IANOS

SUSTAINABLE SOLUTIONS
for islands' decarbonisation

D6.4 – Terceira's Use Cases Deployment Plan Report

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H2020-LC-SC3-2018-2019-2020 / H2020-LC-SC3-2020-EC-ES-SCC
EUROPEAN COMMISSION
Innovation and Networks Executive Agency
Grant agreement no. 957810

PROJECT CONTRACTUAL DETAILS

Project title	IntegrAted SolutioNs for the DecarbOnization and Smartification of Islands
Project acronym	IANOS
Grant agreement no.	957810
Project start date	01-10-2020
Project end date	30-09-2024
Duration	48 months
Project Coordinator	João Gonçalo Maciel (EDP) - JoaoGoncalo.Maciel@edp.com

DOCUMENT DETAILS

Deliverable no.	D6.4
Dissemination level	Public
Work package	WP6 - Deployment, Use Cases Realization and Monitoring at LH#2 (Terceira)
Task	T6.2 Deployment Plan and Risk Management
Due date	29/04/2022
Actual submission date	29/04/2022
Lead beneficiary	EDP

Version	***Date***	***Beneficiary***	***Changes***
0.1	First Draft	EDP	Started the document and TOC
0.2	22/02/2022	Partners in Terceira	Sent to partners to collect inputs and altered accordingly
0.3	01/04/2022	EFACEC and UNI	Sent for revision
0.4	20/04/2022	EDP	Altered according to feedback from reviewers and readied for submission

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Executive Summary

Targeting the decarbonisation of key sectors that may boost the energy transition in island territories, IANOS aims to test, implement, and monitor the performance of innovative technologies and resources' management techniques, that can cope with harsh operational environments, more common in isolated systems, where lower inertia maximises the impact of technical constraints.

Islands also represent real testbeds where is easier to study the impact of emerging technical challenges. Using smaller but also more stressed environments, such as islands, key technologies can be extensively tried out, paving the way for scalability and replicability assessments before targeting large interconnected continental systems, where is expected these challenges to appear next.

Included in the LH#2 guidebook series, after concluding the technical characterisation of the pilot sites from Terceira, D6.4 presents the deployment plan to be followed during the use cases implementation in Terceira. The plan aims to propose the follow-up approach to the deployment of a set of solutions initially characterised in Terceira's technologies roadmap, key to implement and operate the use cases defined for the project Lighthouse Island 2.

The envisioned deployment plan includes reference timelines for the testing, transportation, site deployment and commissioning phases, considering the technologies' specifications and installation requirements shared by the solutions' providers. The report also presents strategies to engage key stakeholders, monitor risks and manage critical activities that can impact the use cases operation.

The key contributors are the partners involved in T6.2, namely site manager(s) and owner(s), and all solution providers actively involved in developing and setting-up the validation environments proposed for Terceira.

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Abbreviations

API	Application Programming Interface
BESS	Battery Energy Storage System
DER	Distributed Energy Resources
DG	Distributed Generation
DSM	Demand Side Management
DSO	Distribution System Operator
EV	Electric Vehicle
FFR	Fast Frequency Response
HEMS	Home Energy Management System
LEC	Local Energy Community
LV	Low Voltage
MPPT	Maximum Power Point Tracking
PCM	Phase-Change Material
PI	Progress Indicator
PV	Photovoltaic
RES	Renewable Energy Sources
SoC	State of Charge
TRL	Technology Readiness Level
TT	Transaction Track
UC	Use Case
V2G	Vehicle to Grid
VPP	Virtual Power Plant
WP	Work Package

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1. Introduction

1.1. Purpose and Scope of the Deliverable

IANOS project interventions aim at promoting the decarbonisation of several sectors in the lighthouse islands, Ameland and Terceira, and fellow islands, Bora-Bora, Lampedusa and Nisyros. To achieve this, 9 Use Cases (UC) will be implemented, relying on both innovative technology and citizen engagement initiatives. These UCs have been thoroughly described in deliverable *D2.1, Report on Islands requirements engineering and Use Cases definitions.*

The present deliverable *D6.4 – Terceira's Use Cases Deployment Plan Report –,* developed under Task *T6.2, Deployment Plan and Risk Management,* presents an in-depth analysis of all the technologies to be deployed in the Azorean island of Terceira, exploring requirements, challenges and risks linked to with each one, and the several phases foreseen until the full-scale demonstrator starts to operate.

Moreover, this deliverable aims to provide a comprehensive guide to be used by the solution providers during the deployment of their technologies, including indicative timelines, milestones and Progress Indicators (PIs) for each step required.

1.2. Structure of the Deliverable

This deliverable is structured as follows:

- Chapter 2: The UCs, such as presented in deliverable *D2.1,* are summarised, highlighting its goals and key technologies involved in the operation.
- Chapter 3: The different sites to intervene and the technologies are further characterised, adding detail on roadblocks that may arise. Chapter 2 also underlines the technological set-up of each demo site.
- Chapter 4: This chapter starts by explaining the different deployment phases for each site and technology involved. It further deeps the analysis over the roadblocks encountered, for each technology, in each site, and provides possible solutions and risk management actions to avoid them. The chapter also refers what are the responsibilities and roles of the different stakeholders during the deployment period, including when there are challenges to overcome and risk mitigation measures or alternative approaches must be considered.

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- Chapter 5: PIs are proposed to follow-up and measure the success of each deployment phase. These PIs will be helpful for the different stakeholders to know where in the deployment plan a certain technology stands, and how well according to the plan is the deployment happening.
- Chapter 6: The deployment plan is presented. In this chapter, a table is presented containing the in-detail description of the deployment plan for each technology in each site. Furthermore, Gantt diagrams with the proposed timelines are presented, including critical milestones to achieve in each technology deployment, pilot site implementation and UC operationalization.
- Chapter 7: Recommendations are made. This chapters aims at providing recommendations based on the roadblocks, challenges, stakeholders' requirements, and timings identified in the deployment plan.
- Chapter 8: The annexes are provided, adding more detail, and complementing some of the information included in the other sections of the deliverable – e.g., tables and charts.

1.3. Relation to Other Deliverables

This WP relates solely to the lighthouse island of Terceira and aims to prepare demonstrate the several UCs and technologies defined for this island and detailed in *T2.1 – Islands Requirements engineering and use case definitions*.

The present deliverable is included in Task T6.2, under Work Package (WP) 6 - *Deployment, Use Cases Realization and Monitoring at LH#2 (Terceira).* Through D6.4, T6.2 aims at detailing Terceira's deployment plan, and as mentioned includes: the reference timelines; transportation, site deployment and commissioning requirements, according to the demo physical ecosystems and solutions' specifications; relevant stakeholders' engagement, including end-users; and risk management strategy.

Closely related to this deliverable are the reports developed in Task *T6.1 - Technologies Engineering and System Dimensioning (advancement of TRLs)*. The content of deliverable *D6.1 – Initial TRL assessment and development of Terceira technologies roadmaps,* will be important for the characterisation of technologies and identification of possible roadblocks mentioned in chapters 3 and 4. The deliverables *D6.2 – Terceira UCs equipment engineering and laboratorial validation,* and *D6.3 – Terceira UCs preliminary iVPP integration tests,* are also related to D6.4, since they will report on the laboratory tests performed and proper integration required to ensure that all technologies are compliant with the specs, the Technology Readiness Level (TRL) advancements and all the innovative features proposed are matched, and that desirable connectivity and interoperability are fine, providing the needed context to operate the different UCs.

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Finally, T6.2 will provide inputs for Task *T7.1 – Technical and Social Impact Assessment*, where the achievements from the demonstration will be measured and assessed.

In summary, deliverable D6.4 will receive inputs from both T2.1, namely on the UCs definition, and T6.1, namely on the technologies and sites characterisation. This deliverable will also provide inputs for tasks T6.3, T6.4, T6.5 and T7.1.

Figure 1 highlights the relationships described, also pointing to the flux of outputs/inputs expected.

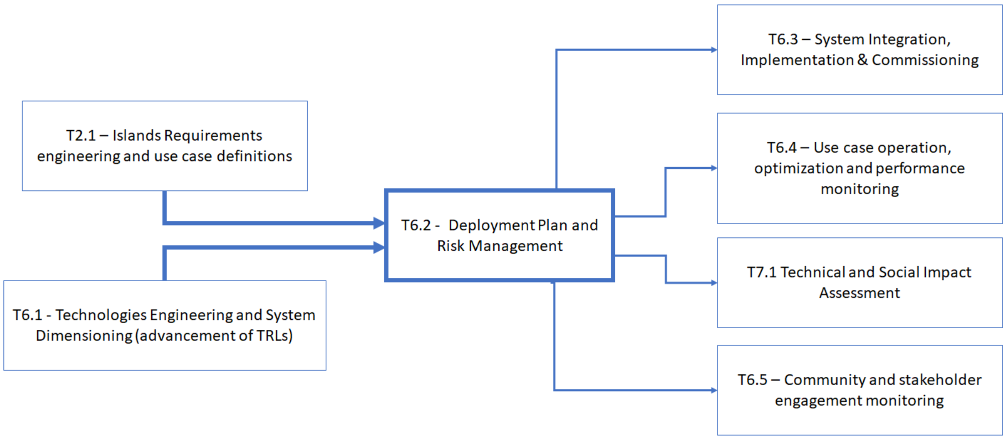

Figure 1 Relation between other tasks and task 6.2.

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2. Terceira's Use Cases Definition

This section summarises the UCs to be addressed in the Terceira lighthouse demonstration and described in *D2.1 – Report on islands requirements engineering and use cases definition*[1], linking its operation with all the preceding deployment stages, providing the context of the deployment plan presented in the following sections.

The UCs demonstrated in IANOS have been divided in 3 Transition Tracks (TT), linked to key technical and application challenges aligned with major stages of islands decarbonisation roadmaps. The proposed TTs are: *TT#1 - Energy efficiency and grid support for extremely high RES penetration; TT#2 - Decarbonization through electrification and support from non-emitting fuels; and TT#3: Empowered Local Energy Communities.*

2.1. Transition Track 1: Energy efficiency and grid support for extremely high RES penetration

2.1.1. Use Case 1: Community demand-side driven self-consumption maximisation

The scope of this UC is to promote the optimal use of behind-the-meter flexible assets, available at residential consumer premises, and maximise self-consumption from Renewable Energy Sources (RES), thereby reducing energy curtailment and increasing system's efficiency. When able to monitor and control their intraday energy use matching it with self-generation, consumers can explore their self-consumption potential and target the minimisation of their costs with imported electricity.

This UC will be demonstrated by a community of users from the same neighbourhood and the optimised management of available flexible assets and Distributed Generation (DG) units will be performed at locally. Main goals are linked to RES-based self-consumption maximisation, overall energy curtailment reduction, and avoidance of grid congestions, ensuring a reliable supply by keeping components within their thermal limits, the system's voltage profile stable.

In Terceira, this UC operation relies on the successful deployment of the following technologies:

[1] This chapter was written using inputs from the new version of D2.1 to be submitted at the same time as the present deliverable in April 2022.

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PV panels with embedded microinverters – BeOn: plug & play solar kits – Photovoltaic (PV) panels with embedded microinverters – to be installed in 40 houses and the community centre in the residential district of *Terra Chã*. They will be used to increase local DG from RES and help maximise self-consumption. The kits can be connected to any electric socket, cutting down on complexity and infrastructure needs. The kit can be constantly monitored by locally implemented Home Energy Management Systems (HEMS) and relevant data, such as the generation output, can be shared with high-level control modules at the intelligent Virtual Power Plant (iVPP).

Heat batteries – Sunamp: Phase-Change Material (PCM) batteries which will be centrally managed. The integrated solution will heat water for domestic use while using surplus PV generation, contributing to maximise the economic and environmental benefit provided by individual self-consumption potential. 24 batteries will be installed in the *Terra Chã* neighbourhood.

Electrochemical batteries: off-the shelf systems, each composed by an electrochemical battery and the battery inverter, will be installed in the premises of 16 customers. Within the scope of this UC the batteries State of Charge (SoC) will be managed, by the HEMS, considering the DG output and the instant load profile, willing to maximise self-consumption.

Electric water heaters – UniNova: Five electric water heating systems will be installed in residential end-users' premises. The use of the appliance's flexibility, provided by non-intrusive monitoring and control technologies, will help to increase self-generated electricity absorption while boosting demand-response for grid-services. A coordinated management of flexible residential systems, such as the electric water heater, and other grid-connected assets will assist system operators tackle local grid constraints.

HEMS – Cleanwatts: the HEMS allow real-time monitoring, management and control of flexible assets and Distributed Energy Resources (DER) within the consumer premises. Data collection and aggregation, that will be shared with the iVPP, will be used to supervise and control flexible assets that can actively contribute to an optimised management of the distribution system. Cleanwatts HEMS will be installed in 20 residential consumers from *Terra Chã* neighbourhood.

Fog Enabled Intelligent Device – Plus (FEID-PLUS) – CERTH: will collect other equipment self-monitoring data and implement energy management strategies involving other home appliances. The FEID-PLUS will also be connected to the iVPP, for data communication and control set-points reception, and will be installed in the other 20 residential buildings, as an alternative to Cleanwatts systems.

intelligent Virtual Power Plant (iVPP) – CERTH: the iVPP will act as an upper-level system's monitoring and control module, optimally managing behind-the-meter assets, such as flexible loads, DG and other DER. Within the scope of UC 1, the iVPP algorithms will use field data to define optimal control targeting self-

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consumption maximisation and grid constraints avoidance/mitigation, while considering users' experience and comfort.

In this UC the iVPP uses real-time data from locally deployed energy management systems and weather forecasts to optimise electricity consumption, considering the flexibility available to match intraday load and DG profiles. Setpoints are then sent to the HEMS at field level, that will coordinate the response of the household ecosystem.

2.1.2. Use Case 2: Community supply-side optimal dispatch and intra-day services provision

This UC points to the use of flexibility from utility-scale supply side-assets and minimise energy curtailment in periods of high RES penetration. For this purpose, the contribution from several distributed energy storage assets is considered, including large-scale Battery Energy Storage Systems (BESS). The storage capacity is mobilised to absorb dispatchable generation, that can be later used in periods when there is high demand, and the RES output is more intermittent. UC's goals look at providing systems' flexibility on the generation side, avoiding grid constraints, and reducing curtailment.

UC 2 implementation will consider grid-connected assets, such as a wind park, a geothermal plant, small scale PV farm, a waste incineration plant and a 15 MW BESS. The iVPP optimisation modules will be fed with information from these assets' operating state, (e.g., large-scale BESS SoC, non-variable geothermal generation, and forecasts on systems aggregated consumption) and will compute dispatch set-points, also considering the intra-day balancing services needed. These set-point suggestions will then be sent to EDA (Terceira DSO – "Electricidade dos Açores") dispatch centre which will use them to manage the grid in a more flexible way.

2.1.3. Use Case 3: Island-wide, any-scale storage utilisation for fast response ancillary services

UC 3 aims at demonstrating the provision of fast ancillary services to the grid, when reliability and safety are compromised and storage systems of any-scale can be mobilised, assisting the operator during required fast-response to critical balancing constraints. These storage systems help balancing the power system by either store energy when there is generation surplus, helping to defer its use, or discharge in periods of high demand, assisting on systems balancing and frequency stabilisation.

Within the context of the demonstration in Terceira, the technologies to be applied to this UC are:

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Flywheel – Teraloop: solution that stores kinetic energy in a spinning mass. The flywheel will be installed in the dairy factory of Pronicol, in Terceira. Pronicol factory is one of the largest electricity consumers in Terceira and their sensitive milk pasteurisation processes are drastically affected by power outages.

UC 3 will also use a 15MW BESS, controlled by the system operator, as well as the distributed electrochemical batteries installed in the residential premises of 16 end-users, and identified in UC 1.

The iVPP will also be proposing a coordinated action from these different storage assets and manage their combined response when providing needed fast ancillary services, namely FFR (Fast Frequency Response) and voltage support. The set-points computed by the iVPP will work as suggestions in order not to interfere with daily asset operation.

2.1.4. Use Case 4: Demand side management and smart grid methods to support power quality and congestion management services

The scope of this UC is the provision of slow ancillary services to the grid using available demand flexibility from distributed resources of the island. Additionally, this UC also aims to demonstrate smart grid management methods with interesting impacts system's stability, such as optimised control of end-user's local generation and storage capacity, regulating active and reactive power injection. This UC targets the activation of crucial resources when the optimal dispatch is not enough to assure an efficient and stable operation of the power system.

Apart from stable operation, other main objectives tackle energy curtailment minimisation, congestions management support, using demand flexibility as a mean to provide slow ancillary services.

The technologies involved in this UC beside the large scale 15MW BESS, are:

Smart Energy Router – UniNova: behind-the-meter inverter based in power electronics building blocks that promote a "smart" management of the energy flows to and from different sources (such as PV Panels, buffer batteries and the grid). The smart energy router will be supplied together with a battery buffer and will be capable of performing phase balance in tree-phase circuits. Moreover, data collection and communication functions will be available, so relevant information can be shared with upper-level management systems, such as the iVPP. Two smart energy router systems will be installed in residential buildings with PV-based self-consumption units in Terceira.

Hybrid Transformer – EFACEC: the transformer will be equipped with a voltage regulation block, capable of performing dynamic stepless voltage regulation at the LV level of the secondary substation. This feature may contribute to power losses minimisation and increase the network's DG hosting capacity, promoting RES penetration at the distribution system.

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The IANOS iVPP performs an optimisation considering the individual contribution of all the above-mentioned assets, targeting improved system's stability and load balancing while minimising RES curtailment.

2.2. Transition Track 2: Decarbonisation through electrification and support from non-emitting fuels

TT 2 comprises three UCs from which only the one dedicated to the decarbonisation of transportation is going to be implemented in Terceira.

2.2.1. Use Case 5: Decarbonisation of transport and the role of electric mobility in stabilising the energy system

This UC focuses on the decarbonisation of the transport sector. In Terceira the decarbonisation process foreseen targets land-based transport, and the installation of Electric Vehicles' (EVs) bidirectional chargers aims to promote electric mobility as a path to the island's decarbonisation, while demonstrating the active role that EVs may assume in systems stability, since their combined load impact is not neglectable but the grid services that can be provided by EVs through Vehicle-to-Grid (V2G) capable charging stations. UC 5 implementation will also comprise the preparation of a roadmap to decarbonise the transport sector, studying the potential of electric chargers, hydrogen taxis, V2G and smart charging schemes, to reach the proposed targets.

The technologies involved in this UC are:

V2G charging stations – EFAEM: two V2G charging stations provided by EFAEM will be installed. One of them will be installed at EDA's headquarters, in Angra do Heroísmo, and the other at the geothermal power plant of Pico Alto.

The V2G charging stations will be connected to the iVPP, which will be able to control their charge/discharge cycles, actively involving these assets in coordinated frequency and voltage regulation processes.

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2.3. Transition Track 3: Empowered local energy communities

TT 3 deals with the active engagement of citizens in project actions and in the overall island's energy transition.

2.3.1. Use Case 9: Active citizen and LEC engagement into decarbonisation transition

The scope of this UC is to promote citizens engagement at the local community level, involving them in the island's energy transition. The maximum reach of the UC refers to the whole island's inhabitants (both permanent and not), while the first target will be just a part of them, directly involved in IANOS activities. Key local stakeholders and IANOS partners will promote a proactive engagement and implement actions aligned with the needs identified within the impacted community, e.g., targeting end-user's empowerment and energy efficiency literacy increase.

In Terceira, a Local Energy Community (LEC) will be simulated. The 40 residential households will serve as participants for a simulated LEC where their assets will be simulated to be used in an aggregated form. This experiment will try to foster local participation of the residents, create awareness for the importance and usefulness of increasing renewable-based DG penetration, and promote a conscient and optimised management and use of distributed resources. It will also result in an improvement in the monitoring and controllability of assets critical to boost the desired transition while putting the beneficiaries, namely end-users and communities, in the centre, as active actors of change.

This UC implementation entails several activities and does not depend on any technical innovation brought by the IANOS technology providers ecosystem.

The abovementioned technologies will be installed, and the mentioned UCs implemented, according to the requirements and following the guidelines provided in the next sections. Comprehensive risk plans and fitted progress indicators, that will also be presented in the next sections, will provide all the information required to successfully deploy the proposed pilot ecosystem and operate the demonstration foreseen.

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3. Technical Characterization of Sites and Technologies

The UCs mentioned in the previous section will be happening in different locations of the Terceira Island. Because the purpose of this document is to provide a practical deployment plan of each technology, the following sections will be divided by each site (location). Section 3 will describe each site and the technologies which will be deployed in it for each UC, giving a better understanding of the practicalities of the UCs.

Apart from the technological clusters deployed at the pilot sites, IANOS entails a higher-level functional layer, implemented through a iVPP platform based on software and hardware components, that will look into all island energy streams and act within multiple timeframes, leveraging from demand-side flexibility aggregation feeding predictive energy management features that will be used to foster ancillary services fitted to deal with congestion management while ensuring balancing and reducing renewable-based generation curtailment.

iVPP core functionalities include: (i) multi-temporal dispatch that considers RES variability, seasonality and storage capacity, when compensating imbalances within various timeframes while aware of uncertainties due to technical constraints such as ramp-up and down times; (ii) flexibility extraction from DSM-based services, supported by efficient variable RES uncertainties' forecasting and based on demand profiling through novel meta-learning; (iii) local-to-global energy assets' management, using edge-to-cloud infrastructure to deliver intelligence at Low Voltage (LV) flexible consumers and prosumers and tackle local-to-regional area supply and demand balancing.

3.1. Pilot Site 1 - Residential Buildings

Pilot site #1 will host UC 1, UC 3 and UC 4, which are more aligned with the LV costumer / LV network perspectives, thus mainly oriented to extract and value flexibility from small-scale flexible consumers and distributed prosumers from the residential segment.

The proposed pilot site targets the secondary substations level, downstream LV feeders, and connected end-users that can actively contribute to system's dynamic management. It includes residential buildings in the parish of *Terra Chã,* as well as other end-users' houses around the Terceira Island.

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3.1.1. *Terra Chã* Residential Buildings

The parish of *Terra Chã*, located in the metropolitan area of *Angra do Heroísmo*, the capital city of *Terceira*, will host the technologies used for UC 1. In a neighbourhood from *Terra Chã*, 40 customers will be engaged in the project activities, and actively involved in the considered UCs implementation and operation. A representative group of end-users is chosen considering technical and social criteria, and after assessing typical load profiles, energy vectors mix involved in the community's day-by-day demand, type of electricity and gas contracts and tariffs, whether if the households are main residencies or not, and the number of inhabitants per household, the 40 end-users' group was considered suitable to host the deployment of some of IANOS key behind-the-meter technologies. Furthermore, clustering criteria were also applied, and now looking into the conditions presented by the neighbourhood's infrastructure, a cluster of households with similar construction, supplied by the same secondary substation and with a common gas distribution network, was considered relevant, since it can mitigate the variability of installation requirements faced, and maximise the impact of local flexibility in upstream networks and components. All the 40 testers selected are powered from the same secondary substation, part of the *RESPA* – *"Rede Elétrica de Serviço Público dos Açores"*, and operated by the local DSO *EDA* – *"Electricidade dos Açores"*. The contracted power at the 40 households is within a range close to 3.45kVA, and the voltage rate is 0.4 kV.

Specific information on each house will be collected during the first technical visits, during the preparation of the installation phase. Examples of relevant information are: possible locations and space available to instal the batteries, area available on the rooftops, for PV panels installation, local Wi-Fi coverage, and existence of other electrical appliances, such as electric water heater. However, since most of this information is not available yet the deployment plan will be periodically updated.

The list of technologies that will be installed at the end-users' premises in *Terra Chã* includes: 40 solar kits – PV panels with embedded microinverters –, 24 heat batteries and 16 electrochemical batteries, 20 HEMS and 20 equivalent solutions provided by FEID-Plus systems.

PV panels with embedded microinverters – BeOn:

Be-on will be updating its microinverters and plug & play solar kit, aligning it with the scope of IANOS UC 1, focused on community demand-side driven self-consumption. Their development plan within IANOS will be based on the following information.

<u>Departing TRL</u>: 6 – technology validated in relevant environment

<u>Targeted TRL, to be achieved within IANOS</u>: 8 – system complete and qualified

<u>Innovative features</u>:

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- BeOn's solar kit is modular, allowing for easily update a PV installation without changing the initial setup.
- Integration of communication and compatibility protocols in the microinverters' firmware and hardware allowing for advanced control.
- An Application Programming Interface (API) will be developed so that relevant monitoring data originated by the microinverter can be shared with upstream supervision and control layers, turning the system into a more grid-friendly DG unit, easily integrated with IANOS iVPP.
- Communication capabilities will be upgraded to provide real time data on energy output, allowing real time Maximum Power Point Tracking (MPPT) adjustments, following grid necessities, batteries SoC and instantaneous load characteristics.

Heat battery – Sunamp:

Highly efficient heat energy storage and processing technology. Uses a PCM which releases or stores energy as it changes its phase.

Departing TRL: 5 – technology validated in relevant environment

Targeted TRL, to be achieved within IANOS: 7 – system prototype demonstration in operational environment

Innovative features:

- Mechanical design upgraded to make it possible to turn the battery into a stackable solution.
- Control interfaces will be adapted to achieve full integration with iVPP.

HEMS – Cleanwatts:

The HEMS from Cleanwatts will allow remote monitoring, manage and control of relevant behind-the-meter assets deployed on-site. This system can integrate different hardware and user interfaces. In IANOS, the HEMS will be developed and deployment according to the following.

Departing TRL:

(Platform), 9 – actual system proven in operational environment

(Interfaces and Integrability), 6 – technology validated in relevant environment

Targeted TRL, to be achieved within IANOS:

(Platform), 9 - actual system proven in operational environment

(Interfaces and Integrability), 8 - system complete and qualified

Innovative features:

- Extended integration with new hardware components will increase the solution's interoperability capacity.

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FEID-Plus – CERTH:

The FEID-Plus from CERTH will communicate with the iVPP receiving control set-points to manage the different storage assets in a flexible way. The FEID-Plus uses cloud and fog-enabled devices which enhance data-processing capabilities.

Departing TRL: 6 – technology validated in relevant environment

Targeted TRL, to be achieved within IANOS: 8 – system complete and qualified

Innovative features:

- Advanced forecasting mechanisms for energy consumption and PV generation using innovative machine learning techniques.
- Integration protocols for communication with iVPP as well as controlling of the storage assets on ground.
- Advancements to the FEID controller, supporting on-the-edge intelligence for on-the-fly decision making along with special control signals.

3.1.2. Electric Water Heaters' Residential Buildings

5 Electric Water Heaters will be used to implement UC 1 and will also be installed in residential buildings. However, the installation locations are not yet closed. The desirable installation conditions and linked requirements were assessed, and the identification of targeted end-users will proceed during the next technical visits to the pilot site.

Electric water heaters – UNINOVA:

UNINOVA's water heater will be used as a load-driven flexibility source. This will be done using non-intrusive sensors and a control module that will enable the water heater to be monitored and managed remotely by the iVPP .

Departing TRL: 4 – technology validated in laboratory

Targeted TRL, to be achieved within IANOS: 7 – system prototype demonstration in operational environment

Innovative features:

- Non-intrusive characterisation of electric water heater state.
- Extension of energy flexibility from water heaters to community-level.
- Multi-objective optimisation targeting flexibility demand and user-experience variables.

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3.1.3. Smart Energy Router's Residential Buildings

UNINOVA is bringing another solution to be installed in residential buildings, 2 Smart Energy Routers. The households receiving the smart energy router should be equipped with RES-based distribution generation units for self-consumption. As for the Electric Water Heater the final locations of the Smart Energy Routers are not yet closed, but the sites' desirable characteristics as well as the installation requirements were identified, and the targeted end-users should be engaged within the next couple of months.

Smart Energy Routers – UNINOVA:

These devices will be responsible for grid-to-grid communication, energy management and integration of multiple generation units within the scope of IANOS. It will receive instructions from the iVPP and control individual assets accordingly. The development of the Smart Energy Routers will happen having in mind the following.

Departing TRL: 5 – technology validated in relevant environment

Targeted TRL, to be achieved within IANOS: 7 – system prototype demonstration in operational environment

Innovative features:

- Enhancement of the digital capabilities, such as communication and interrogability, in terms of services based on control set-points computed by high-level centralised solutions.
- Adaptation of the design for the requirements of geographical islands.
- Development of intelligent algorithms to support energy communities' cooperation mechanisms.
- Enhancement with flexibility algorithms that will consider demand-side-flexibility.

All technologies mentioned above are still being developed and tested, and the specifications of the exact solutions/systems to be deployed should be available during the next months. Additionally, integration/operationalisation requirements should be identified during the specs' analysis, also feeding the testing plans to be prepared and applied during the acceptance phase and pre-pilot validation tests. Main characteristics, installation requirements and constraints imposed by these technologies are also presented in the table in *Annex 1 - Technology Characteristics Relevant during Installation and Integration*.

A comprehensive characterisation of each technology to be deployed, including the innovations and TRL advancements proposed in IANOS is published in *D6.1 – Initial TRL assessment and development of Terceira technologies roadmaps*. In this deliverable we provide a summarised version of the information in D6.1, more aligned with the technological ecosystems that will support the UCs implementation, and the deployment stages, linking innovations' development and key features' testing with field installation, commissioning, and operationalisation.

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3.2. Pilot Site 2 - Pronicol Factory

The flywheel that will be used to implement UC 3 will be installed at a dairy factory operated by Pronicol, one of the biggest electricity consumers in Terceira. The goal is to explore the potential that this technology offers in terms of power quality and reliability improvement, provided by fast inertia response, needed due to the extremely sensitive pasteurization processes that the factory performs daily. With this UC, the flywheel will mitigate the impacts that power outages and reconnections may have in the client's processes and cope with stability and balancing support requests.

The site characteristics of Pronicol's factory are presented in Table 1.

Table 1 Site characteristics of Pronicol Factory.

Type of energy supply contracts (electricity / gas and electricity):	TBD
Type of electrical installations (three-phase / single-phase):	Type B installation, supplied by the RESPA in Medium, High or Extra High Voltage (MV, HV or EHV). Three-phase, 400Vac, 50Hz
Secondary substation number / LV feeder number / CPE, "Código de Ponto de Entrega" / Type of use:	3PT10300000 / TBD / TBD / "Industry"
Contracted power (kVA):	TBD
Rated voltage (kV):	15

Flywheel – Teraloop:

The foreseen solutions, provided by Teraloop, differs from conventional ones since it uses a hub-less outer-rotor design, which greatly reduces radial stress and allows for the full use of the material tensile stress properties, resulting in higher energy density. It is also very scalable what reduces the cost per unit of energy stored. The flywheel controls will need to be adapted and become compatible with the iVPP monitoring and control requirements.

Departing TRL: 6 – technology validated in relevant environment

Targeted TRL, to be achieved within IANOS: 8 – system complete and qualified

Innovative features:

- High-speed testing and operation at a range of 6000-18000 RPM, offering 3kWh of energy storage.
- Adaptation of the control systems to be compatible with the iVPP.
- Usage of a patented and prototyped hub-less outer-rotor design.
- Provision of FFR.

3.3. Pilot Site 3 – *Terra Chã* Substation

In *Terra Chã*, besides the interventions proposed for the residential buildings, also the Medium Voltage / Low Voltage – (MV/LV) secondary substation will be intervened. This secondary substation supplies the

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residential buildings of *Terra Chã* and will be revamped, since its power transformer will be replaced by a new hybrid distribution transformer, which includes an innovative voltage regulation block, a key feature to be tested in the implementation of UC 4.

The most relevant characteristics of the secondary substation are present inTable 2.

Table 2 Characteristics of Terra Chã Substation.

Voltage Level [kV]	15 / 0.42
Transformer rated voltage	15±2x2.5% / 0.42± 12%
Rated current [A]	15.4 / 550
Transformer rated power (kVA):	400
Frequency (Hz):	50
Ucc (%):	4
Number of transformers:	1
Type of ventilation (oil natural/forced, air natural/forced):	ONAN
Type of circuit breaker (vacuum / SF6):	TBD
Neutral earthing system:	DYN5
Cabin dimension – wxhxd (mm), volume (m^3):	3500x6000x2600, 54.60

Hybrid Transformer – EFACEC:

The Hybrid Transformer will be supplied by EFACEC and will be able to perform active and reactive power regulation more dynamically, supporting local stability and improving power quality. Moreover, the voltage regulation mechanism designed will allow stepless phase by phase voltage regulation with power factor control. New windings to the magnetic circuit and an upgraded mechanical layout will also be achieved.

Departing TRL: 5 – technology validated in relevant environment

Targeted TRL, to be achieved within IANOS: 7 – system prototype demonstration in operational environment

Innovative Features:

- Voltage regulation block which, by using power electronics, allows to dynamically perform stepless LV regulation.
- Advanced monitoring and diagnostic functions will be available, allowing transformer's status and condition assessment.

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3.4. Pilot Site 4 - V2G Charging Stations

UC 5 will use EVs and charging stations offering flexibility to the grid, targeting land mobility decarbonisation while studying the smooth integration of EVs and the use of e-mobility driven flexibility to stabilise and balance hosting grids. Two new EV chargers will be installed in different locations, at the geothermal power plant of *Pico Alto*, and at EDA's headquarters, in *Angra do Heroísmo*. Despite this, Table 3 indicates some of both sites' characteristics.

Table 3 Site characteristics for the EV Charging Stations.

Type of electrical installations (three-phase / single-phase):	Type B installation, supplied by the RESPA in Medium, High or Extra High Voltage.
LV feeder number / Type of use:	- (dedicated secondary substation) /"Office/Industry"
Contracted power (kVA):	TBD
Rated voltage (kV):	TBD
Other assets available, e.g., solar PV, solar thermal, ...	TBD
Type of access, EV charging infrastructure (public access / private access):	Private access
Type of use, EV charging infrastructure:	Exclusive private use
Type of parking (street / parking lot with zone dedicated to EVs charging):	Private parking lot
Type of connection to the hosting electrical infrastructure	Connected to a dedicated secondary switchboard
EV charging infrastructure dimensioning:	
Circuit breaker current rating (A):	25 (3P+N)
Rated power (kVA):	15
Demand factor:	1
Neutral earthing system:	TT single ground, rod <1W

V2G Chargers – EFAEM:

Two EV chargers of 12 kWe will be installed in Terceira by EFAEM, who will also be developing the software layers needed for the chargers to support vehicle-to-X functionalities. These chargers will be testing the role of electric mobility in assisting grid stabilisation, allowing the iVPP to adjust the charging patterns in order to cope with instant balancing requirements. To achieve this, several functionalities will be improved during IANOS, such as load balancing between charging stations, voltage regulation, dynamic charging profile and grid frequency regulation.

<u>Departing TRL</u>: 5 – technology validated in relevant environment

<u>Targeted TRL, to be achieved within IANOS</u>: 7 – system prototype demonstration in operational environment

<u>Innovative Features</u>:

- Smart charger with control algorithms for ancillary services and grid support, like dynamic charging profile scheduling, voltage regulation, grid frequency regulation.
- Development of an industrial prototype compliant with all certification requirements.

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4. Roadblocks and Risk Management

This section describes the different risks and possible roadblocks that may impact the deployment of each technology, considering the several phases proposed. A summary of each deployment phase comes first, followed by the identification of the risks linked to each technology deployment, where also the key stakeholders involved are identified, which will be responsible for monitoring and tackling any roadblock encountered. Communication channels between stakeholders and methodologies to be applied will also be described.

4.1. Deployment Phases

During the deployment phase six different phases can be identified for each technology: Development, Lab Testing, Transportation, Installation & Commissioning, Integration and Operation & Monitoring, as represented in Figure 2.

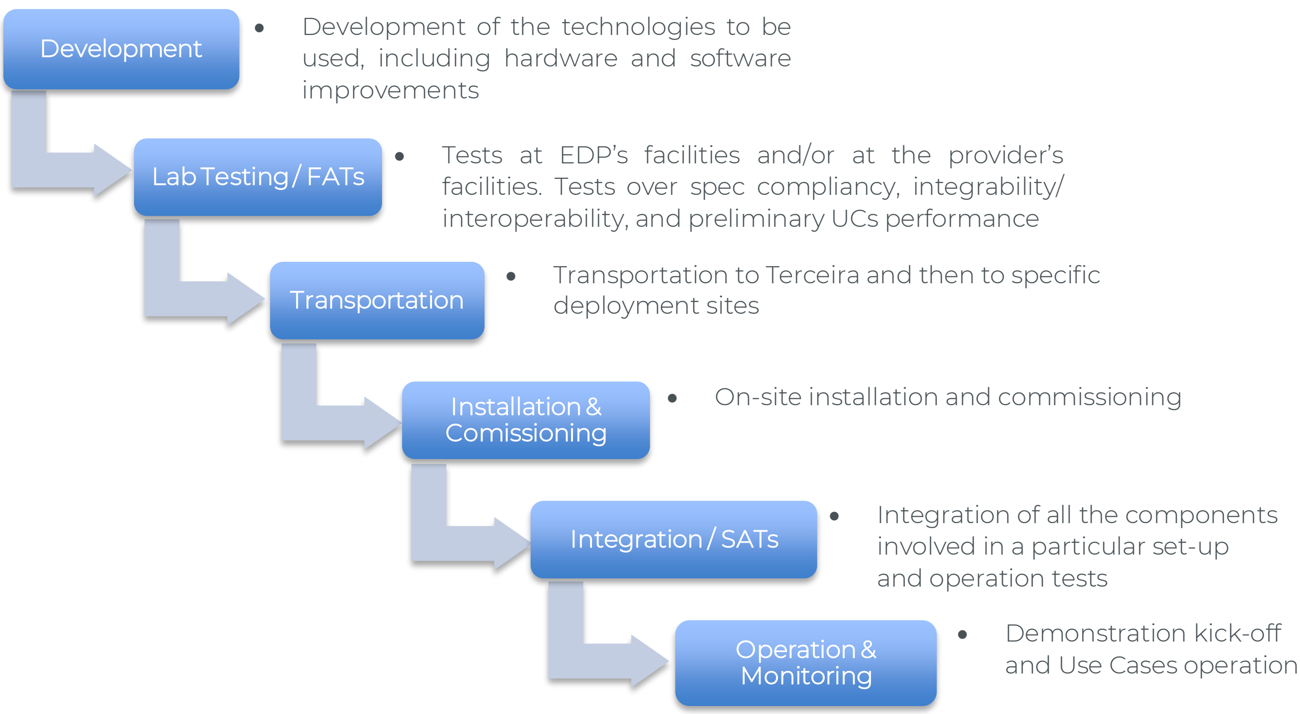

Figure 2 Deployment stages diagram.

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4.2. General Risks

The different stages foreseen will call for technology providers, pilot site owners/managers, and external stakeholders required, e.g., installers, to a close monitoring and assessment of work progress and any emerging risk. If each technology provider is the main responsible during the development and factory acceptance tests phase, after shipment, either to the lab facilities where the preliminary integration tests will be performed or the pilot site, the site manager(s) will start following-up incoming stages, since the lab testing phase will provide valuable insights that must be reported and passed to local stakeholders in charge of site installations. Moreover, the site manager(s)/owner(s) will also mediate the interactions between technology providers, installers, and end-users.

Next the main challenges foreseen for the deployment phase, per technology and transversal to the entire deployment, will be characterised. General risks, transversal to the different stages regardless of the technology, are identified in Table 4. Moreover, suggestions on how to tackle (prevent/mitigate) the different risks are also included. An estimation of the probability and impact linked to the different risks presented is also included, allowing to scan the risk tables and highlight roadblocks than can impact deployment's critical path.

Table 4 General risks related to the deployment stage, related to all technologies to be implemented within IANOS.

Deployment Phases	Risk	Preventive/ Mitigation actions	Probability	Impact
Development	Delays due to raw material/ components shortage.	Acquire material as early as possible Resorting to alternative/new suppliers.	Very High	High
	Delays due to unforeseen requirements or features to cope with and be implemented.	Revisit and assess the relevant UCs where your technology will be used. Get involved in WP4 discussions on ICT architecture, solutions connectivity, interoperability and integrability. Debate with the integrator (Cleanwatts), the site manager (EDP NEW) and the site owner (EDA) the valid alternatives to push forward without impacting project objectives, mainly demonstration goals.	Low	High
Lab Testing	Lab testing failure (spec compliancy, integrability /interoperability, UC performance).	Reassess the Grant Agreement, D2.1 and D6.1 to check for the exact features proposed. Study the pilot environment, described in "LH#2 Pilot Guidebook - Technical characterization of the sites to be intervene in Terceira", that will host your solution and the required local and remote interactions requested from your solution. Assess the possibility of intervening in other units not yet concluded (still in development).	Low	Very High
Transportation	Delays in logistics, shipment preparation and transportation.	Start preparing the shipping process earlier and contact key local partners for help/assistance if needed (EDP Labelec for factory-lab transportation / EDA for factory-pilot site transportation).	Medium	High

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	High cost of transportation, due to worldwide energy crisis.	Assess with transportation companies if planned shipping, booked in advance, can be more affordable than on-time-shipping.	High	Medium
Installation & Commissioning	Delays due to lack of local support (local installers).	Start preparing the installation phase earlier, resorting to the pool of local resources that EDA and EDP are preparing and will make available, and contact the installers to schedule the services in advance (EDA can also support in this process).	Low	High
	Pilot site not ready/prepared to host the installation activities.	Share in advance your installation plan, including timings and required conditions (e.g., equipment, other systems required to connect to, etc) Check the possibility of complying with all installation and commissioning requirements immediately or at least leave everything prepared so other providers can conclude your own commissioning easily. Book or request, to the local partner responsible (EDA), a preliminary visit to the installation site, to check the compliancy of all installation requirements mentioned and the exact installation conditions required.	Low	Very High
	Products installed in demo sites are not certified in Portugal and the local commissions expect a certification.	Obtain a temporary or permanent exemption for the demo sites involved in the project.	Low	Medium
Integration & SAT	Site integration/ preliminary UCs validation not possible due to the absence of a proper environment (e.g., other solutions are missing, or upper monitoring and control systems are not yet available).	Check the possibility of performing the integration tests remotely.	High	Very High
	Communication through APIs and other technology interfaces may not be working.	Coordinate ahead, make sure all communication and integration protocols are compatible and ensure proper interoperability. Preliminary lab-tests will provide valuable inputs on this but reaching-up the main local integrator (Cleanwatts) in advance will certainly help to clarify on any additional implementation needed.	Low	Medium
Operation & Monitoring	Lack of components, breaking down of specific pieces or abnormal behaviour may interfere with project operation and harm the user's normal usage of certain equipments	Have reserve pieces and backups for components which may be easily damaged, and/or quickly prepare ahead for the quick removal of equipment form the users' houses	Medium	High
	Control by the iVPP of grid connected assets may be limited if this equipment is considered key for the grid opertation by the DSO	UC owners, Local integrators and DSO should reassess control possibilities	Medium	High

4.3. Technology Specific Risks

Going through all deployment phases, each technology will be vulnerable to specific risks. These risks, as well as the possible mitigation solutions, are presented next. For each technology, the probability of specific risks to materialise and the measurement of their impact, possibly affecting the UCs performance, are also presented in the tables.

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The iVPP, despite not being physically installed in a particular site, will also go through the previously mentioned deployment phases, and the risks, possible mitigation actions and relevant stakeholders responsible for monitor and act are presented in Table 5.

Table 5 Technology risks and mitigation measures related to each deployment phase of the iVPP.

Technology Name (Provider)	Deployment Phases	Risks Associated	Mitigation Measures	Stakeholder/ Responsible	Probability	Impact
iVPP (CERTH)	Development	Forecasting Engine: Lack of data due to transmission problems may result in delayed development.	Adopt and apply pre-processing techniques such as data imputation.	Impacts: CERTH Solver: CERTH	Low	Medium
		Forecasting Engine: High variability of renewables may lead to inaccuracies.	Contact a local source of accurate weather forecasting.	Impacts: CERTH Solver: EDA	Medium	Medium
		Virtual Energy Console: Human-computer interface may be inadequate due to limitations in programming languages and tools, affecting design and intuitiveness.	Perform tests prior to commissioning and adapt where needed	Impacts: Customers Solver: Cleanwatts	Low	Low
	Lab Testing	-	-	-	-	-
	Transportation	-	-	-	-	-
	Installation & Commissioning	-	-	-	-	-
	Integration & SAT	Virtual Energy Console: Proper interoperability between all assets may not be ensured.	Communicate to each partner and ensure the existence and proper application of communication protocols and APIs.	Impacts: SunAmp, EFACEC, UniNova, Cleanwatts, BeOn, CERTH Solver: Cleanwatts	Low	High
	Operation & Monitoring	Aggregation: Data transmission problems may arise resulting on lack of data.	Adopt and apply pre-processing techniques such as outlier detection and data imputation.	Impacts: CERTH, Cleanwatts Solver: CERTH, Cleanwatts	Low	High
		Aggregation: Data privacy may not be ensured.	Adopt standards and technologies to ensure privacy of users.	Impacts: Customers Solver: ETRA	Very low	Low

4.3.1. Pilot Site 1 - Residential Buildings

As explained in section 2 “Terceira’s Use Cases Definition”, the technologies to be installed in residential buildings are: Solar Kits, Heat Batteries, Electrochemical Batteries, HEMs, FEID-Plus, Electric Water Heaters and Smart Energy Routers. The risks associated to the development, deployment and UC operation using these technologies, as well as the mitigation measures to be applied and the key stakeholders to involve when trying to tackle the risks are presented in Table 6.

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Table 6 Technology risks, mitigation actions and stakeholders related to each deployment phase of each technology to be installed at the residential buildings in the Terra Chã Neighbourhood.

Technology Name (Provider)	Deployment Phases	Risks Associated	Mitigation Measures	Stakeholder/ Responsible	Probability	Impact
PV Panels and MicroInverter Kit (BeON)	Development	-	-	-	-	-
	Lab Testing	Testing by EDP workers needed	Training sessions with BeOn will be performed.	Impacts: EDP, Solver: BeON	High	Medium
	Transportation	-	-	-	-	-
	Installation and Commissioning	Smart Meters needed, resulting in additional costs of 100€/unit	Review where additional smart meters will be needed and which partner may have alternative solutions.	Impacts: EDP Solver: EDP	Low	Low
	Integration & SAT	-	-	-	-	-
	Operation & Monitoring	-	-	-	-	-
Heat Batteries (SunAmp)	Development	New functionalities to be added for iVPP integration may put CE mark at risk	Verify CE mark requirements and adjust accordingly.	Impacts: SunAmp, Solver: SunAmp	Low	Low
		Global shortage of components can lead to a delay in manufacturing and increasing costs of hardware	Relevant partners should decide asap which size will be installed in order to manufacture the solutions according to availability of materials	Impacts: SunAmp, Solver: SunAmp + relevant partner	High	Medium
	Lab Testing	Missing transportation equipment	Read manuals carefully and plan receiving the heat batteries in advance.	Impacts: local installation team, Solver: local installation team	Low	Low
	Transportation	-	-	-		
	Installation and Commissioning	Local installers aren't prepared for installation	SunAmp will provide remote training and support. Installation manual will also be provided.	Impacts: local installation team, Solver: SunAmp	Medium	Medium
		Unforeseen problems during installation	Installer will make videos and photos of the problems and those will be sent to SunAmp. After the analysis done by SunAmp, solutions will be provided.	Impacts: local installation team, Solver: SunAmp	Medium	Low
		Hydraulic compatibility	Identify correct tube diameters and define connection components in advance.	Impacts: local installation team, Solver: Local installation team	Low	Low
	Integration & SAT	2.8 kW resistor is needed and PV is only 1.5kW	There may be the need of getting extra power from the grid.	Impacts: SunAmp, EDA Solver: EDA	Low	Low
	Operation & Monitoring	-	-	-	-	-
Electrochem. Batteries	Transportation	Equipment damage during transportation	Request special packaging, specific for dangerous materials, such as batteries, providing extra protection.	Impacts: local installation team and EDP Solver: EDP	Medium	High
	Installation and Commissioning	Not enough space indoor for the installation of the batteries	Request site visits and reassess installation conditions.	Impacts: local installation team and EDP Solver: EDP	Low	High
	Integration & SAT	Incompatible with HEMS/FEID-Plus gateways	Request help from integrators during the preparation of the tendering process.	Impacts: Cleanwatts, CERTH Solver: EDP	Low	High

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			Test the equipment integrability before pilot deployment.			
	Operation & Monitoring	-	-	-	-	-
HEMS (Cleanwatts)	Development	-	-	-	-	-
	Lab Testing	-	-	-	-	-
	Transportation	-	-	-	-	-
	Installation and Commissioning	Bad Wi-fi communication	Check wi-fi coverage. Additionally, wi-fi signal boosters can be installed.	Impacts: Cleanwatts; Solver: EDA, EDP	High	High
		Smart Plugs not communicating correctly with Cloogy Hub	Investigate solutions and potential obstacles for the Zigbee communications, providing information of the sockets where the Smart Plugs can be installed.	Impacts: Cleanwatts; Solver: EDA, EDP	Medium	High
	Integration & SAT	-	-	-	-	-
	Operation & Monitoring	-	-	-	-	-
FEID-Plus (CERTH)	Development	-	-	-	-	-
	Lab Testing	-	-	-	-	-
	Transportation	-	-	-	-	-
	Installation and Commissioning	Users may be reluctant to install additional equipment	Reach the customers and find common ground, focusing on environmental benefits and cost/energy reduction.	Impacts: CERTH, Solver: EDA, EDP	High	Very High
	Integration & SAT	Bad network connection	Ensure local network conditions.	Impacts: CERTH, Solver: EDA, EDP	High	High
	Operation & Monitoring	Insufficient data	Start collecting data at an early stage and/or implement forecast methods using historical data available.	Impacts: CERTH, Solver: EDA, CERTH	Low	High
		Privacy and data protection may not be guaranteed	Anonymise information delivered to iVPP.	Impacts: CERTH, Solver: CERTH	Very Low	Low
Electric Water Heaters (UniNova)	Development	-	-	-	-	-
	Lab Testing	-	-	-	-	-
	Transportation	Equipment damage during transportation	Acquisition of spare parts for critical elements that must be replaced in Terceira, after the transportation (replacement of damaged parts may introduce delays).	Impacts: UniNova; Solver: UniNova	Medium	High
	Installation and Commissioning	Bad Wi-fi communication	Check Wi-fi signal strength in all houses.	Impacts: UniNova; Solver: EDA, UniNova	High	High
		Space for water heaters and sensors might not be enough in some of the customers' premises	Perform site visits and re assess specific installation conditions.	Impacts: UniNova; Solver: EDA, UniNova	High	Medium
	Integration & SAT	-	-	-	-	-
	Operation & Monitoring	Privacy and data protection may not be guaranteed	Anonymise information collected.	Impacts: users, Solver: UniNova	Very Low	Low
Smart Energy Router (UniNova)	Development	-	-	-	-	-
	Lab Testing	-	-	-	-	-
	Transportation	Equipment damage during transportation	Acquisition of spare parts for critical elements that must be replaced in Terceira, after the transportation (replacement of damaged parts may introduce delays).	Impacts: UniNova, EDA; Solver: EDA, UniNova	Medium	High

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	Installation and Commissioning	Bad Wi-fi communication	Check Wi-fi signal strength in all houses.	Impacts: UniNova, EDA; Solver: EDA, UniNova	High	High
		Space for smart energy routers might not be enough in some of the customers' premises	Perform site visits and re assess specific installation conditions.	Impacts: UniNova, EDA; Solver: EDA, UniNova	Low	High
		Certification and other requirements by DSO may be needed, to establish grid connection	Cooperate with local DSO, possibly install an automatic circuit breaker.	Impacts: UniNova, EDA; Solver: UniNova	Low	Medium
	Integration & SAT	Routers have capacity for up to 5 kW, which may not be enough for large self-consumption capacity	Assess available self-consumption units in advance, if needed, use both smart energy routers in one location.	Impacts: UniNova; Solver: EDA, EDP	Very Low	Low
	Operation & Monitoring	-	-	-	-	-

4.3.2. Pilot Site 2 - Pronicol Factory

In Table 7 the risks linked to the flywheel deployment, the only technology that will be installed at pilot site 2, are identified.

Table 7 Risks at each deployment phase for the Flywheel at Pronicol's Factory.

Technology Name (Provider)	Deployment Phases	Risks Associated	Mitigation Measures	Stakeholder/ Responsible	Probability	Impact
Flywheel (Teraloop)	Development	Lack of funding may delay project implementation	Teraloop broadened the scope of target funding sources.	Impacts: Teraloop; Solver: Teraloop	Medium	Medium
	Lab Testing	Control systems may fail	Elaborate test plans before each flywheel operation event.	Impacts: Teraloop; Solver: Teraloop	Low	High
	Transportation	Heavy and large flywheel may need special transportation means	Contact local transportation companies to ensure proper transportation.	Impacts: Teraloop; Solver: EDA, transportation company	Very High	High
	Installation and Commissioning	Material for handling flywheel may be needed on site (ex. cranes)	Closely interact with local partners and customer to ensure the needed material is available and can be used on site.	Impacts: Teraloop, customer; Solver: EDA, Teraloop	Very High	High
		Construction works may be needed before installing and commissioning the flywheel	Teraloop and EDA should be in contact with Pronicol and verify site characteristics in order to identify this necessity early and contact a local constructor.	Impacts: Teraloop; Solver: Teraloop, local installers	Very High	High
	Integration & SAT	Flywheel data monitoring not compatible with local SCADA system. Risk that manual tuning of drive adjusted to activation profile for the drive be required.	Close monitoring of system's design during technical specification phase. This includes site visit and verification of findings and discussion with local integration service providers, ensuring that appropriate personnel are involved in the commissioning of the device.	Impacts: Teraloop; Solver: Teraloop	Medium	High
	Operation & Monitoring	Temperature and humidity during the summer may require reduced duty cycle of the flywheel.	Prepare for installation of AVAC within the container.	Impacts: Teraloop; Solver: Teraloop	High	Medium

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4.3.3. *Pilot Site 3 – Terra Chã Substation*

At the Secondary Substation powering the targeted neighbourhood in Terra Chã, the Hybrid Transformer will be installed. Table 8 indicates the risks related to each of the transformer's deployment phases.

Table 8 Risks related to each deployment phase of the Hybrid Transformer.

Technology Name (Provider)	Deployment Phases	Risks Associated	Mitigation Measures	Stakeholder/ Responsible	Probability	Impact
Hybrid Transformer (EFACEC)	Development	Development of power transformer, monitoring system and voltage regulation, as described in D6.1, can be delayed due to the complexity of the system	Start development at an early stage taking the proper tests.	Impacts: EFACEC; Solver: EFACEC	Very High	Very High
		Delays due to difficulties in hiring human resources specialized in power electronics may impact the foreseen deadlines and/or make it hard to cope with some of the requirements considered	Contact universities for recruitment. Prioritize the hiring of this type of resource.	Impacts: EFACEC; Solver: EFACEC	Very High	Very High
		Failure to comply with EDA specific requirements	Find a solution to test according to compromise with EDA.	Impacts: EFACEC Solver: EDA, EFACEC, EDP	Medium	High
	Lab Testing	-	-	-	-	-
	Transportation	Risk of damage during maritime transport	Equipment should be packed considering the specific conditions of its transportation.	Impacts: EFACEC; Solver: EFACEC	High	High
	Installation and Commissioning	Certification from local authorities may be missing prior to connecting to the grid	Contact local authorities timely.	Impacts: EFACEC; Solver: EDA	Low	Medium
		Extra space for transformer, bypass cabinet and regulator cabinet needed (1500mm 1700mmx900mm + 650mmx1900mmx350mm + 1000mmx1930mmx560mm)	Obtain the characteristics of the site prior to the installation and review the design of the equipment if needed.	Impacts: EFACEC; Solver: EFACEC, EDA	Very High	High
		Industrial low voltage supply may not be available	Detailed study on necessary changes and equipment at the site.	Impacts: EFACEC; Solver: EFACEC, EDA	High	High
		Improper operation or maintenance of the hybrid transformer voltage regulator	Inclusion of the ByPass cabinet.	Impacts: EDA Solver: EDA, EFACEC	Low	High
	Integration & SAT	Poor quality cellular signal	Use signal amplification equipment.	Impacts: EFACEC; Solver: EFACEC, EDA	Low	Low
		Integration of network assets via SCADA may not allow for enough granularity	Reach a conclusion on the lowest granularity needed/possible and integrate all assets based on this.	Impacts: Cleanwatts; Solver: EDA, Cleanwatts	Low	Medium
	Operation & Monitoring	Operation may fail due to complexity of the system	Surveillance of the operation through EFACEC platform to anticipate possible faults.	Impacts: EFACEC; Solver: EFACEC	High	Very High
		Operation start will be delayed due to development difficulties	Estimate the delays in advance to prevent major impact on the project	Impacts: EFACEC, EDA; Solver: EFACEC	Very High	High

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4.3.4. Pilot Site 4 - V2G Charging Stations

Table 9 presents the risks related to the V2G chargers, to be used in UC 5 implementation.

Table 9 Risks and mitigation actions related to the V2G chargers at each deployment phase

Technology Name (Provider)	Deployment Phases	Risks Associated	Mitigation Measures	Stakeholder/ Responsible	Probability	Impact
V2G Chargers (EFAEM)	Development	One of the chargers may be exposed to harsh climate conditions	Increase protection levels for the specific charger, according to site conditions described by EDA.	Impacts: EFAEM; Solver: EFAEM	High	Very High
	Lab Testing	The V2G chargers will be tested in several laboratories, requiring an EV simulator, prepared for bidirectional power flow	Review and prepare the testing plans and specific testing conditions using a portable EV simulator, compatible with bidirectional power flows.	Impacts: EFAEM, Solver: EFAEM	Medium	Low
	Transportation	-	-	-	-	-
	Installation & Commissioning	Required certification to connect the asset to the distribution grid may not be concluded in time	Review local certification needs timely.	Impacts: EFAEM; Solver: EFAEM	Low	Medium
	Integration & SAT	Communication protocols may not be compatible	Meet with partners (ETRA and Cleanwatts) to ensure compatibility.	Impacts: EFAEM; Cleanwatts, ETRA Solver: EFAEM; CleanWatts, ETRA	Low	Medium
	Operation & Monitoring	Charger exposed to harsh conditions may have early faults	Closely monitor the equipment and consider regular inspections/maintenance actions.	Impacts: EFAEM; Solver: EFAEM	High	Very High

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5. Measuring deployment success

This section includes the definition of metrics proposed to assess deployment accomplishments and measure their impacts. The perspectives of stakeholders involved in site management, local support, work coordination, as well as in technology development and assembly. Thus, the content proposed resulted in a set of PIs targeting individual achievements foreseen for each solution's deployment, as well as PIs aiming to assist in overall pilot implementation monitoring. For each set PIs, either solution provider or site management oriented, an assessment console is provided, dynamically highlighting the progress status trough a graphic interface.

The critical phases for the deployment of each technology are presented next. Regarding the overall evolution of the pilot site operationalisation, the PIs are mainly linked to the general progress in each pilot site, or intervened location. The entities responsible for managing the site and coordinating the work can follow-up the implementation status in each location intervened, monitor possible constraints affecting the UCs operationalisation, and prepare fitted contingency plans, involving key partners working on integrated implementations.

5.1. Solution provider-oriented PIs

The following sets of PIs are linked to the deployment plans established for each technology, based on the critical stages and milestones defined between providers, site owner and/or managers and local representatives, providing installation services and supporting pilot commissioning and operationalisation.

The proposed indicators will guide the solution providers and installers throughout the entire deployment phase, and follow-up the work progress closely, detect constraints and request assistance on any issue critical to the implementation.

5.1.1. PV panels with microinverters – BeOn

☐ Lab testing phase

Is the first phase after the development conclusion. Targets the assessment over solutions' spec compliancy, the validation of all critical features, and the integrability and interoperability tests on

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technologies needed to implement and operate each UC. Accounts for 33,33% of the progress required during the deployment stage. When both, spec compliancy and integrability & interoperability tests are concluded, the lab testing phase is closed, and the deployment progress reaches 33,33%.

☐ Spec compliancy tests [50%]

Spec compliancy tested according to the testing plan and the product datasheet (relevant features to UCs implementation)

☐ Integrability and interoperability tests [100%]

Interoperability/integration with the Enterprise Service Bus

☐ Transportation and deployment phase

Follows the lab testing phase, and includes the shipment, reception, transportation, delivery, and installation at the final location. Also accounts for 33,33% of the progress required during the deployment stage, and when all the steps are concluded the deployment progress reaches 66,66%.

☐ Shipped [33,33%]

☐ Received [66,66%]

At local installer facilities

☐ Moved to pilot site and installed [100%]

Local installer work concluded

☐ Site acceptance and operationalisation phase

This phase concludes the deployment plan of a particular technology. Following the lab testing, transportation and site deployment, the technologies are fully integrated in the pilot ecosystem, site acceptance test are performed, and the relevant UCs are implemented, and can start to operate. When all the UCs involving a particular solution are implemented, the deployment progress reaches 100%, and the pilot operation can start.

☐ Commissioned [50%]

All the 40 systems

☐ Operational [100%]

All the UCs are operational

5.1.2. Heat batteries – Sunamp

☐ Lab testing phase

☐ Spec compliancy tests

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Spec compliancy tested according to the testing plan and the product datasheet (relevant features to UCs implementation)

☐ Integrability and interoperability tests

Interoperability/integration with the Enterprise Service Bus and/or HEMS and FEID-Plus

☐ Transportation and deployment phase

☐ Shipped

☐ Received

At local installer facilities

☐ Moved to pilot site and installed

Local installer work concluded

☐ Site acceptance and operationalisation phase

☐ Commissioned

All the 24 systems

☐ Operational

All the UCs are operational

5.1.3. HEMS (Cloogy) – CleanWatts

☐ Lab testing phase

☐ Spec compliancy tests

Spec compliancy tested according to the testing plan and the product datasheet (relevant features to UCs implementation)

☐ Integrability and interoperability tests

Interoperability/integration with the electrochemical batteries and the iVPP, through the cloud-based server

☐ Transportation and deployment phase

☐ Shipped

☐ Received

At local installer facilities

☐ Moved to pilot site and installed

Local installer work concluded

☐ Site acceptance and operationalisation phase

☐ Commissioned

All the 20 systems

☐ Operational

All the UCs are operational

5.1.4. HEMS (FEID-Plus) – CERTH

☐ Lab testing phase

☐ Spec compliancy tests

Spec compliancy tested according to the testing plan and the product datasheet (relevant features to UCs implementation)

☐ Integrability and interoperability tests

Interoperability/integration with the Enterprise Service Bus

☐ Transportation and deployment phase

☐ Shipped

☐ Received

At local installer facilities

☐ Moved to pilot site and installed

Local installer work concluded

☐ Site acceptance and operationalisation phase

☐ Commissioned

All the 20 systems

☐ Operational

All the UCs are operational

5.1.5. Electric water heaters – UniNova

☐ Lab testing phase

☐ Spec compliancy tests

Spec compliancy tested according to the testing plan and the product datasheet (relevant features to UCs implementation)

☐ Integrability and interoperability tests

Interoperability/integration with the Enterprise Service Bus

☐ Transportation and deployment phase

☐ Shipped

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☐ Received

At local installer facilities

☐ Moved to pilot site and installed

Local installer work concluded

☐ Site acceptance and operationalisation phase

☐ Commissioned

All the 5 systems

☐ Operational

All the UCs are operational

5.1.6. Smart Energy Routers – UniNova

☐ Lab testing phase

☐ Spec compliancy tests

Spec compliancy tested according to the testing plan and the product datasheet (relevant features to UCs implementation)

☐ Integrability and interoperability tests

Interoperability/integration with the Enterprise Service Bus

☐ Transportation and deployment phase

☐ Shipped

☐ Received

At local installer facilities

☐ Moved to pilot site and installed

Local installer work concluded

☐ Site acceptance and operationalisation phase

☐ Commissioned

All the 2 systems

☐ Operational

All the UCs are operational

5.1.7. Flywheel – Teraloop

☐ FATs phase

☐ Integrability and interoperability tests

Interoperability/integration with the Enterprise Service Bus

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☐ Transportation and deployment phase

☐ Shipped

☐ Received

At local installer facilities

☐ Moved to pilot site and installed

Local installer work concluded

☐ Site acceptance and operationalisation phase

☐ Commissioned

☐ Operational

All the UCs are operational

5.1.8. Hybrid Distribution Transformer – EFACEC

☐ FATs phase

☐ Integrability and interoperability tests

Interoperability/integration with the Enterprise Service Bus and the System Operator's Platform

☐ Transportation and deployment phase

☐ Shipped

☐ Received

At local installer facilities

☐ Moved to pilot site and installed

Local installer work concluded

☐ Site acceptance and operationalisation phase

☐ Commissioned

☐ Operational

All the UCs are operational

5.1.9. V2G EV Chargers – EFAEM

☐ Lab testing phase

☐ Spec compliancy tests

Spec compliancy tested according to the testing plan and the product datasheet

☐ Integrability and interoperability tests

Interoperability/integration with the Enterprise Service Bus

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☐ Transportation and deployment phase

☐ Shipped

☐ Received

At local installer facilities

☐ Moved to pilot site and installed

Local installer work concluded

☐ Site acceptance and operationalisation phase

☐ Commissioned

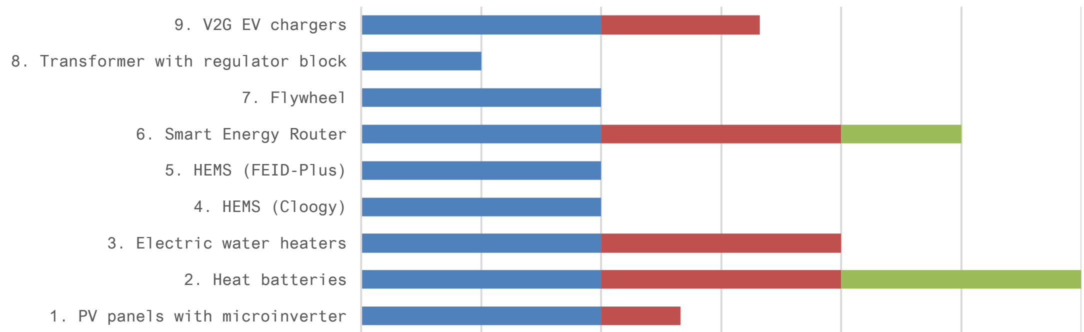
All the 2 systems

☐ Operational

All the UCs are operational

PIs assessment console:

An interactive console to assist on the progress indicators' assessment is proposed next. It is based on the deployment's break down structure presented and introduces an easy way to follow-up the progress achieved, providing a visual perspective on how the different deployment stages are progressing. The chart in Figure 3 aims to illustrate the assessment console's display. As an example, by checking different stages within the deployment of each technology, the progress status is updated, and the execution percentage is provided through by the dedicated interface.



	1. PV panels with microinverter	2. Heat batteries	3. Electric water heaters	4. HEMS (Cloogy)	5. HEMS (FEID-Plus)	6. Smart Energy Router	7. Flywheel	8. Transformer with regulator block	9. V2G EV chargers
Factory/Lab testing	1	1	1	1	1	1	1	0,5	1
Transportation and deployment	0,33	1	1	0	0	1	0	0	0,66
Site acceptance and operationalisation	0	1	0	0	0	0,5	0	0	0

Figure 3 PI assessment console, allowing to follow-up the progress on the deployment of each technology/UC – the data used is not real, and aims only to exemplify the console's interface.

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5.2. Site management-oriented PIs

More oriented to the coordination and management of all pilot sites interventions and prior impactful activities, e.g., development, preliminary acceptance tests and transportation, the following set of PIs targets the general progress on each pilot deployment, helping the site manager to monitor the actions required to ensure solutions' integrability and UCs successful implementation.

The proposed indicators will guide the site manager throughout the entire deployment phase, facilitating the follow-up and the detection of any deviations that may require direct intervention.

5.2.1. Pilot site 1 – Residential Buildings

☐ Testing phase

Accounts for 33,33% of the deployment progress linked to the pilot site implementation. The testing phase is concluded when all the solutions to be integrated in a particular pilot site are tested and ready to be shipped to Terceira.

☐ Lab testing for all the residential equipment [100%]

- ☐ 1. PV panels with microinverters [16,67%]
- ☐ 2. Heat batteries [33,33%]
- ☐ 3. HEMS (Cloogy) [50%]
- ☐ 4. HEMS (FEID-Plus) [66,66%]
- ☐ 5. Electric water heaters [83,33%]
- ☐ 6. Smart Energy Routers [100%]

☐ Transportation and deployment phase

Accounts for 66,66% of the deployment progress and is concluded when all the solutions involved in the pilot site operation are moved into and installed at their final locations.

☐ Shipped [33,33%]

- ☐ 1. PV panels with microinverters [16,67%]
- ☐ 2. Heat batteries [33,33%]
- ☐ 3. HEMS (Cloogy) [50%]
- ☐ 4. HEMS (FEID-Plus) [66,66%]
- ☐ 5. Electric water heaters [83,33%]
- ☐ 6. Smart Energy Routers [100%]

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☐ Received [66,66%]

☐ 1. PV panels with microinverters [16,67%]

☐ 2. Heat batteries [33,33%]

☐ 3. HEMS (Cloogy) [50%]

☐ 4. HEMS (FEID-Plus) [66,66%]

☐ 5. Electric water heaters [83,33%]

☐ 6. Smart Energy Routers [100%]

☐ Moved to pilot site and installed [100%]

☐ 1. PV panels with microinverters [16,67%]

☐ 2. Heat batteries [33,33%]

☐ 3. HEMS (Cloogy) [50%]

☐ 4. HEMS (FEID-Plus) [66,66%]

☐ 5. Electric water heaters [83,33%]

☐ 6. Smart Energy Routers [100%]

☐ Site acceptance and operationalisation phase

Concludes the implementation of the pilot site, i.e., the deployment of all technologies involved in the pilot operation. After site acceptance and operationalisation steps are concluded for all the solutions, the deployment of a pilot site reaches 100%, and the demonstration can start.

☐ Commissioned [50%]

☐☐1. PV panels with microinverters [16,67%]

☐ 2. Heat batteries [33,33%]

☐ 3. HEMS (Cloogy) [50%]

☐ 4. HEMS (FEID-Plus) [66,66%]

☐ 5. Electric water heaters [83,33%]

☐ 6. Smart Energy Routers [100%]

☐ Operational [100%]

☐ UC 1 [33,33%]

☐ UC 3 [66,66%]

☐ UC 4 [100%]

5.2.2. Pilot site 2 – Pronicol Factory

- ☐ Testing phase
  - ☐ FATs for all private large-scale assets
    - ☐ 7. Flywheel
- ☐ Transportation and deployment phase
  - ☐ Shipped
    - ☐ 7. Flywheel
  - ☐ Received
    - ☐ 7. Flywheel
  - ☐ Moved to pilot site and installed
    - ☐ 7. Flywheel
- ☐ Site acceptance and operationalisation phase
  - ☐ Commissioned
    - ☐ 7. Flywheel
  - ☐ Operational
    - ☐ UC 3

5.2.3. Pilot site 3 – Terra Chã Substation

- ☐ Testing phase
- ☐ FATs for all grid assets
  - ☐ 8. Hybrid Transformer
- ☐ Transportation and deployment phase
  - ☐ Shipped
    - ☐ 8. Hybrid Transformer
  - ☐ Received
    - ☐ 8. Hybrid Transformer
  - ☐ Moved to pilot site and installed
    - ☐ 8. Hybrid Transformer
- ☐ Site acceptance and operationalisation phase
  - ☐ Commissioned
    - ☐ 8. Hybrid Transformer

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☐ Operational

☐ UC 4

5.2.4. *Pilot site 4 – V2G Charging Stations*

☐ Testing phase

☐ Lab testing for the equipment

☐ 9. V2G EV chargers

☐ Transportation and deployment phase

☐ Shipped

☐ 9. V2G EV chargers

☐ Received

☐ 9. V2G EV chargers

☐ Moved to pilot site and installed

☐ 9. V2G EV chargers

☒ Site acceptance and operationalisation phase

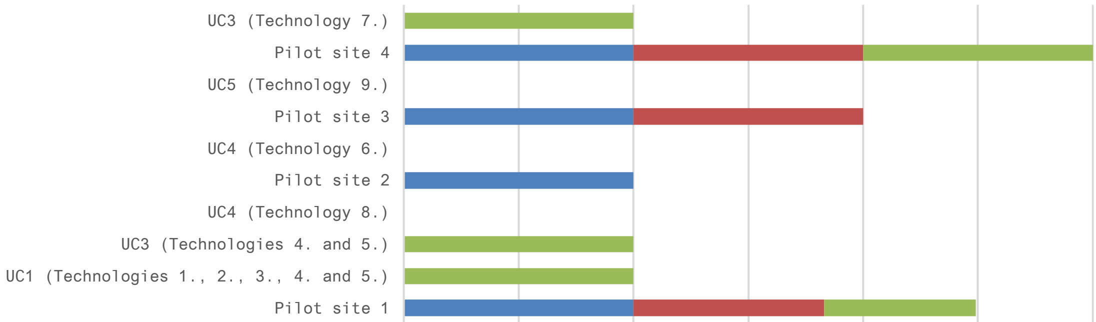
☐ Commissioned

☐ 9. V2G EV chargers

☐ Operational

☐ UC 5

PI assessment console:



	Pilot site 1	UC1 (Technologies 1., 2., 3., 4. and 5.)	UC3 (Technologies 4. and 5.)	UC4 (Technology 8.)	Pilot site 2	UC4 (Technology 6.)	Pilot site 3	UC5 (Technology 9.)	Pilot site 4	UC3 (Technology 7.)
Testing	1	0	0	0	1	0	1	0	1	0
Transportation and deployment	0,83	0	0	0	0	0	1	0	1	0
Site acceptance and operationalisation	0,66	1	1	0	0	0	0	0	1	1

Figure 4 Assessment console for each pilot test site.

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6. Deployment plan

In this section of the deliverable the Deployment Plan is presented, in the form of a Gantt Chart. A Gantt Chart is presented of each one of the technologies proposed for Terceira, as well as a dedicated Gantt Chart for each UCs to be implemented, considering the deployment timelines proposed for a particular set of technologies that composes a UC ecosystem.

Table 10 Expected deployment timeline per technology, including PV Panels, Heat Batteries, Electric Water Heaters, HEMS and FEID-Plus

			2022											
Technology Name	Deployment Phase	Deployment Step	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
PV Panels and MicroInverter Kit (BeON)	Development	Development of API to communicate to iVPP	■	■	■	■	■							
		Enlargement of communication capabilities	■	■										
	Lab Testing	Elaborate the test plan					■							
		Transportation to EDP lab						■						
		SPEC Compliancy tests							■					
		Integrability and interoperability tests							■					
	Transportation	Contact local transporter in Terceira							■					
		Shipped to Terceira								■				
		Received at local installer facilities									■			
	Installation & Commissioning	Preparation and tutorials to local installer team								■				
		Moved to pilot site and installed									■	■		
	Integration & SAT	Commissioning of all 40 systems										■		
		Operationalize all UCs										■	■	
	Operation & Monitoring	Start of operation											●	
Heat Batteries (SunAmp)	Development	Development of basic product	■											
		Integration of MODBUS	■	■	■	■	■	■						
	Lab Testing	Preparation of test plan						■						
		Transportation to testing facilities							■					
		SPEC Compliancy tests							■					
		Integrability and interoperability tests							■					
	Transportation	Shipped to Terceira								■				
		Received at local installer facilities								■				
	Installation & Commissioning	Tutorials for installation team							■	■				
		Moved to pilot site and installed									■	■		
	Integration & SAT	Commissioning of all 24 systems										■		
		Operationalize all UCs										■		
	Operation & Monitoring	Start of Operation											●	
Electric Water Heaters (UniNova)	Development	Solution development	■	■	■	■	■	■						
	Lab Testing	Preparation of testing plan						■						
		Transportation to EDP Lab						■						
		SPEC Compliancy tests							■					
		Integrability and interoperability tests							■					
	Transportation	Shipped to Terceira								■	■			
		Received at local installer facilities									■			
	Installation & Commissioning	Collection of data on users at each house									■			
		Site visits to evaluate the installation premises									■			
		Moved to pilot site and installed										■		
	Integration & SAT	Commissioning of all 5 systems										■		
		Operationalize all UCs										■		
	Operation & Monitoring	Start of operation											●	
HEMS (CleanWatts)	Development	Development of communication through ESB			■	■								
	Lab Testing	Preparation of test plan			■	■								
		Transportation to EDP lab				■								
		SPEC Compliancy tests				■								
		Integrability and interoperability tests					■							
	Transportation	Shipped to Terceira					■							
		Received at local installer facilities					■							
	Installation & Commissioning	Training to installation technicians					■	■						
		Moved to pilot site and installed						■						
	Integration & SAT	Commissioning of all 20 systems						■						
		Operationalize all UCs						■						
	Operation & Monitoring	Start of operation							●					
FEID-Plus (CERTH)	Development	Finalize product Development	■	■	■	■								
		Protocol development					■							
	Lab Testing	Prepare testing plan					■							
		Transportation to EDP lab						■						
		SPEC Compliancy tests							■					
		Integrability and Interoperability tests							■					
	Transportation	Shipped to Terceira								■				
		Received at local installer facilities								■				
	Installation&Commissioning	Moved to pilot site and installed									■			
	Integration & SAT	Commissioning of all 20 systems									■			
		Operationalize all UCs									■			
	Operation & Monitoring	Start of operation										●		

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Table 11 Expected timelines for the deployment of the V2G Chargers, Smart Energy Router, Flywheel

Technology Name	Deployment Phase	Deployment Step	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
V2G Chargers (EFAEM)	Development	Development of standard charger	■	■	■	■								
		Development of charger with added IP protection	■	■	■	■	■	■						
		Development of integration with ESB (ETRA)		■	■	■								
	Lab Testing	Preparation of test plan					■							
		Transportation to EDP lab (std charger)					■							
		SPEC Compliancy tests (std charger)						■	■					
		Integrability and interoperability tests						■	■					
	Transportation	Shipped to Terceira							■					
		Received at local installer facilities							■					
	Installation & Commissioning	Moved to pilot site and installed								■				
	Integration & SAT	Commissioning of all 2 systems								■				
		Operationalize all UCs								■				
	Operation & Monitoring	Start of operation									■ (red)			
Smart Energy Router (UniNova)	Development	Development of solution	■	■	■	■	■	■						
	Lab Testing	Preparation of testing plan						■						
		Transportation to EDP Lab							■					
		SPEC Compliancy tests							■					
		Integrability and interoperability tests							■					
	Transportation	Shipped to Terceira								■				
		Received at local installer facilities								■				
	Installation & Commissioning	Visit installation sites and assess requirements									■			
		Moved to pilot site and installed									■			
	SAT & Operation	Commissioning of all 2 systems									■			
		Operationalize all UCs									■			
	Operation & Monitoring	Start of operation										■ (red)		
Flywheel (Teraloop)	Development	Development of solution	■	■	■	■	■							
	Lab Testing	Integrability and interoperability tests (Finland)				■	■	■	■					
	Transportation	Shipped to Terceira								■				
		Received at local installer facilities								■				
	Installation & Commissioning	Visit to installation site								■				
		Modifications to container									■			
		Moved to pilot site and installed									■			
	Integration & SAT	Commissioning									■			
		Operationalize all UCs									■			
	Operation & Monitoring	Start of operation										■ (red)		

As identified in the risk management tables in Section 4, there is a very high probability that the development of the Hybrid Transformer is delayed due to difficulties in meeting the requirements. This will result in a delay in the timeline of this technology and a delay in the operation start. The hybrid transformer provided by EFACEC will likely see its development delayed until after December 2022 and, thus, the following table is a first estimate and will be updated, along with the risk management tables, when more information is received.

Table 12 Deployment timeline expected for the Hybrid Transformer

			2022												2023				
Technology Name	Deployment Phase	Deployment Step	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Hybrid Transformer (EFACEC)	Development	Development of Power transformer	■	■	■	■	■	■	■	■	■	■	■	■					
		Development of monitoring system	■	■	■	■	■	■	■	■	■	■	■	■					
		Development of voltage regulation block	■	■	■	■	■	■	■	■	■	■	■	■					
	Lab Testing	Factory acceptance tests											■	■	■				
	Transportation	Transportation to Terceira														■			
	Installation & Commissioning	Visit to site to ensure suitability														■			
		Site arrangements						4									■		
		Installation of equipment															■		
	Integration & SAT	Integration with other components															■		
	Operation & Monitoring	Start of operation																■ (red)	

The above presented timelines were built considering the inputs received from the technology providers and aim to reflect their individual expectations at the time of submission of this deliverable.

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Assessing these timelines, it is possible to extract the information required to estimate a timeline for the implementation of each of the UCs proposed, as shown next.

6.1.1. Use Case 1 – Community demand-side driven self-consumption maximization

The technologies used for this UC will be installed at the Pilot Site 1 – Residential Buildings, and include the PV Panels with embedded microinverters, provided by BeOn, the heat batteries from Sunamp, the HEMS from Cleanwatts, the FEID-Plus provided by CERTH, the Electric Water Heaters from Uninova and the Electrochemical Batteries. Considering each technology's deployment timeline, UC 1 implementation timeline is as follows, pointing to **November 2022 as the beginning of the UC operation.**

Table 13 Expected timeline for the deployment of Use Case 1

	2022											
Deployment Phase	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Development	■	■	■	■	■	■						
Lab Testing				■	■	■	■					
Transportation					■	■	■	■	■			
Installation & Commissioning						■	■	■	■	■		
Integration & SAT							■	■	■	■	■	
Operation & Monitoring											■	

6.1.2. Use Case 2 – Community supply-side optimal dispatch and intra-day services provision

In UC 2 island's renewable assets such as the geothermal power plant, wind and solar farms will be integrated within the iVPP operational landscape. These assets will be monitored and the iVPP will consider them when computing optimal operation state for the Terceira's power system. The iVPP is the innovative solution IANOS is adding to this UC, with different software components being developed or upgraded. Entirely relying on non-physical components, the implementation of this UC is only dependent on the development and full integration of the different iVPP modules designed. **Accordingly, the proposed UC timeline points to August 2022 as operation start month.**

6.1.3. Use Case 3 – Island-wide, any-scale storage utilization for fast response ancillary services

UC 3 explores flywheel's added capacity in fast ancillary services provision, using the system to be deployed at Pilot Site 2 – Pronicol Factory. Being the only IANOS physical asset involved in the UC

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implementation, the proposed UC timeline only depends on the flywheel development, testing, transportation, and installation. As shown next, the UC operation start is expected for October 2022.

Table 14 Deployment timeline expected for Use Case 3

	2022											
Deployment Phase	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Development												
Lab Testing												
Transportation												
Installation & Commissioning												
Integration & SAT												
Operation & Monitoring												

6.1.4. Use Case 4 – Demand-side management and smart grid methods to support power quality and congestion management services

In UC 4, the involved technologies are the Smart Energy Router, from UniNova, and the Hybrid Transformer from EFACEC, installed respectively at Pilot Site 1 – Residential Buildings and Pilot Site 3 – *Terra Chã* Substation. These two technologies have very different deployment timelines, due to the expected delays in the Hybrid Transformer development. Moreover, since their operation is not related and their contribution to the UC implementation is independent, it is expected that the UC operation can start as soon as the Smart Energy Routers (2 units) are installed and fully commissioned. The timeline proposed next reflects precisely these two moments, when the UC start operating with the Smart Energy Routers and latter with both technologies contributing. With the early deployment of the Smart Energy Routers, the UC operation can start from October 2022, also involving the Hybrid Transformer in latter stage, in April 2023.

Table 15 Deployment timeline expected for Use Case 4

	2022												2023			
Deployment Phase	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Development																
Lab Testing																
Transportation																
Installation & Commissioning																
Integration & SAT																
Operation & Monitoring																

This UC will be the last one to start its full operation. This delay in relation to the other UCs is due to a delay in the development of the Hybrid Transformer, as mentioned previously in the document. The present timeline will be updated as soon as the final expected timeline for the Hybrid Transformer development is concluded.

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6.1.5. Use Case 5 – Decarbonization of transport and the role of electric mobility in stabilizing the energy system

UC 5 relates to electric mobility and will be demonstrate the capacity of the V2G chargers provided by EFAEM, which should take part in systems balancing and stabilisation. This technology will be installed at Pilot Site 4, and the UC timeline proposed only depends on its deployment, with **September 2022 pointed as the first operation month.**

Table 16 Expected deployment timeline for Use Case 5

	2022											
Deployment Phase	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Development												
Lab Testing												
Transportation												
Installation & Commissioning												
Integration & SAT												
Operation & Monitoring												

Only depending on the installation of the V2G chargers, the timeline for the deployment of UC 5 will be as first estimated.

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7. Conclusions and Recommendations

This document provides a comprehensive guide on the deployment of all technologies to be installed at Terceira for the implementation of the UCs predicted in deliverable *D2.1 Report on Islands requirements engineering and Use Cases definitions*, and the execution of the demonstrations. It also aims to become a useful tool to be used by technology providers as well as site managers to follow-up the deployment.

Section 6, *Deployment Plan,* is the summary of the information gathered, and provides a visual guide through the deployment timelines of IANOS in Terceira, with specific timelines per technology and UC.

Having in mind the several phases identified, all the risks and anticipated challenges are also presented, including preventive/mitigation ideas. In this final section some considerations and recommendations are also provided, mainly highlighting the critical achievements to accomplish, management tips to apply, and follow-up advice.

7.1. Recommendations

During deployment, the most crucial phase will start after the technologies have arrived at Terceira. This is when the installation, commissioning and afterwards UCs' operation can start. It is important that, at this stage, a clear communication path is stablished, together with work coordination and cooperation based on the management strategy suggested, coming from the risk and risk management strategy proposed. To assist on this critical phase, local support from EDA's work force in Terceira will be constantly available. Local installers and equipment/service providers were identified and contacted, aiming to set-up a pool of resources that can be activated and support installation/maintenance/repair. Moreover, site manager (EDP) and main integrator (Cleanwatts), will be available to help tackling and solving any risks that come to pass. Some recommendations on that behalf go as follows:

- Before moving into the pre-installation (preparation) and installation phases, take the preliminary integration tests serious, actively contributing and carefully revising the testing plans meanwhile shared, aiming to frame a full validation of specs, communications and required integrations:

These tests will be performed within restricted/controlled conditions, but already gathering key components in a common test-ring, making it an opportunity to test integrability and interoperability, and perhaps pass relevant knowledge to third parties, in this case the lab team, but that can be used to instruct local installers latter on.

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- When pre-installation (preparation) and installation phases start, promote periodic meetings between technology providers and installation teams will be key to keep communicating and aligning expectation of work quality and progress:

These meetings could start by promoting tutorials on the installation if needed. Later, the meetings would be used to provide the status of the installation and clarify any doubts on how to proceed or tackle unexpected challenges, as well as to promote discussions solutions/mitigation measures to apply.

- When pre-installation (preparation) and installation phases start, consider having local presence, at least for the first days of the work involving a particular technology:

It's important to have physical presence in the installation site, to stablish some guidelines and references on how to address the installation and commissioning, and keep up with the initial work, perhaps having the chance to solve problems that otherwise could scale-up or spread across the installation process. Again, on the local presence, consider to actively involve EDA, or at least make them aware on the work progress, since their experience and proximity to end-users/pilot owners can avoid or quickly solve unexpected roadblocks.

Finally, this report is meant to provide a useful guide for technology providers, site managers and UC owners during the deployment of the project in Terceira island. It is expected that some of the content of this report, such as the PIs and the timelines, will be changed accordingly to the actual deployment of all technologies. For the sake of project follow-up and pilot interventions management, D6.4 can be updated/restated internally, but respecting the basic structure included in this report, to be submitted to the European Commission.

8. Annex

8.1. Annex 1 - Technology Characteristics Relevant during Installation and Integration

Technology	Solar Kits	Heat Batteries	HEMS	FEID-Plus	Electric Water Heaters and controls	Hybrid Transformer	Energy Router	V2G Chargers	Flywheel
Responsible	SunAmp	SunAmp	Cleanwatts	CERTH	UniNova	EFACEC	UniNova	EFAEM	Teraloop
Location	Rooftop	Indoor	Indoor	Indoor	Indoor	Indoor	Outdoor	Outdoor	Outdoor with container
Size [mm]	2m2 per panel 10m2 in total	575x440x365	Gateway: 90x90x33 Smart meter: 39x36x17 Transmitter: 113x75x27, Smart Plugs: 80x80x45	96x72x50	Controls: 300x300x300	Cabin: 3500x6000x2600 Power Transformer: 1500 x 1700 x 900 Regulator Block: 1000x2000x1000 Bypass Cabinet: 650x1950x350 Distance of 100mm from walls	(Space for installation) 1000x1000x1000	740x646x415	Flywheel: 1000x750x533 Cabinets: 2400x2000x800 Flywheel and cooling system: 2000x2000x2000 Power electronics: 2000x1000x2000
Volume [m3]		0.092			Controls: 0.027	Cabin: 54.60 Power Transformer: 2.3 Regulator Block: 1.08 Bypass Cabinet: 0.38	0.030	0.198	Flywheel: 0.400 Cabinets: 3.840 Flywheel and cooling system: 8 Power electronics: 4
Weight [kg]		74			Controls:	Power Transformer: 2000 Regulator Block: 850 Bypass Cabinet: 200	1	60	Flywheel: 1200 Cabinets: 1100
Connectivity and Connections		Power cable to PCB, power cable to heating element	LAN and Wi-Fi	Ethernet	Controls: Wi-Fi	Cell phone signal required	Wi-Fi	GSM Modem / Ethernet	Electrical connection needs 400VAC. Auxiliary systems require 230 VAC and 16 A sockets
Installation Trainings		Yes, training required. Manual and support will be provided	Yes, training required. Will be provided by Cleanwatts	No need. Manual was provided.	Local installers under UniNova supervision	No need, own installation	Local installers under UniNova supervision		

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Installation Needs		15 cm space around and 45 cm above.	Requires a smart phone or laptop for commissioning	5VDC power supply required. Electrician and laptop required	Electrician certified by DGEG and plumber needed. Space around hot-water output (20x20x20mm)	Industrial LV to supply aux systems. Crane truck to lift transformer is required using lifting lugs in the cover 24mm spanner will be needed to place transformer over the wheels	Certified electrician needed	Wall mounted; free space should be considered. Personal Computer	Concrete floor, M24 bolts anchored in the concrete and able to sustain 1500 kg/m2. Primary protection should include 3x250 A main fuses for 100 kW machine
Data Communication		RS-232 data protocol, Modbus under development	API can integrate all platforms	Modbus, Wi-Fi or Bluetooth	API	MODBUS TCP IP (RJ45 plug)	API	-	-
Other		2.8 kW resistor	Cleanwatts app gives access to the user				Three-phase electrical installation and Solar PV required.	Protection cover against collisions should be added	Dry environment with good ventilation needed. Consumption of 4kWh

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