

Wi-fi data acquisition systems based on a low-cost autonomous sensor network that measures multiple environmental variables, providing real-time information on temperature, humidity, atmospheric pressure, UV radiation, harmful gases, luminosity and noise, and also correlates its historical data in order to establish a map of the organic behavior of a specific area (street, square, city). The city sweepers will have some sensors on board. As they are travelling all over Alkmaar, data can be obtained this way.

How the IE can bring a market change and how market changes may affect the IE:

Sensors will provide real-time information on city characteristics and will be integrated with the city information platform. Governments and citizens will be able to **speed up the metabolism of city governments and cities Governance structures**, giving agencies the ability to watch events as they unfold, understand how demand patterns are changing, and respond with faster and often lower-cost solutions.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#5, since they support the introduction of innovative technologies and products combined with CIPs that enable the increase in efficiency and effectiveness of the city's governance and the engagement with the citizens.

Negatively		Neutral		**Positively**	**X**

Innovative Element (IE) #	**4.3.7**	**Description/Title**	**City Data Hub**

Current market needs that the IE will address:

The is poised to grow fast the coming years. And with that growth indeed comes more data or better: data is what we are after with the Internet of Things, in order to gain big insights and drive relevant actions and operations to achieve whatever outcome: big data analytics with a purpose; smart data for smart applications – and inevitably artificial intelligence to make sense of all that data. All these sectors are growing exponentially.

Value proposition of the IE:

A City Data Hub stores all city data into one centralized location and act as a source for both the CIP and the Citizen Information Platform.

How the IE can bring a market change and how market changes may affect the IE:

City Data Hubs are seen as a way to end data silos in a fast growing and increasingly unstructured big data universe. In POCITYF data lake advancements will include intelligence integration into the data lakes and visualization which may lead to informed action and machine learning.

How current and future market changes/challenges affect POCITYF's Objective:

The foreseen market changes are expected to positively affect POCITYF Objective#5, since data hubs can support the collection, storage and analysis of data in CIPs and support the introduction of innovative technologies and products that enable the increase in efficiency and effectiveness of the cities and the engagement of `citizens.

Negatively		Neutral		**Positively**	**X**

Table 35 Business models and innovation for IS-4.3

Innovative Element (IE) #	**4.3.1**	**Description/Title**	**City Urban Platform (CIP extension)**

Business Models – capturing value from the IE:

- Design Services and implementation of data integration and cross platform collaboration of city relevant digital platforms - Direct sales to the municipalities. The IE indirectly allows the cost reduction and improvement of the citizens' quality of life
- Platform as a Service (PaaS) – provide the environment to support the ability to build, test and deploy cloud services.

Innovative Element (IE) #	**4.3.2**	**Description/Title**	**Wi-fi data acquisition systems**

Business Models – capturing value from the IE:

UNINOVA as a research center does not envisage profit, however, has a close cooperation with Academia and Industry. A suitable business model could be based on the mass deployment of Wi-Fi Data Acquisition Systems. UNINOVA can use their links to industrial tissue to promote technology and knowledge transfer

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or support the creation of spin-offs associated to the exploitation of knowledge related with the Wi-Fi Data Acquisition Systems. Business Models for a spin off might include:

- Direct installation of a sensor network;
- Services for installation, maintenance and monitoring of sensor network
- Infrastructure as a Service (IaaS). Integration of data collection with platforms or engines that perform data analytics and provide visualizations.

Innovative Element (IE) #	**4.3.3**	**Description/Title**	**Data lake intelligence for positive communities**

Business Models – capturing value from the IE:

- Data As A Service (DaaS). Data management that uses the cloud to deliver data storage, integration, processing, and/or analytics services via a network connection to end users or companies that may use the data for the development of new products/ services

Innovative Element (IE) #	**4.3.4**	**Description/Title**	**Smart cloud for innovative startups**

Business Models – capturing value from the IE:

Still under discussion, but the business model can be based on knowledge services to cities and Startups. Potential Business Models include:

- Infrastructure as a Service (IaaS). Core infrastructure for cloud resource management- architecture and essential service provider capabilities.
- Software as a Service (SaaS) – exploit the architecture for the operations of software applications.
- Platform as a Service (PaaS) – provide the environment to support the ability to build, test and deploy cloud services.
- Business Process as a Service (BPaaS)- Provide the means to implement business processes as services. The cloud service provider adoption pattern manages BPaaS in a same manner as SaaS.

Innovative Element (IE) #	**4.3.5**	**Description/Title**	**Citizen Information Platform**

Business Models – capturing value from the IE:

- Design Services and implementation of data integration and cross platform collaboration of city relevant digital platforms
- Platform as a Service (PaaS) – provide the environment to support the ability to build, test and deploy cloud services.
- Social engagement (in for example the POCITYF projects) is a non-monetary added value that will be achieved as the Smart City Platform provides for citizens, business and communities to be involved in value co-creation and create a feeling of co-ownership.
- Smart City Innovation will cut city's costs in many areas. For example, in the transport sector: 1) parking areas could be better monitored and managed and therefore parking lots will be more efficiently used. Therefore, no additional parking lots have to be constructed 2) smart traffic lights can help optimize road usage and minimize traffic jams.
- The quality of life of citizens will be improved. For example, IoT sensors in garbage bins will deliver a signal when they are almost full. This will minimize citizens 'exposure to full garbage bins. And besides, it will cut cost for the waste management teams as they are able to optimize their routes.

Innovative Element (IE) #	**4.3.6**	**Description/Title**	**Data acquisition system**

Business Models – capturing value from the IE:

- Direct installation of a sensor network;
- Services for installation, maintenance and monitoring of sensor network
- Infrastructure as a Service (IaaS). Integration of data collection with platforms or engines that perform data analytics and provide visualizations.

Innovative Element (IE) #	**4.3.7**	**Description/Title**	**City Data Hub**

Business Models – capturing value from the IE:

- Data As A Service (DaaS). Data management that uses the cloud to deliver data storage, integration, processing, and/or analytics services via a network connection to end users or companies that may use the data for the development of new products/ services

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4.6 Progress related to Project Objective #10

Objective 10: Identify related regulatory barriers, legal aspects and data security/protection and propose practical recommendations on how to overcome them

To increase the POCITYF impact, the developed solutions will be replicated in various EU cities. However, due to the currently fragmented EU regulation, underpinning the various interventions at an EU level and also due to the consideration of special legislative conditions in relation to cultural heritage sites, suggestions for developing a legal framework at an EU level for furthering Smart Cities and communities will be developed. The increased use of smart grids and appliances entails the need to focus on issues involving data security and protection. Recommendations by the Smart Grid Task Force will be taken into account in the practical implementation of all demonstrations within **WP6** & **WP7** for the two LHs and replications within **WP8** for the six (6) FCs. RUG which acts as a horizontal partner regarding regulation, will be linked with legislators/regulatory bodies at national level for each of the LHs and FCs (WP1, WP8). Data security/protection issues in relation to the framework for data exchange and related roles and responsibilities, together with the technical issues supporting the exchange of data in a secure and interoperable manner, and the data analytics techniques for data processing are addressed in WP2 and WP10, capitalizing on POCITYF partners expertise in that field (e.g. VTT, AIT, CERTH).

Data security management and data protection frameworks (including privacy and security of sensitive information) are reported in Deliverable D11.6 under the dedicated Task 11.6 – Cyber security Management.

The identification of regulatory barriers and legal aspects imposed by the regulatory framework on building/districts and microgrids is assessed in D1.2 under Task 1.2 – Assessment of the regulation framework for PE (Cultural Heritage) buildings/districts and micro-grids. Even though not a strictly technical matter, innovation can be achieved under Objective 10 and concerning regulatory frameworks. Such innovation includes for example novel regulatory and legal frameworks, created especially for historic sites, that can be also applied to residential districts. In this first semester report, a first attempt to identify such innovation is performed and the results are summarized in Table 35. The information is quite preliminary at this stage and it will be updated accordingly during the project in collaboration with relevant WPs.

Table 36 Innovation resulting from regulatory aspects

Related ETT #	**1**	**Solution/aspect affected by the regulatory framework**	**Energy transition of cultural heritage / historical buildings**
Current regulatory framework and barriers imposed:			
Currently, the regulatory framework poses significant barriers for the energy transition of cultural heritage/historical buildings. Laws relevant to visual impact and cultural protection can be found in most countries within EU and are setting severe restrictions regarding the retrofitting of cultural heritage buildings; particularly the appearance of front (street) facades, windows, etc. Indicatively, for the case of Ioannina (Greece) there is a national law for the cultural heritage (N3028/2002), article 10, that prohibits changes of the protected buildings, such as façade changes, or even certain uses of the building, or sometimes enforces the use of certain materials. The law also enforces to get approval for every technical work of change of use to a protected building, from the Ministry of Culture and Sports. The Minister approves any work after the opinion of the Central Archeological Council. For the case of Hvidovre and Denmark, cultural heritage buildings are covered by a conservation urban plan statute, a conservation local plan or designated in accordance with Section 19 (appointed by the minister) of the Danish Building Protection Act. In these cases, the planning has sought to preserve the external appearance of the buildings in question as part of the building whole. It is the state that administers the protected buildings, while the municipalities are responsible for the cultural heritage. The buildings worth preserving are covered by the Building Regulations 2018 including energy efficiency and any exempt from the provisions of the BR is made only under special circumstances.			

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Besides the challenges arising from the regulation relevant to cultural heritage, barriers are also imposed due to the financial attractiveness of relevant solutions. Several investments will not be financially interesting on the short term. Especially for monuments-very old buildings it will be interesting to develop an object (and not subject/owner) based way to finance these measures. This will give homeowners a longer horizon (payback time) and will encourage to make long term investments.

POCITYF's response:

It is of high significance that the regulatory framework in each country supports the installation of novel technologies that do not disturb visually and on specific micro-locations (e.g. backyard – not visually exposed). POCITYF brings on board and will demonstrate innovative technologies with low visual impact and low construction impact supporting this goal. Lessons learned and outcomes if this process can act as a starting point for further discussing alterations of the regulatory framework to support energy transition of cultural heritage buildings. It would be useful if POCITYF could get a global approval from relevant national public bodies (e.g. the Ministry of Culture and Sports in Greece), for a group of solutions, with specific requirements and application methods, to be used in buildings of cultural heritage and historical buildings and exempt them for any further approvals in the law. In the case of usage limitations, the POCITYF's solutions will be more global and compatible to many building's usages (thus being able to roll out even without changing the regulatory or legal framework). Moreover, in cases such as Hvidovre, where no protected buildings are identified (only buildings registered under SAVE values), POCITYF can increase awareness of the city's history and cultural heritage values. Also, to deal with the financial attractiveness of relevant solutions, POCITYF will examine object-based finance possibilities that can be transferred from the current owner to the next owner.

Envisioned innovation resulting from POCITYF's response:

Since changing the regulatory framework about cultural heritage seems to be very difficult (if not impossible) under the framework of an H2020 project, POCITYF sees more possibilities on technology innovation that can meet the current legislative barriers. At the moment, these kinds of interventions-solutions must be agreed on a case-by-case basis. If specific solutions under a protocol were approved globally for any cultural heritage/historical building, there won't be necessary to get approval for every different building, for applying these solutions. POCITYF will also facilitate the provision of long-term horizon for investments that have longer pay back times than usual. Finally, through POCITYF cultural heritage identification and increased awareness can be achieved towards new regulations and cultural preserving strategies.

Related ETT #	**1**	**Solution/aspect affected by the regulatory framework**	**P2P energy trading**

Current regulatory framework and barriers imposed:

In most cases (countries), if you deliver energy from one peer to another and the public domain (grid or public space) is being used, the delivering party is seen as an energy supplier. This implicits that parties have to meet permit regulation. In case of companies (neighbors/citizens in this case) which are only departed from each other through public space (a pavement, or a street) this brings up relatively great barriers. The regulatory framework on P2P trading significantly varies among countries. For instance, in Granada (Spain) the regulation has started favoring these kinds of schemes after last year whereas in Celje (Slovenia) the legislation does not allow P2P energy trading at the moment. In Ioannina (Greece) there is a regulatory framework that permits it, but a lot of bureaucracy is involved that is challenging actual implementation. However, it is expected that the regulatory framework will be more and more favoring energy trading schemes (further pushed by EU energy goals and initiatives on energy communities etc.).

POCITYF's response:

In order for this solution to be rolled-out, it has to be made very easy for companies to trade and deliver energy between each other especially when they are established close to each other. The less hurdles, the better, because hurdles take time to overcome. This discourages companies (neighbors/citizens) to invest time in these otherwise straightforward solutions (from a technical and energy point of view). POCITYF will deliver good practice examples, case studies and knowledge transfer that can help on that. Lessons learnt

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and tools developed are also expected to simplify the existing P2P energy trading processes and local energy generation.

Envisioned innovation resulting from POCITYF's response:

Building a local energy supply network - local energy trade facilitates a fast transition and lowers the requirement of grid reinforcements. Future changes in the regulation and outcomes from POCITYF are expected to improve the efficiency, time needed and simplify energy transactions at both legal and technical level. The demands and pressure of the market (providers, users) could accelerate change. Especially SME's are focused on their own company and they want to be unburdened.

Related ETT #	**1**	**Solution/aspect affected by the regulatory framework**	**Community Solar Farms – Self consumption**

Current regulatory framework and barriers imposed:

Besides the points mentioned at P2P energy trading, the GDPR regulation is really strict and has to be taken into account when Community Solar Farms are developed. If energy is divided between several owners/users and the costs are divided by consumption this data cannot be shared automatically. Several documents have to be set up and parties have to comply these GDPR regulations. Similarly, to P2P energy trading, the regulatory framework relevant to community solar farms and self-consumption varies among countries but is not expected to pose significant barriers since self-consumption is increasingly promoted. In most cases, the regulation promotes and regulates the use of electricity generated from RES also for multi-dwelling buildings, buildings with mixed use and communities; energy is primarily intended for self-supply. Nevertheless, in Denmark (Hvidovre FC) for instance, self-consumption is regulated by the **Act of Electricity Taxes**. Electricity consumption from plants over 6 kW can no longer be offset in the collective electricity supply without having to pay taxes. This is a problem for social housing companies.

POCITYF's response:

As mentioned above, the regulation framework does not pose significant barriers for this solution/aspect thus POCITYF aims to take advantage of it and support it. Simplifying the procedures for obtaining various permits can significantly help. Making it more attractive for social housing to install PV can also boost the development of community solar farms. Developments take place when using data to improve. For use of each other's relevant data (and thus behavior) it is required to share data. This implicits that GDPR regulation has to be applied. If public entities provide standard and reliable contract, high costs will be avoided for the participants.

Envisioned innovation resulting from POCITYF's response:

Outcomes of POCITYF (being supported by the current regulation framework) are expected to facilitate the wider application of this solution by supporting changes in user mind-set and increasing acceptability of shared devices. It is also envisioned that the initial costs will be reduced whereas it will speed up procedures and will decrease the time to be invested before partnerships are accomplished.

Related ETT #	**1**	**Solution/aspect affected by the regulatory framework**	**Waste collection/management**

Current regulatory framework and barriers imposed:

The current regulatory framework allows/promotes recycling and valorization (including construction waste), even though increasing awareness is needed as there is social contestation. An issue that may arise though is relevant to the protection of data. The data which will be used when analyzing the waste streams may not be that detailed that individual households will be revealed. If so the GDPR regulation will have to be applied. Long term contracts often lead to tenders, because public parties are often involved.

POCITYF's response:

POCITYF will demonstrate novel waste collection/management schemes, the outcomes of which can help improve social contestation. Significant changes in the regulatory framework are not expected since it already favors efficient and novel waste collection/management schemes. For very innovative tenders (since public parties are often involved with waste collection), regulation may need to be further lightened.

Envisioned innovation resulting from POCITYF's response:

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With less contestation many companies would be interested on taking advantage of resources (waste) we have. Companies will be more willing to invest in innovation, which will lead to collaboration for longer periods.

Related ETT #	**2**	**Solution/aspect affected by the regulatory framework**	**Virtual Power Plant (VPP)**

Current regulatory framework and barriers imposed:

Generally, there are two value drivers relevant to VPP: 1. Wholesale Markets: a) Organized to maintain a system-wide balance; b) The VPP is operated to optimize the financial position in these markets; c) Allowed in current regulation; d) Market mechanisms are designed for bulk generation: not always the best fit for VPPs. 2. Delivering network services: a) Existing for the transmission level; b) Currently limited for the DSO level: no or limited regulation; c) There are several pilots with local markets currently[54]. Significant differentiations can be found on the regulatory framework among countries. For instance, in Granada (Spain) it is not allowed for Power Plants further than 500 meters one to each other whereas in Celje (Slovenia) the legislation does not allow a cloud-based power plant for trading or selling of electricity.

POCITYF's response:

The EU Clean Energy Directive mentions consumer access to electricity markets and energy communities as things that need to be allowed by regulation in the near future. Since it is difficult to achieve the changes in the regulatory framework in the short term; good practice examples, case studies, knowledge transfer (to be produced by POCITYF) can help setting a solid base for change.

Envisioned innovation resulting from POCITYF's response:

VPPs is a way to empower citizens and consumers and give them the tools to access the markets. With a good knowledge and better legislation VPP would be easier to be promoted. The demands and pressure of the market could also accelerate change.

Related ETT #	**2**	**Solution/aspect affected by the regulatory framework**	**DC Grid**

Current regulatory framework and barriers imposed:

Direct Current Grid is usually controlled by the national law and big utilities and is very difficult to be found in small-medium applications, since the whole electricity system of most countries is tailored to AC. In many cases the DC is not regulated (e.g. Slovenia) but more and more small-scale applications are piloted throughout Europe. In The Netherlands for example, there are experiments with DC in small local areas[55].

POCITYF's response:

Further promotion of the benefits of DC Grids for faster development and positive actions in the establishment of legislation is needed.

Envisioned innovation resulting from POCITYF's response:

Dissemination of knowledge in this area might trigger demand for these services.

Related ETT #	**2**	**Solution/aspect affected by the regulatory framework**	**District level electricity storage**

Current regulatory framework and barriers imposed:

The regulatory framework on energy self-consumption and exchange has been improved over the last years on a European level, nevertheless specific needs should be studied. In The Netherlands for example, the main impediment are the tax rules. When electricity is stored in the public system, double taxes are paid, since taxes must be paid when the energy from the storage is used. When a party stores electricity in the public system, it pays taxes when it uses this stored energy. Also, grid operators are not allowed to

[54] There is a special Dutch regulation for experiments in the electricity sector (Experimenten Elektriciteitswet). In an experiment, it is possible to share electricity in an area and also store it. So, in an experiment, it would be possible to engage in an energy positive community, where electricity is produced and shared by the Members (in a special community grid but sometimes it even can be done virtually), and where only the surplus or deficit electricity of the community is fed into the public grid.

[55] This is possible due to the rules on Experimenten Electriciteitswet. The Experiment may engage in DC.

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store electricity. This is a European law: grid operators must be independent and are not allowed to trade energy. Perhaps they could exploit storage facilities for other parties, storing this electricity.

POCITYF's response:

Changes in procedures for obtaining the permission to build the infrastructure could be of great added value for facilitating the wide scale implementation of district level electricity storage.

Envisioned innovation resulting from POCITYF's response:

Outcomes of POCITYF (being supported by the current regulation framework) are expected to facilitate the wider application of this solution potentially offering faster construction of the entire system and more application options.

Related ETT #	**3**	**Solution/aspect affected by the regulatory framework**	**EV Charging**

Current regulatory framework and barriers imposed:

European and national regulatory framework has improved lately on this issue, and now the main barrier is that of standardization and providing incentives for EV penetration. However, EV charging is currently implemented only in larger urban areas.

POCITYF's response:

As mentioned above, the regulation framework does not pose significant barriers for this solution/aspect thus POCITYF aims to take advantage of it and support it. Improvement of the incentives to this kind of mobility and better standardization for the use of EV charging stations are expected to help wide scale roll-out of this solution. Changes in procedures for obtaining the permission to build the infrastructure may also arise.

Envisioned innovation resulting from POCITYF's response:

Outcomes of POCITYF (being supported by the current regulation framework) are expected to raise awareness of users to use this kind of infrastructure and facilitate faster implementation and greater potential for actual use.

Related ETT #	**3**	**Solution/aspect affected by the regulatory framework**	**V2G**

Current regulatory framework and barriers imposed:

This is a quite innovative solution which is not regulated in most countries yet. In that respect there is a significant room for improvement and developing guidelines and recommendations for this issue based on actual experiences and case studies.

POCITYF's response:

Since regulatory framework does not exist, we first need to establish it. Positive promotion and knowledge transfer would help wide scale roll-out of V2G and POCITYF plans to contribute positively on that.

Envisioned innovation resulting from POCITYF's response:

Establishing a simple, comprehensible and flexible legislative framework that protects the interests of the user and promotes implementation (different financial mechanisms) is needed. Relevant innovations to be demonstrated and lessons learnt from POCITYF will help building a solid basis for V2G applications.

Related ETT #	**3**	**Solution/aspect affected by the regulatory framework**	**EV Sharing**

Current regulatory framework and barriers imposed:

EV sharing is generally allowed in most countries and is not opposed to current regulatory frameworks, however until now is mostly being implemented in large urban areas by big companies.

POCITYF's response:

Promotion activities for faster implementation and acceptance for users would help wide scale roll-out of EV sharing and POCITYF plans to contribute positively on that.

Envisioned innovation resulting from POCITYF's response:

Novel financial incentives could arise due to POCITYF implementation (respective business models are expected to be developed).

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Related ETT #	4	Solution/aspect affected by the regulatory framework	CIP – enabled services and data collection/sharing
Current regulatory framework and barriers imposed:			
The basic regulation relevant to this solution/aspect is the GDPR which permits data collection but in a stringent way, the implications of which have not been fully understood by many. GDPR forces to certain actions about collecting, storing and using citizens' information. It's not a barrier but it demands specific actions and processes. According to the extent of the CIP, maybe the NIS Directive is applicable too. National legislation may also affect this aspect. For instance, Dutch privacy guidelines on energy data, ban public display of energy data on an individual level.			
POCITYF's response:			
POCITYF will suggest all the needed technical specifications, processes and roles of the City's Information Platform, from the design till the production process in order to be according the GDPR and the NIS Directive, if this is necessary. All energy data will be shown on individual level after consent.			
Envisioned innovation resulting from POCITYF's response:			
Better privacy handling will increase the attractiveness of monitoring, and therefore the possibility to optimize the positive energy districts. Applicable guidelines are more needed, than regulation changes, to help cities use and protect their CIPs.			

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5 Critical implementation risks and mitigation actions (1st semester)

The risks and mitigation action analysis are assessed in D11.4 under Task 11.2 – Quality and Risk Management. A detailed presentation and discussion of all critical implementation risks and mitigation actions regarding all WPs and also technical and innovation progress is presented therein. This analysis is critical to the correct roll-out of the project and an essential aspect of technical and innovation management. In order to avoid duplication of information the detailed description of risks and mitigation plans is therefore omitted in this deliverable. We briefly note some critical issues that in this early stage of the project might affect the implementation of technologies and thus also affect the descriptions provided in Section 4. The following table contains this information.

Table 37 Critical risks and mitigation actions

Risk #	1	**Concerned LH**	Alkmaar
District heating grid connectivity			
• New residences Bloemwijk have excellent insulation values, which results in very low heat demand • High costs to connect district heating, Bloemwijk lies far away from existing grid (black lined). Not financially feasible for new residence. • High-rise lies even further away: To connect district heating for (only) 130 apartments of high-rise this is financial not feasible. • Technical risks to drill new piping underneath the train track for high-rise building • Partnership of HVC in Pocityf becomes uncertain			
Mitigation Analysis			
Actions			
• New residences Bloemwijk: connection to Heat pumps with heating/cooling storage • High-rise with powernest, gas connected (energy negative) • Two new high-rise buildings (retrofitted) connected to district heating in 2021 in area Kooimeer			
Feasibility and Impact			
• High probability in execution of these projects • No extra costs • Overall project remains energy positive (~170%) • Willingness of Pocityf partners: van Alckmaer & Woonwaard & HVC			
Risk #	2	**Concerned LH**	Alkmaar
Replacement of GasFreeWorks PEB			
• The original location to for the erection of the GasFreeWorks building in Overstad is not available anymore and obsolete. Therefor DBL has to look for an alternative location. • some IE cannot be executed or shall be executed in an altered way (e.g. Hydrogen fuel cells, PCM, heat island concept, triple glazing, li-ion batteries, insulation with circular materials, DC grid). • Partnership of DBL in POCITYF becomes uncertain.			
Mitigation Analysis			
Actions			
• A lot has been identified (Olympia Park A) which is inside the demonstration area. DBL is interested in building a sustainability hub there depending on business model and feasibility studies. Solutions can be integrated in the new building.			
Feasibility and Impact			
• DBL needs to find additional parties as the lot is too large for a sustainable business model. Ongoing talks with the Municipality (lot owner) and Alkmaar Sports (interested party) towards a final decision. • Impact to be assessed.			

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6 Impact on SMEs (1st semester)

POCITYF systematically increases energy systems integration and pushes energy performance levels significantly beyond the levels of current EU building codes in order to realize Europe wide deployment of Positive Energy Districts by 2050.In terms of how the project impacts SMEs, POCITYF has strategically designed activities that valorize methods and tools such as the Tipping approach, the Eco-Acupuncture, and the smart cloud for innovative startups which aim to support business development and growth exploiting project results or initiating novel entrepreneurial activities as startups or spin offs leveraging the demonstration of innovative solutions and their potential for future replication.

The POCITYF commercial solutions demonstrated for each ETT will be evaluated as per their potential to create synergic systemic packages (Smart city integrated solutions - IS) either through the existing legal entities of the participating organizations under joint sales agreements among project's commercial partners including EDPL, Schneider, Ubiwhere, Onyx, Tegola, Neroa, AMPS power, ENERSIS and Kimatica, and SMEs, or startups, or through new legal entities i.e. spin-offs that may arise from the legal partnering of the consortium members. This process of examining immediate market exploitation potential will foster faster replication and market uptake. It will have an immediate impact on both the growth of existing ventures and the creation of new ventures. Shareholders agreements, equity distribution, roles/responsibilities and up-front contributions will be discussed and resolved during the business innovation planning activities of the POCITYF. The participation in the project of large companies like EDP, Schneider and Sonae present an opportunity to identify first investors of spin-offs that will emerge from existing partners or startups offering solutions relevant to the project integrated solutions bringing new ideas to the market. Startups will emerge from the participatory approaches that POCITYF will deploy for encouraging the generation of novel ideas with market potential.

At this early stage of the project, the impact on SMEs either through the creation of spin-offs or startups, cannot be easily quantified. In the following updated versions of this deliverable, this impact will be analyzed while being continuously monitored throughout the project. Table 35 presents the POCITYF vision in creating a positive impact on business development, particularly in SMEs in 3 different timeframes.

Table 38 Vision for POCITYF's impact on SMEs

Short Term (1-3 years)	Mid-Term (4-5 years)	Long-term (until 2030)
Generate ideas about new services and business models. +25 Start-ups established, finding "cases for concepts" trough POCITYF events, guides, platforms etc.	Information on validated services and business models +50 Start-ups established. +10 Start-ups reached SME-level within POCITYF-related initiatives.	Business opportunities for replication and spin-offs. +100 Start-ups and +25 new SMEs established. >200 new jobs created

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7 ANNEX I – Innovative elements per local partner

The tables below present the two LH ecosystems, local partners and related IEs. These tables have been formed in collaboration with the LH Site Managers. This list is to be updated accordingly during the following month.

ALKMAAR ECOSYSTEM	
Local Partner	Innovative Elements
Enersis	• GRIDS energyCity
TNO	• ReFlex (ex-PowerMatcher) • HEAT matcher thermal grid controller • Smart distribution management plan (contributing)
Stichting Energy Valley - SEV	• TIPPING approach • Eco-Acupuncture • Value based design • InnoFest concept
NEROA	• VPP - Virtual Power Plant • HEMS/BEMS/CEMS
Alliander	• Smart Solar Charging
CONNEXXION	• V2G (with Alliander) • Intelligent and optimal control algorithms
Van Alckmaer	• Insulation with circular materials • Li-ion batteries / Li-metal batteries • EV Sharing • Stationary Batteries • DHC (biomass, waste, geothermal)
DBL (=Duurzaam Bouwloket)	• Triple glazing • Li-ion batteries / Li-metal batteries • Fuel cells (hydrogen) • PCM in the floor • DC grid • Heat Island concept • Aquifer Thermal Energy Storage – ATES (with GA)
HVC	• DHC (biomass, waste, geothermal) • Low temperature heat grid • Geothermal heat source
Woonwaard	• Hybrid wind/solar generation system (Powernest) • Solar roofs and facades • Circular economy building practices (with Van Alckmaer, Inholland)
Gemeente Alkmaar (GA)	• Hydrogen powered HD vehicles • City Information Platform • Citizen Information Platform • Data acquisition system • City Data hub • Solar Roads • DC lighting with EV charging • Reverse collection of waste

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	• Waste management tools • Low temperature waste heat
Inholland University of Applied Sciences (Inholland)	• Thermo acoustic heat pumps • Cascaded heat pumps • Composite façade panels • Circular economy building practices

EVORA ECOSYSTEM	
Local Partner	Innovative Elements
ONYX	• PV glass • PV canopy • PV skylight
INESCTEC	• Bidirectional smart inverters • Micro-grid controller platform • Gamification platform • Smart bidirectional chargers to support V2G applications • HEMS • EV charger prototype with PV integration • Bidirectional smart inverters for EV smart charging and V2G applications • Mobile apps on energy consumption
UNINOVA	• Energy router • Control algorithms • Wi-fi data acquisition systems • Tourist apps
Ubiwhere (UW)	• Smart lamps with EV charging and 5G functionalities • Pay-As-You-Throw (PAYT) • City Urban Platform (CIP extension)
SONAE	• Mobile apps on energy consumption (provided by INESC) • Control algorithms • Freezing storage in store • EV charging management platform
Betteries (ex – AMPS Power)	• 2nd life residential batteries
TEGOLA	• Tegosolar PV • Traditional PV shingle
DECSIS	• Positive computing center • Smart cloud for innovative start-ups • Data lake intelligence for positive communities • Community Solar Farm (with CME, **EDPL**)
Schneider (SE)	• Building Management System (BMS)
Kimatica	• P2P energy trading platform / Digital transformation in Social Innovation
Municipality of Evora (CME)	• Smart distribution management system • Community Solar Farm (with DECSIS, **EDPL**) • EV sharing scheme • Cultural experiences market (mobile app)
University of Evora (UEvora)	• LV and MV storage system (with EDPL)
EDP Labelec (EDPL)	• LV and MV storage system (with UEvora) • Market Oriented building flexibility services

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

	• Community Solar Farm (with CME, DECSIS)
PACT	• Mobile apps on energy consumption (provided by INESC)

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8 ANNEX II – Documents supporting monitoring and coordination

Figure 2 depicts the POCITYF demonstration progress tracker demo screen.

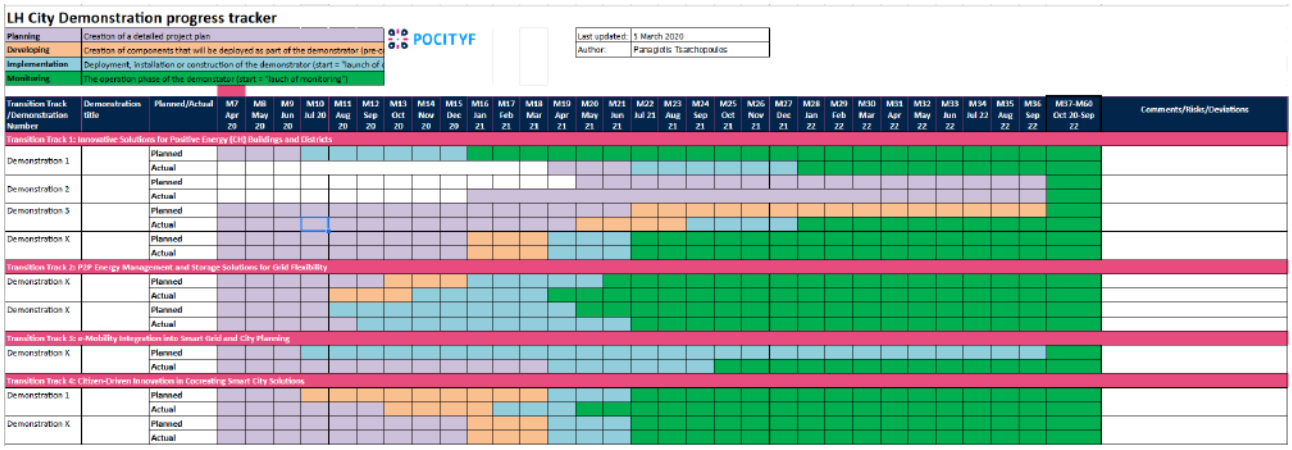

Figure 2 POCITYF Demonstrations progress tracker demo screen

The questionnaire template used to collect information from each local partner per IE are depicted in Fig. 3 and 4.

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POCITYF

T11.3 - Innovation/Market Needs/Business Models - DATA COLLECTION

Responsible Horizon partners	CERTH	Responsible LH/FC	PLEASE FILL IN
Innovative Element (IE)	PLEASE FILL IN	Responsible Local Partners	PLEASE FILL IN
EET(if applicable) and Project Objective	PLEASE FILL IN	IS (if applicable)	PLEASE FILL IN
Date	February 12, 2020	Version	1.0

EACH LOCAL PARTNER RESPONSIBLE FOR AN INNOVATIVE ELEMENT SHOULD FILL THIS QUESTIONNAIRE ACCORDINGLY. IF A PARTNER DEALS WITH SEVERAL IEs, A SEPARATE QUESTIONNAIRE IS REQUESTED FOR EACH OF THOSE.

PLEASE CHECK ALSO IN-DOC COMMENTS AND THE EXAMPLE QUESTIONNAIRE PROVIDED.

Technical Innovation Title

1. Provide a strong and clear title for the innovation element ? [1 line max]
   a. [Type an answer here.]

The Innovation Title field is key and needs to be strong and clear. Examples of poor and good titles are below. If meaningful please ensure there is a for clause in the Innovation title.	
Poor innovation title	Good innovation title

POCITYF

Figure 3 POCITYF T&I progress questionnaire template (page 1/2)

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Laser Design Platform	Improved semiconductor laser design platform **for** RWG lasers
Novel Robot Arm	Dextrous robotic slave arm **for** high radiation environments

Progress of Technical Innovation

1. What are the innovative aspects of the IE ? [10 lines]
   a. [Type an answer here.]
2. What is the IE level of innovation and how the TRL will be advanced from level X to level Y ? [5-10 lines]
   a. [Type an answer here.]

Market needs, changes and progress on resulting innovation of IS2.1

1. What are the current market needs that the IE will address? [10 lines]
   a. [Type an answer here.]
2. What is the Value Proposition of the IE ? [10 lines]
   a. [Type an answer here.]
3. How the IE can bring a market change and how market changes may affect the IE? [10 lines]
   a. [Type an answer here.]
4. How current and future market changes/challenges affect the Project Objective? [5-10 lines]
   a. [Type an answer here.]

Business models - Business/Market Uptake Innovation

1. How do you envision capturing value from the IE - What will be your business model? [10-15 lines]
   a. [Type an answer here.]
   b. [Type an answer here.]

External Bottlenecks of the innovation

1. Which are the external bottlenecks that compromise the ability of your organization to exploit the IE in the market place? [10 lines]
   a. [Type an answer here.]

Figure 4 POCITYF T&I progress questionnaire template (page 2/2)

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9 ANNEX III – External Bottlenecks

The following tables include external bottlenecks that may compromise the ability of each organization to exploit the IE in the marketplace. They have been identified by the local partners per IE and provide a very useful dataset of risks that may arise towards the exploitation of technologies.

External Bottlenecks of the innovation for IS-1.1

Innovative Element (IE) #	**1.1.1**	**Description/Title**	**PV Glass**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
No external bottlenecks have been identified at this stage			
Innovative Element (IE) #	**1.1.2**	**Description/Title**	**PV Canopy**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
No external bottlenecks have been identified at this stage			
Innovative Element (IE) #	**1.1.3**	**Description/Title**	**PV Skylight**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
No external bottlenecks have been identified at this stage			
Innovative Element (IE) #	**1.1.4**	**Description/Title**	**Tegosolar PV**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
If cultural heritage restrictions impose a curvy shingle it will be a bottleneck since today there is no solution at a reasonable TRL that can give a curvy element producing energy.			
Innovative Element (IE) #	**1.1.5**	**Description/Title**	**Traditional PV Shingle**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
If cultural heritage restrictions impose a curvy shingle it will be a bottleneck since today there is no solution at a reasonable TRL that can give a curvy element producing energy.			
Innovative Element (IE) #	**1.1.6**	**Description/Title**	**Bidirectional Smart Inverters**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Legislation and regulation as well as lack of investment from industrial companies are key factors that comprise the ability of exploiting this IE in the marketplace.			
Innovative Element (IE) #	**1.1.7**	**Description/Title**	**Energy Router**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
The full exploitation of the energy router potential can be compromised by external technical issues, such as cybersecurity issues associated with the energy sector or lack of Smart Grid Infrastructure, or external legal issues, such as privacy rules or bureaucracy.			
Innovative Element (IE) #	**1.1.8**	**Description/Title**	**Building Management System (BMS)**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Some bottlenecks that can comprise the ability of the BMS solution for historical buildings in current European/Global Market are a) Changes in the regulations on NZEBs or Smart Readiness Indicator, that penalize for some reason the BMS system. (This is almost impossible, as the regulation trends seen in the last years is exactly the opposite); b) Up-rise of flexible Home Automation HA (domestic) solutions, take over the market of Building Automation. (This is very unlike as the HA solutions are currently limited to DIY market); c) Competitors coming up with new/innovative services which make their BMS solutions more favorable compared to Schneider Electric one. (This is possible, and due to this Schneider Electric is releasing several services (EcoStruxure Building Advisor, EcoStruxure Workplace Advisor, EcoStruxure Facility Expert etc.).			
Innovative Element (IE) #	**1.1.9**	**Description/Title**	**2nd Life Residential Batteries**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
There is in general, a lack of skilled workers in Europe in the field of power electronics, which are crucial for battery system design and optimization. Furthermore, there is still unclarity in the regulative field, especially regarding safety requirements and recycling requirements of car manufacturers but also other			

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battery system providers. Also, future recycling costs are still difficult to estimate. The non-standardized form factor and configuration of the EV-batteries bares a risk of compatibility in future, even if Betteries GmbH is ensuring compatibility with major batteries in consideration today and under discussion in industry.

Innovative Element (IE) #	**1.1.10**	**Description/Title**	**HEMS/BEMS**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Legislation and regulation as well as lack of investment from industrial companies are key factors that comprise the ability of exploiting this IE in the marketplace.			
Innovative Element (IE) #	**1.1.11**	**Description/Title**	**Positive Computing Centre**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Some external bottlenecks identified go from funding gap to support energy transition and solutions, energy storage for night periods usage, legislation and space to increase energy production. The need to comply with standards and strict regulation, certifications, are a strong limitation to test new solutions in the datacenter environment. Some actions may have impact on customers equipment and needs to be fully validated and authorized by the end-customer.			
Innovative Element (IE) #	**1.1.12**	**Description/Title**	**Insulation with Circular Materials**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
The materials may not suitable for use in specific situations for building or building physics // The chance that insufficient materials are available // The use of this type of material requires a very high investment.			
Innovative Element (IE) #	**1.1.13**	**Description/Title**	**Triple Glazing**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
The weight of triple glass is higher, so this implicit several difficulties // Because triple glass has more depth, it doesn't always fit in the rebate. Because of this, extra costs may arise for the users. This will increase the initial investments.			
Innovative Element (IE) #	**1.1.14**	**Description/Title**	**Solar Roofs and Facades**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Acceptance of this IE by the tenants of the building.			
Innovative Element (IE) #	**1.1.15**	**Description/Title**	**Thermo Acoustic Heat Pumps**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Social housing companies will need to cooperate with BLUEHEART Company and this new technique and will need to change the way of installing heat pumps. Therefore, possibly there would be needed less workforce, which would be an advantage, while the energy transition is lacking human capital.			
Innovative Element (IE) #	**1.1.16**	**Description/Title**	**Hybrid wind/solar generation system (Powernest)**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
In the Alkmaar demo site, there is probably no problem with legislation. However, in future projects legislative issues could form a bottleneck. The Powernest is a 4,8-meter-high installation which doesn't always fits in zoning plans. Zoning plan might have to be altered.			
Innovative Element (IE) #	**1.1.17**	**Description/Title**	**Li-ion Batteries**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Because of the possibility for homeowners in the Netherlands to deliver directly to the grid a battery is not yet interesting for them. Though for some buildings it can be interesting to act stand alone on the energy household // The batteries are still expensive: high initiative costs.			
Innovative Element (IE) #	**1.1.18**	**Description/Title**	**Cascaded Heat Pumps**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
No external bottlenecks have been identified at this stage			
Innovative Element (IE) #	**1.1.19**	**Description/Title**	**Composite Facade Panels**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
No external bottlenecks have been identified at this stage			

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Innovative Element (IE) #	1.1.20	Description/Title	PCM in the floor
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Nowadays the technique isn't fully developed and might be difficult to control and adjust the phase changes (of the materials used in the floor).			

External Bottlenecks of the innovation for IS-1.2

Innovative Element (IE) #	1.2.1	Description/Title	Smart Lamps with EV Charging and 5G functionalities
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Currently, the bottleneck is the indecision about the 5G technology and how the mobile operators can explore the 5G market. Because the rent of 5G infrastructure is the more interesting revenue to the Smart Lamppost owner, without a clear definition of 5G market it's difficult to exploit in large scale the IE market. Although the EV charging market can be another source of revenues, the value is lower compared with the revenues from 5G market and only interesting in combination with other markets.			
Innovative Element (IE) #	**1.2.2**	**Description/Title**	**Energy Router**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Check IS1.1 – IE #7			
Innovative Element (IE) #	**1.2.3**	**Description/Title**	**Smart Distribution Management System**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
No external bottlenecks have been identified at this stage This IE is subject to replacement. Info will be updated in following versions of the deliverable.			
Innovative Element (IE) #	**1.2.4**	**Description/Title**	**P2P Energy Trading Platform**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Lack of funding and availability on developers			
Innovative Element (IE) #	**1.2.5**	**Description/Title**	**Community Solar Farm**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
No external bottlenecks have been identified at this stage			
Innovative Element (IE) #	**1.2.6**	**Description/Title**	**DHC (biomass, waste, geothermal)**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
No external bottlenecks have been identified at this stage			
Innovative Element (IE) #	**1.2.7**	**Description/Title**	**Aquifer Thermal Energy Storage (ATES)**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
It is difficult linking supply and demand // It is difficult to control/optimize the technique, which is necessary to earn back the large investment // For single use/larger buildings it can make them dependent of this technique. In case of malfunctions it can bring problems.			
Innovative Element (IE) #	**1.2.8**	**Description/Title**	**Li-ion / Li-metal Batteries**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
lack of support base among residents // Legislation (parking standard) // Funding issues			
Innovative Element (IE) #	**1.2.9**	**Description/Title**	**DC Lighting with EV Charging**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Regulatory barriers for public DC grid: Alkmaar need a ruling from the ACM (Netherlands Authority for Consumers and Markets) as the regulations and standards still need to be determined for public DC grids // Funding issues.			
Innovative Element (IE) #	**1.2.10**	**Description/Title**	**Solar Roads**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Check IS3.2			
Innovative Element (IE) #	**1.2.11**	**Description/Title**	**V2G**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			

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Check IS3.1

External Bottlenecks of the innovation for IS-1.3

Innovative Element (IE) #	1.3.1	Description/Title	2nd Life Residential Batteries
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Check IS1.1 – IE #9			
Innovative Element (IE) #	**1.3.2**	**Description/Title**	**Pay-As-You-Throw (PAYT)**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
The main bottleneck of the PAYT system is the containers adaptation. Currently, cities have already installed a large number of containers that would need adaptation and since this cost is directly associated with cities, the main obstacle may be the financial issue.			
Innovative Element (IE) #	**1.3.3**	**Description/Title**	**Reverse Collection of Waste**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Separate collection of the re-usable commodities causes multiple (3 to 4) separate waste bins, which aren't emptied every week. This causes additional space and can cause odor, which many residents don't like and for some who live in small residential houses/apartments this forms a problem // Not all residents are convinced that the separated commodities are re-used in a proper way. Some believe the separated materials are mixed together at the waste plant before it is burned in the ovens // New plastic remains far cheaper than recycled plastics, due to the low oil prices and not all plastics can be used for recycling. This also feeds the belief that recycling has no use to some residents // Some citizens sabotage the separate collecting of waste and add plastic to GFT streams, causing additional (micro) shredded plastic to enter the environment. Currently about 1 to 2% of the GFT contains plastics			
Innovative Element (IE) #	**1.3.4**	**Description/Title**	**Circular Economy Building Practices**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Skills in the workforce is essential for the application of this IE; Multidisciplinary teams and 21st century skills need to be developed. Also, smart and digital innovation is necessary to deal with reduction of labor force.			
Innovative Element (IE) #	**1.3.5**	**Description/Title**	**ATES**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Check IS1.2			
Innovative Element (IE) #	**1.3.6**	**Description/Title**	**PCM in the floor**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Check IS1.1			
Innovative Element (IE) #	**1.3.7**	**Description/Title**	**Waste Management Tools**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
There is no legislation with regards to this topic of material mapping during construction phase of a building // Chosen design solution of new products or buildings could cause a bottleneck for the innovation.			

External Bottlenecks of the innovation for IS-2.1

Innovative Element (IE) #	2.1.1	Description/Title	2nd life residential batteries
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Check IE #1.1.9			
Innovative Element (IE) #	**2.1.2**	**Description/Title**	**Micro-grid controller platform**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
The implementation of compatible functional and communications architectures capable of supporting the concept along with the limited access to sensing and controlling equipment due to the smart grid transition phase are identified bottlenecks that could influence the innovation and technological advance of this IE. This IE is subject to replacement. Info will be updated in following versions of the deliverable.			

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Innovative Element (IE) #	2.1.3	Description/Title	Control Algorithms
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
The deployment of the Flexibility Control Algorithms can be affected by the lack of software interfaces with existing and new controllable devices which are not ensured by UNINOVA and, in the worst-case scenario, by the lack of controllable devices made available on time during POCITYF.			
Innovative Element (IE) #	**2.1.4**	**Description/Title**	**LV and MV connected storage systems**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
No external bottlenecks have been identified at this stage			
Innovative Element (IE) #	**2.1.5**	**Description/Title**	**P2P energy trading platform**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Check IE #1.2.4			
Innovative Element (IE) #	**2.1.6**	**Description/Title**	**City Energy Management System**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
The interconnectivity between all the nodes, relying on computer networks to interlink everything. These computer networks are not always available on location, or simply too expensive to be feasible. Lack of skills in the workforce can also be a problem later on in the project. Some special interfacing software needs to be written for every type of device that is going to be connected to the energy management network. This software is highly modular, so this issue might only cause time delays, and there is already a pool of interfacing modules from other projects.			
Innovative Element (IE) #	**2.1.7**	**Description/Title**	**ReFlex (previously PowerMatcher**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Check ICT Solution #3			
Innovative Element (IE) #	**2.1.8**	**Description/Title**	**Stationary batteries**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
• Lack of support base among residents. • Legislation (parking standard). • Funding issues. Check also IE #1.1.17			
Innovative Element (IE) #	**2.1.9**	**Description/Title**	**Virtual Power Plant (VPP)**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
The VPP is relying on the HEMS/BEMS/CEMS to be implemented correctly, as it is part of the supply side in this smart grid system.			
Innovative Element (IE) #	**2.1.10**	**Description/Title**	**V2G**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Check IE #3.1.4			
Innovative Element (IE) #	**2.1.11**	**Description/Title**	**DC grid**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Products are often designed for use on AC grids.			
Innovative Element (IE) #	**2.1.12**	**Description/Title**	**Fuel cells (hydrogen)**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
The investment for this solution is still very expensive, so really high starting costs occur, which are difficult to earn back on short notice. Moreover, the infrastructure for Hydrogen isn't available everywhere.			

External Bottlenecks of the innovation for IS-2.2

Innovative Element (IE) #	2.2.1	Description/Title	Freezing storage in store
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
No external bottlenecks have been identified at this stage			
Innovative Element (IE) #	**2.2.2**	**Description/Title**	**Market-oriented building flexibility services**

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External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
No external bottlenecks have been identified at this stage			
Innovative Element (IE) #	**2.2.3**	**Description/Title**	**Low temperature heat grid**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
The price of the newly engineered sets. To change all existing equipment in existing buildings and provide them with the new delivery sets.			
Innovative Element (IE) #	**2.2.4**	**Description/Title**	**Geothermal heat source**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
No external bottlenecks have been identified at this stage			
Innovative Element (IE) #	**2.2.5**	**Description/Title**	**Low temperature waste heat**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
No external bottlenecks have been identified at this stage			
Innovative Element (IE) #	**2.2.6**	**Description/Title**	**ATES**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Check IS #1.2			
Innovative Element (IE) #	**2.2.7**	**Description/Title**	**HEAT matcher thermal grid controller**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
HeatMatcher for Buildings IP has been promoted in the past to market companies active in the Building Energy Management System domain, like Siemens, PRIVA and Johnson Controls. It appears difficult to sell the IP without the experts willing to leave TNO. Skills and knowledge of the technology in this case is crucial.			
Innovative Element (IE) #	**2.2.8**	**Description/Title**	**Heat Island concept**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
The main identified bottleneck lay in the amount and sort of technologies used, as a new interface needs to be developed for each one. To date, the equipment/device supplier are not able to deliver the required interfaces and thus the interface developement related party has to be included in the implementation process.			

External Bottlenecks of the innovation for IS-3.1

Innovative Element (IE) #	**3.1.1**	**Description/Title**	**EV charging management platform**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
No external bottlenecks have been identified at this stage			
Innovative Element (IE) #	**3.1.2**	**Description/Title**	**EV charger prototype with PV integration**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
The main bottlenecks that can have a huge impact on the exploitation of the IE in the marketplace are legal and funding issues. More specifically, the introduction of new local and international legislation and the lack of investment from industrial companies play a vital role for the deployment of the technology.			
Innovative Element (IE) #	**3.1.3**	**Description/Title**	**Bidirectional smart inverters for EV smart charging and V2G applications**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Check IE #1.1.6			
Innovative Element (IE) #	**3.1.4**	**Description/Title**	**V2G**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
A major bottleneck at this moment will be the legislation, the maintenance warranties of the bus and battery, and the impact of the enlarged number of charging and depletion cycles of the batteries. These impacts could lead to a non-existing business case in energy trading. Next to that the availability of public transport buses with batteries that could do V2G services is depending on the product planning developments at bus OEM's. The impact on grid operator side is unknown at this moment.			

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With regards to city public transport planning there is a challenge that the Bus OEM will not be able to provide V2G on today's buses in operation in Alkmaar due to battery warranty restrictions, or non-development of onboard battery diagnostics and IT product planning at OEM site. With regards to ICT solutions operational data will be necessary to further develop IT systems for controlling energy levels within buses.

Innovative Element (IE) #	**3.1.5**	**Description/Title**	**Smart lamp posts with EV charging and 5G functionalities**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Check IE #1.2.1			
Innovative Element (IE) #	**3.1.6**	**Description/Title**	**Intelligent and optimal control algorithms**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Two main external bottlenecks may pose a problem and should be taken into account at this time: • The non-sharing of data between suppliers could lead to suboptimal solutions • The exclusivity of the supplier with the product or price of the developed IT product could slow down an efficient energy transition.			
Innovative Element (IE) #	**3.1.7**	**Description/Title**	**Smart solar charging**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
No external bottlenecks have been identified at this stage			
Innovative Element (IE) #	**3.1.8**	**Description/Title**	**Virtual Power Plant (VPP)**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
No external bottlenecks have been identified at this stage			
Innovative Element (IE) #	**3.1.9**	**Description/Title**	**DC lighting with EV charging**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
The market development of the IE can be compromised by two main obstacles: • Regulatory barriers for public DC grid: Alkmaar need a ruling from the ACM (Netherlands Authority for Consumers and Markets) as the regulations and standards still need to be determined for public DC grids • Some citizens (strongly) object against the introduction of 5G and fear the transmitted signals will create serious health problems. • Potential claims from the 5G provider to the municipality • Funding issues			

External Bottlenecks of the innovation for IS-3.2

Innovative Element (IE) #	**3.2.1**	**Description/Title**	**EV sharing**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
The main bottlenecks that impede IE market development and exploitation are currently the lack of support from residents, deficient legislation progress in car-sharing (parking standards) and funding issues.			
Innovative Element (IE) #	**3.2.2**	**Description/Title**	**Hydrogen Powered HD Vehicles**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Several risks while introducing hydrogen fueled DH transport vehicles can be legislation, public opinion, technical issues and financial reasons. In more detail, some external bottlenecks are: • Funding issues • Legislation related to hydrogen fueled vehicles and hydrogen tanking and storage facilities • Safety issues with regards to hydrogen • Public opinion • Availability of hydrogen tanking and storage facilities			
Innovative Element (IE) #	**3.3.3**	**Description/Title**	**Solar Roads**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Current bottlenecks that may pose a threat for the technology are:			

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- Funding issues: The costs of a solar road are considered very high (3-4 times solar panels on a roof and a conventional pavement layer, the payback time is approximately 50 years). These figures are based on the experience performed at a solar bike road at Krommenie.
- High costs for grid connection, which has to be (over) dimensioned for peak loads only in the summer.
- Reconsideration of the chosen materials of the panels due to the high costs, and the expected negative environmental impact during the lifetime (LCA) of the panels.

External Bottlenecks of the ICT Solutions

ICT Solution #	1	Description/Title	Connect with Energy
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
No external bottlenecks have been identified at this stage			
ICT Solution #	**2**	**Description/Title**	**GRIDS energyCity**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
Lack of data of the building stock.			
ICT Solution #	**3**	**Description/Title**	**Reflex (previously known as PowerMatcher)**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
• Currently the cost of connecting flexible assets is too high. Only the flexibility of very large assets is exploitable in a cost-effective way. Further standardization is needed. This is expected to be solved in the future. • Barriers to enter energy markets are quite high at the moment. New markets, which are easier to access, are being developed (e.g. ETPA in the Netherlands), as well as regulation that makes it easier to utilize flexibility (Clean Energy Package). • The market is not yet mature. The business case of currently connected assets is well enough to utilize them for one particular market (i.e. not performing value stacking). These companies typically have other priorities.			

External Bottlenecks of the innovation for IS-4.1

Innovative Element (IE) #	4.1.1	Description/Title	Digital transformation in Social Innovation
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
• Lack of utility or city interest in social responsibility, since it is not usually first priority. • Lack of funding and availability on developers			
Innovative Element (IE) #	**4.1.2**	**Description/Title**	**Gamification platform**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
The complexity and uncertainty in the process of game designs and the reaction of users in the cities to gamescan be considered as bottlenecks in exploitation of IE. The games designed for one group may not be appealing for another group of users which make the exploitation tricky. Another point is the experience in social sciences and behavior analysis approaches in the workforce. Although, such experience exist within the organization, the social science knowledge and its adaptability to various behavior types may not be sufficient.			
Innovative Element (IE) #	**4.1.3**	**Description/Title**	**Tourist apps**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
The exploitation of the tourist app does not seem to have important constraints. Nevertheless, external technical issues, like cybersecurity and/or data protection and privacy can compromise the app dissemination depending on the country legal framework.			
Innovative Element (IE) #	**4.1.4**	**Description/Title**	**Cultural experiences market (mobile app)**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
No external bottlenecks have been identified at this stage			
Innovative Element (IE) #	**4.1.5**	**Description/Title**	**Mobile apps on energy consumption**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
No external bottlenecks have been identified at this stage			

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Innovative Element (IE) #	4.1.6	Description/Title	Design based Value Mapping for Communities
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			

Innovative Element (IE) #	4.1.7	Description/Title	InnoFest concept
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
No bottlenecks expected so far. However, if too many festivals want to join the POCIFEST sub-activity, a lack of incubating manpower might occur.			

External Bottlenecks of the innovation for IS-4.2

Innovative Element (IE) #	4.2.1	Description/Title	TIPPING approach
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
No bottlenecks are expected so far, but the TIPPING approach presupposes a basic willingness from all actors in the energy transition quadruple helix to engage and take co-responsibility vis-à-vis an attitude of leasing out all or most responsibilities, tasks and expertise building to external consultants.			
Innovative Element (IE) #	**4.2.2**	**Description/Title**	**Eco-Acupuncture**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
No external bottlenecks have been identified at this stage			

External Bottlenecks of the innovation for IS-4.3

Innovative Element (IE) #	4.3.1	Description/Title	City Urban Platform (CIP extension)
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
The main bottleneck is the possibility that other platforms already exist in cities, which makes it difficult for decision-makers to become aware of the gains that this IE can bring to their city.			
Innovative Element (IE) #	**4.3.2**	**Description/Title**	**Wi-fi data acquisition systems**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
While the power supply of the Wi-Fi Data Acquisition Systems is completely ensured by their integrated PV module and battery, local Wi-Fi networks are still needed to upload the collected data. Therefore, problems and/or changes in local communication infrastructures can compromise the operation of this IE. Additionally, although no personal data is collected, changes in data privacy legislation can also impact the operation of the Wi-Fi Data Acquisition Systems.			
Innovative Element (IE) #	**4.3.3**	**Description/Title**	**Data lake intelligence for positive communities**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
No external bottlenecks have been identified at this stage			
Innovative Element (IE) #	**4.3.4**	**Description/Title**	**Smart cloud for innovative startups**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
The success of the IE depends greatly on the capabilities of entrepreneurs and city decision-makers. In addition, the lack of skills and quantity of workforce number at local level can be a problem.			
Innovative Element (IE) #	**4.3.5**	**Description/Title**	**Citizen Information Platform**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
No external bottlenecks have been identified at this stage			
Innovative Element (IE) #	**4.3.6**	**Description/Title**	**Data acquisition system**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
No external bottlenecks have been identified at this stage			
Innovative Element (IE) #	**4.3.7**	**Description/Title**	**City Data Hub**
External bottlenecks that comprise the ability of exploiting the IE in the marketplace:			
No external bottlenecks have been identified at this stage			

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