Pilot Quality Assurance Guide

D9.1

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Deliverable

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TWINERGY	**957736**	**Intelligent interconnection of prosumers in positive energy communities with twins of things for digital energy markets**

DELIVERABLE REFERENCE NUMBER AND TITLE

D9.1

Pilot Quality Assurance Guide

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Statement of Originality

This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

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Executive Summary

The main objective of this deliverable is to provide a single point of reference for the pilot quality assurance procedures applied to all internal and external results of the individual pilot sites during the project implementation. In this deliverable, the pilot quality assurance approach is presented and the procedures and tools that the consortium follows for quality assurance reporting are described. The Pilot Quality Assurance Guide is a complementary deliverable which, along with D1.3 "Quality Assurance Plan", D1.5 "Project Management Plan", and D9.2 "General Pilot Management Plan", is intended to be used by all the pilot leaders as a guideline to ensure quality assurance of pilot processes and outputs and to prevent possible deviations from the project work plan. The Pilot Quality Assurance Guide should be updated throughout the project, whenever the aforementioned procedures are modified or the TwinERGY participants agree on including additional information and processes.

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1. Introduction

The main aim of the TwinERGY project is to introduce an innovative energy system aligned with EU regulations that will combine already existing advanced technologies into a new interoperable framework, business models and consumer-centric services to offer a comprehensive solution to empower citizens active participation into the new EU energy market. For this to be achieved, TwinERGY project will consider the involvement of energy consumers' associations, providing substantial knowledge regarding the consumers and the energy market relations, since consumer behavior is considered as the main concept for understanding, managing and accomplishing sustainable energy consumption. In line with all the above, TwinERGY is a "user-oriented" project in which the participation of consumers is important for a successful outcome. In this way, the consortium shows its respect to the European and national legislation regarding privacy and safety issues, as well as its concern about the privacy and safety protection of project participants.

1.1 Deliverable Scope

The purpose of quality assurance is to create confidence that the quality plan and controls work properly. To this end, time and effort need to be devoted to review the original quality plan and justify how quality is being assured during the project pilot implementations. TwinERGY synergy recognizes that pilot partners may follow their own internal policy regarding the quality assessment and assurance of their activities. Nevertheless, due to the project scale and the need to facilitate efficient coordination among the several partners, a pilot quality assurance plan is essential to assure quality in all pilot activities and outcomes. This Pilot Quality Assurance Guide should be used for orientation to ensure success throughout all the pilot lifespans.

The Pilot Quality Assurance Guide is a detailed document describing quality assurance procedures and structures to guarantee sufficiency and efficacy of the pilot outcomes. Being in line with the project and pilot management procedures, as well as the project quality assurance plan, which have already been described in D1.5 "Project Management Plan", D9.2 "General Pilot Management Plan" and D1.3 "Quality Assurance Plan", this deliverable aims to define the pilot quality criteria and verify that all internal and external procedures and outcomes meet specific quality objectives and performance indicators throughout the pilot lifecycle.

The Pilot Quality Assurance Guide describes the way that the pilot activities will be executed from a quality management perspective, ensuring that internal standards, processes, and procedures are defined, and their execution is continuously monitored, corrected, and improved, when necessary. Thus, TwinERGY has created a structured quality assessment system to dismantle the different procedures that will take place during the pilot implementation phases.

1.2 Deliverable Structure

The structure of this deliverable consists of the following chapters:

- Chapter 1 is the introductory section of the deliverable which presents the purpose, the structure, the reference documents and the abbreviation list.
- Chapter 2 presents briefly general information about the pilots and its identifying and unique characteristics.
- Chapter 3 describes the quality assurance objectives and the quality assurance planning and control phases while further explaining the Quality Assurance Officers role and responsibilities.
- Chapter 4 presents the Key Performance Indicators that have been established during the quality assurance planning phase for each individual pilot site.
- Chapter 5 explains the procedures that aim to assure high-quality results including quality assurance assessment report preparation software and hardware development and event planning. It also describes the processes of assessing the pre-defined KPIs and metrics.
- The final section of the deliverable contains the Annexes of the Pilot Quality Assurance Guide.

1.3 Reference Documents

This document is based on the following reference documents:

- TwinERGY Grant Agreement no.957736
- TwinERGY Consortium Agreement
- D1.3 Quality Assurance Plan
- D1.5 Project Management Plan
- D9.2 General Pilot Management Plan

1.4 Abbreviation List

Table 1. Abbreviation list

Acronym	Full Name
H2020	Horizon 2020
QA	Quality Assurance
PQAO	Pilot Quality Assurance Officer
PQAAR	Pilot Quality Assurance Assessment Report
HQA	Hardware Quality Assurance
SQA	Software Quality Assurance
HRS	Hardware Requirement Specifications
RES	Renewable Energy Sources

2. Pilot General Information

This section presents a summary of the TwinERGY pilots, briefly referring to the pilot site characteristics and intended activities with a focus on pilot-specific hardware and software components that are to be deployed. More detailed information about each pilot site can be found in D9.2 “General Pilot Management Plan”.

2.1 Athens Pilot

The Greek Pilot will involve a group of residential buildings belonging to the clientele of Mytilineos (counting over 280,000 consumers), used for experimental testing of new solutions and located in Athens, Greece. Charging stations located in the broader area of Athen’s Municipality will also be part of the Greek Pilot Site.

The distribution of electricity is operated by HEDNO (Hellenic Electricity Distribution Network Operator). The energy supply contract is negotiated between the customer and Protergia, which is the energy unit of Mytilineos. None of the houses, that will be participating in the Project, have installed photovoltaic system. The residential buildings will have several measuring devices installed regarding energy and ambient conditions. Smart meters will be capable of measuring the energy usage. Smart plugs will enable the control of electric home appliances to optimize their time of operation. All these measures are implemented with the overall goal of maximizing energy efficiency of the participants and their smooth transition into eco and energy friendlier decisions.

2.2 Steinheim Pilot

The German Pilot is represented by the village of Hagedorn, which is part of the city of Steinheim. It consists of 38 houses with 103 inhabitants. All these inhabitants are potential pilot participants and are included into the pilot activities through various participation levels, as defined in D9.2 “General Pilot Management Plan”. Since Hagedorn has a very high potential of photovoltaic production already available, it is intended to integrate an electric battery storage on a community level, to maximize the use of the renewable energy sources (RES) production of the village without feeding it back to the public grid outside of Hagedorn. Additionally, an electric vehicle with bidirectional charging capabilities will be deployed to expand the overall energy storage capabilities further. The vehicle will also be made available to the pilot participants for car-sharing in daily use. Within individual households, different measuring and switching devices will be installed depending on the selected participation levels. Smart meters will be capable of measuring the energy usage as well as RES production, if available. Smart plugs will enable the control of electric home appliances to optimize their time of operation. A "signal light" will indicate to consumers when and how they can optimally adapt their consumption levels for individual and community-wide benefits. All these measures are implemented with the overall goal of maximizing the usage of RES produced energy at the pilot site. Furthermore, a form of dynamic energy tariff will be assessed with regards to behavioral change and money savings for the participants.

2.3 Benetutti Pilot

Benetutti is a municipality in the Province of Sassari in the Italian region Sardinia. With an area of 98 km2, Benetutti has a population of 2000 people with a yearly energy consumption of 3.700.000 kWh. The Ministry of Productive Activities has granted the Municipality of Benetutti the concession for the distribution of electricity on medium and low voltage power distribution networks for delivery to final customers. Through TwinERGY, the pilot will exploit the various devices already installed in the demo-site, which will involve a group of 20 buildings both residential and public. Within the project, it will be able to monitor real time power loads, RES generation and grid's storage capacity of the whole community and control them utilizing demand response programs, aiming to reduce consumption during the peak hours while increase it during low energy cost periods and to improve predictability of consumption and consumer behavior patterns. The 20 buildings involved refer to a total of 3 different Secondary Substations. Almost all of the buildings have a PV plant system installed.

Within individual households, they already have installed monitoring devices for the total energy demand and for the PV plant production. Even if the current monitoring system is not available for real-time monitoring, the devices can be useful to archive historical data. In order to reach real-time or close to real-time monitoring, different measuring and switching devices will be further installed in almost all facilities. Smart meters will be capable of measuring the energy usage at different energy aggregation level (floor/room/power line) as well as RES production, if available. Smart plugs will monitor and enable the control of electric home appliances to optimize their time of operation.

Similarly, to the German pilot, a "signal light" will indicate to consumers when and how they can optimally adapt their consumption levels for individual and community-wide benefits. The overall goal is to significantly increase the self-consumption maximizing the usage of RES produced energy at building and local district level. Furthermore, a form of dynamic energy tariffs will be assessed with regard to behavioral change and money savings for the participants.

2.4 Bristol Pilot

The focus of activity in the Bristol Pilot is to identify 12 households that have existing Solar PV installed and to increase the onsite usage of the generated energy. This will be achieved through adding in devices and hardware for energy storage (batteries), smart plugs and time appliances to work when grid intensity is low. Energy usage optimisation will take place in each home to manage the batteries and smart plugs in a way that saves money for households and carbon for the environment by ensuring they are charged and discharged at optimal times. The trial will involve a business case assessment to ascertain if these optimising technologies could be scaled up in a cost-effective programme across the city council's social housing portfolio. Each of the homes will have a digital twin undertaken alongside a local community building and a University of Bristol building.

3. Pilot Quality Assurance Plan

The Quality Assurance process is a significant ingredient of the Pilot Management as it can deliver a solid ground for the qualitative implementation of pilot activities, ensuring that they satisfy the TwinERGY high standard requirements and fully achieve its objectives. Quality assurance evaluates the pilot performance and develops recommendations in response. In this direction, a set of activities need to be planned and compiled from the beginning of the project to achieve the desirable quality. At the same time, the operational techniques and activities that will be used to fulfil quality assurance requirements need to be presented. The procedures mentioned above constitute the quality planning and quality control respectively. In TwinERGY, quality planning and quality control are considered as requisites to achieve quality assurance. Hence, Quality Assurance will be determined by defining the objectives and implementing the quality planning and control procedures across pilot related activities, as analyzed in the next sections of this deliverable.

3.1 Quality Assurance Objectives

The main objectives of the Quality Assurance (QA) process, coupled with respective actions, are to:

- Appoint Quality Assurance Officers who can provide clear vision and direction on the pilot activities by establishing and monitoring quality assurance procedures.
- Let all policies and procedures be properly documented and regularly reviewed for pilot progress assessment.
- Establish internal action plans with measurable outcomes (KPIs and metrics) to verify and control the pilot quality.
- Use effective communication networks to keep all TwinERGY partners informed.
- Actively participate in the review process, both internal and external, to drive and promote continual improvement.
- Identify potential deviations at their early stages and feed the information to the Consortium to initiate remedial actions as soon as possible (if necessary).

For these objectives to be achieved, a detailed planning scheme needs to be developed along with certain control procedures for monitoring and evaluating the pilot outcomes.

3.2 Quality Assurance Planning and Control

Quality Assurance is fundamental for all pilot implementation phases and should be implemented by all partners while working on their tasks. This includes:

- Maintain conformity in work methods throughout the pilot activities, in accordance with established policies, procedures, regulations and codes of practice that are analyzed in the Consortium Agreement and in the deliverable D9.2 "General Pilot Management Plan".
- Ensure that all policies, procedures, relevant regulations, and codes of practice are effective and properly adjusted to the pilot's needs.
- Regularly monitor and measure the quality of methods and expected outputs to ensure high quality standards, best value, and continuous improvement.

The purpose of the quality planning and control is to provide a sound basis for:

- The agreement among partners on quality expectations in achieving a satisfactory quality level of key pilot deliverables and processes,
- The provision of information so that all project partners have a common understanding of the pilot objectives and the means to achieve them,
- The quality control of the deliverables and processes so that they best serve their purpose.

In TwinERGY pilots, quality planning is about defining the expected outcomes of the synergy (objectives and milestones) as well as the respective quality criteria, responsibilities, and assessment methods followed by the partners involved. Quality planning is reflected in this document as it specifies quality procedures on the topics that have been identified as most important for this pilot implementation and have not been fully described yet in previous deliverables of WP9 "Pilots".

At the same time, TwinERGY pilots introduce quality control procedures and mechanisms to ensure that the pilot outcomes adhere to a defined set of quality criteria, which had been established during the quality planning phase. "Quality control" is defined as the operational techniques, procedures and objectives that are used to fulfil the requirements of quality. Quality control entails the use of metrics and the constant testing of pilot outcomes to determine if they fit to the predefined criteria and specifications.

In this document, for each of the aforementioned topics, quality goals are set and the processes to control and assure goal accomplishment are defined. More specifically, as part of the quality assurance planning, Pilot Quality Assurance Officers have produced a set of Key Performance Indicators (KPIs) to support high quality outcomes. These KPIs are used as a means of implementing quality planning in relation to processes, roles and responsibilities that have been reported in previous deliverables. Using the KPIs and their metrics as quality control mechanisms in conjunction with the quality assurance procedures described in section 5 of this deliverable, the mapping of quality assurance can be achieved.

3.3 Quality Assurance Officers

One of the main aims of the Pilot Management effort is to design the quality assurance procedures and structures that will ensure that the pilot satisfies its requirements and achieves its full objectives. To this end, the project consortium needs to be deeply committed on assuring high quality results through the continuous monitoring and assessment of the pilot planned activities and outcomes, meaning that quality assurance should rely on the joint contribution of all pilot participants and project partners at all levels. Within the collective effort, the Pilot Quality Assurance Officer(s) will hold the global responsibility for Quality Assurance and Quality Control of the pilot outcomes.

The Pilot Quality Assurance Officers (PQAO) act at the pilot level and are responsible for assessing the predefined quality Key Performance Indicators, applying the Quality Assurance standards (set in this deliverable and in D9.2 "General Pilot Management Plan"), and proposing preventive or corrective measures for mitigating quality related risks, in collaboration with the Project Coordinator. The PQAO scheme may be strengthened throughout the pilot implementation and based on the arising needs of the TwinERGY project. The roles of the PQAOs have been attributed to project members as follows.

Table 2 Overview of Pilot Quality Assurance Officers

Pilot Location	PQAO	Contact Information
Athens	Vavouris Alexander	Email: Alexandros.Vavouris@mytilineos.gr Tel: +30 2103448521
Steinheim	Prof. Dr. Johannes Üpping	Email: johannes.uepping@th-owl.de Tel: +4952617025878
Benetutti	Luigi Sechi Rosolino Sini	Email: l.sechi@stamtech.com Tel: +39 3756473822

		Email: lillinosini@gmail.com
Bristol	Dr. Daniel Scien	Email: Daniel.Schien@bristol.ac.uk Tel: +44 117 331 5369

3.3.1 Athens Pilot Quality Assurance Officers

The role of the PQAO for the Greek Pilot in Athens has been attributed to Vavouris Alexander (Mytilineos).

3.3.2 Steinheim Pilot Quality Assurance Officers

The role of the PQAO for the German Pilot in Hagedorn has been attributed to Prof. Dr. Johannes Üpping (THOWL).

3.3.3 Benetutti Pilot Quality Assurance Officers

The role of the PQAO for the Italian Pilot in Benetutti has been attributed to Luigi Sechi (STAM) and to Rosolino Sini (Benetutti).

3.3.4 Bristol Pilot Quality Assurance Officers

The role of the PQAO for the UK Pilot in Bristol has been attributed to Dr. Daniel Schien (UNIVBRIS).

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4. Quality Assurance Key Performance Indicators

The following Key Performance Indicators (KPIs) will be used in Pilot-related actions to guarantee the optimum quality of the pilot outcomes. KPIs can assist in spotting inefficiencies within different pilot processes by tracking certain metrics. The selected KPIs indicate how efficiently pilot operations have been performing and ensure that any arising issue can be quickly and positively fixed, affecting likewise the pilot implementation. The KPIs will be used as an instrument for the internal quality assessment of various pilot procedures conducted by Pilot Quality Assurance Officers. Any noteworthy issue arising from the quality assessment or quality control implementation will be promptly notified to all relevant partners and pilot participants.

4.1 Athens KPIs

KPI 1

Description: Demand flexibility including EV loads

Metric 1. Reduction of peak load at point of common coupling per household / per EV charger.

Metric 2. Identifying the number and rate of home appliances whose operation is adapted according to the demand response signals.

Metric 3. Average Energy Demand Reduction quantifying the average energy demand reduction achieved through the deployment of various interventions. Interventions are associated to the several services deployed during the roll-out activities; therefore, this KPI needs to be linked to each of those interventions.

Metric 4. Annual CO_2 Emissions Reduction, quantifying the annual CO_2 emissions reduction per pilot, achieved once the roll-out activities have finished.

KPI 2

Description: Penetration of dynamic energy tariffs.

Metric 1. Identifying how many households are willing to invest in dynamic energy tariffs.

Metric 2. Identifying performance of dynamic energy tariffs regarding how much money households can save and how flexible these tariffs would have to be to provide actual benefits. Cost reduction is to be measured.

KPI 3

Description: Participant's responsiveness.
Metric 1. Documenting the active participation rate and acceptance through user engagement activities.
Metric 2. Identifying participants satisfaction through periodic surveys and feedback channels.
Metric 3. Pilot's dropout rate: Number of participants who decided to leave the experiment / Original sample size at the beginning of the pilot's rollout.

KPI 4
Description: Participant's Comfort/Well-being
Metric 1. Operative Temperature: Temperature/Humidity sensors available in pilot's residences will help to calculate Indoor Operative Temperature per Humidity level and Outdoor Temperature Conditions.
Metric 2. Operative Illuminance: Luminance sensors available in pilot's residences will help calculate indoor illuminance level. Considering that outdoor conditions affect the perceived level of luminance, the analysis is distinguished at daytime and night hours.

4.2 Steinheim KPIs

KPI 1
Description: Renewable energy sources (RES) share in energy consumption.
Metric 1. Increases or decreases of RES share measured with smart meters are documented. Indicating the share of emissions free energy used by individual households and on a community-wide level.

KPI 2
Description: Demand flexibility.
Metric 1. Reduction of peak load at grid nodes. Fluctuations in load levels at transformer stations are measured and documented.
Metric 2. Identifying number and rate of home appliances whose operation is adapted according to the demand response signals.
Metric 3. Calculation of a flexibility pool, providing information about the current power consumption or surplus by the battery storage and EV charging station.

KPI 3
Description: Self-consumption ratio.

Metric 1. On a household level, the RES share is measured and documented multiple times a day. Providing information about additional potentials of RES resources.

Metric 2. On a community level, the state of charge for the battery storage is measured and documented multiple times a day. Providing information about additional potentials of RES resources.

Metric 3. Frequency of bidirectional charging of EV by feeding energy into the grid.

Metric 4. On a community level, the periods of time with local surplus related to times with demand, measured from transformer station power levels.

KPI 4

Description: Penetration of dynamic energy tariffs.

Metric 1. Identifying how many households are willing to invest in dynamic energy tariffs.

Metric 2. Identifying performance of dynamic energy tariffs regarding how much money households can save and how flexible these tariffs would have to be to provide actual benefits.

Metric 3. Identifying availability of dynamic energy tariffs in the real world and their obstruction due to regulatory barriers.

KPI 5

Description: Participant's responsiveness.

Metric 1. Documenting the active participation rate and acceptance through user engagement activities.

Metric 2. Identifying participants satisfaction through periodic surveys and feedback channels.

Metric 3. Frequency of EV usage by pilot participants.

4.3 Benetutti KPIs

KPI 1

Description: Renewable energy sources (RES) share in energy consumption.

Metric 1. Increases or decreases of RES share measured with smart meters are documented. Indicating the share of emissions free energy used by individual households and on a community-wide level.

KPI 2

Description: Demand flexibility

Metric 1. Reduction of peak load at point of common coupling per household. Fluctuations in load levels at transformer stations are measured and documented.

Metric 2. Identifying number and rate of home appliances whose operation is adapted according to the demand response signals.

Metric 3. Energy Demand Reduction quantifying the deployment of various interventions. The interventions are associated to the several services deployed during the roll-out activities, Demand Response actions and energy efficiency interventions.

Metric 4. Energy Demand Reduction related to discomfort. Identification of the optimal rate between energy savings and acceptable discomfort and the relation with the money savings.

KPI 3

Description: Self-consumption ratio.

Metric 1. On a household level, the RES energy generation is measured, recorded and documented. Therefore, it is possible to evaluate the facilities self-consumption, providing information about additional potentials of RES resources.

Metric 2. On a community level, energy demand in the Secondary Substation (MT/bt transformer station) is measured and documented. Providing information about additional potentials of RES resources in the power grid branch.

Metric 3. On a community level, local RES surplus in the Secondary Substation (MT/bt transformer station) is measured and documented. Providing information about additional potentials of RES resources in the power grid branch.

Metric 4. Annual CO_2 Emissions Reduction, quantifying the annual CO2 emissions reduction per pilot, achieved once the roll out activities have finished.

KPI 4

Description: Penetration of dynamic energy tariffs.

Metric 1. Identifying how many households are willing to invest in dynamic energy tariffs at the end of the project.

Metric 2. Identifying performance of dynamic energy tariffs regarding how much money households can save and how flexible these tariffs would have to be to provide actual benefits. Cost reduction is to be measured.

Metric 3. Identifying availability of dynamic energy tariffs in the real world and their obstruction due to regulatory barriers.

KPI 5

Description: Participant's responsiveness.

Metric 1. Documenting the active participation rate and acceptance through user engagement activities.

Metric 2. Identifying participants satisfaction through periodic surveys and feedback channels.

Metric 3. Pilot's DR programs dropout rate: Number of participants who decided to leave the experiment / Original sample size at the beginning of the pilot's rollout.

KPI 6

Description: Participant's Comfort/Well-being

Metric 1. Operative Temperature: Temperature/ Humidity sensors available in pilot's residences, will help calculate Indoor Operative Temperature per Humidity level and Outdoor Temperature Conditions.

Metric 2. Operative Wellbeing: Luminance and Acoustic pressure sensors available in pilot's residences, will help calculate indoor illuminance and the noise level. Considering that outdoor conditions affect the perceived level of luminance, the analysis is distinguished at daytime and night hours.

Metric 3. Pilot's dropout rate related to discomfort: Number of participants who decided to leave the experiment / Original sample size at the beginning of the pilot's rollout.

Metric 4. Positive vs negative users' comfort feedback – Rate of negative feedback reported related to energy efficiency solutions.

4.4 Bristol KPIs

KPI 1

Description: Households have a better understanding and engagement around their home energy management.

Metric 1. Active participation rate through user engagement and acceptance; measures the number of users actively participating in the pilots in relation with the total sample that accepted participating: at least 11 should be active out of 12 formally participating homes.

Metric 2. Number of households receiving analysis about the impact of a dynamic price tariff on their household bills and carbon footprint: all 12 participating households.

Metric 3. Number of households self-reporting a greater understanding of energy management in their home: ideally all 12 participants.

KPI 2

Description: Residents maximize self-consumption and self-sufficiency.
Metric 1. Households achieve a self-consumption ratio 42-60%.
Metric 2. The largest daily power consumption value is reduced by 25%.

KPI 3

Description: Participants feel confident in how the project is using their data and for what purpose.
Metric 1. Customer satisfaction of the project overall 9/10.

KPI 4

Description: Residents participate in demand response programs / smart energy tariffs to minimize energy costs and support grid balancing.
Metric 1. Customer responsiveness: measures how many customers have responded to a DR program following a DR signal sent to them, like a change in price, as the total number of signals sent back by the customers. as an absolute number or a percentage. 11 of 12 homes of participants to have responded.
Metric 2. Demand Flexibility; measures at each pilot the increase of the amount of load capacity participating in demand side management 10%.
Metric 3. Percentage of households agree or strongly agree that they would consider switching to a dynamic price tariff if it was shown to be beneficial.

KPI 5

Description: Changed energy behavior to more sustainable patterns.
Metric 1. Number of households who have self-reported to have changed their behaviors around energy usage in their household 12.

5. Quality Assurance Procedures

The European Commission has set as a requirement that all funded projects should plan quality management processes to simplify the consultation process within the project partnership and assist the Project Coordinator in quantifying results and relating them to the project objectives. While there is already a set of Quality Assurance procedures defined for the overall project management in D1.3 "Quality Assurance Plan", in this deliverable a pilot-specific set of Quality Assurance procedures is established that shall be implemented in the Pilot execution process and monitored and evaluated by the Pilot Quality Assurance Officers.

5.1 Pilot Quality Assessment Procedures and Reporting

In the context of quality assessment of pilot operations and processes, an important function is the identification of areas of nonconformity using the pre-defined Key Performance Indicators (Chapter 4 of the present deliverable). If nonconformities are identified, they should be documented by the Pilot Quality Assurance Officers in the appropriate form (Annex 1), where all recommended corrective actions to be applied should be also described and uploaded to the project document repository.

Proposals on corrective actions should be suggested by the Pilot Quality Assurance Officers and be approved by the Pilot Leaders. After the approval is acquired, the Pilot Quality Assurance Officers should contact all involved partners, deliver the Pilot Quality Assurance Assessment Report on their task, and inform them about the recommended corrective measures to be taken.

Corrective actions should ensure:

- Effective handling of all complaints
- Reporting of nonconformities
- Investigation of the causes of nonconformities with reference to the quality system
- Recording the results of the investigation
- Determining the preventive/corrective actions intended to eliminate the causes of the nonconformity
- Application of control tools for effective implementation of corrective actions
- Information communication with the Partners on actions taken and results accomplished

5.2 Software Quality Assurance Procedures

For the Software Quality Assurance (SQA) procedures, please refer to section 5.2 in D1.3 "Quality Assurance Plan". The procedures specified in that deliverable are also valid for pilot-specific software developments and implementations.

5.3 Hardware Quality Assurance Procedures

The Hardware Quality Assurance (HQA) process will respect and act supplementarily to the individual Quality Control and Assurance policy and procedures of technical partners, while it is intended to set a common basis of good practices for all partners and towards achieving the project QA goals. The quality control, however, will mainly rely on individual partner policies, as the type of hardware and the deployment techniques are mostly related to the partner expertise within their specific respective pilots.

The hardware deployment follows a four-phase process (see next section) as far as the HQA is concerned and a set of best practices to be followed by all partners are provided. The set of good practices is produced to help technical partners meet their ultimate goal, which is the functional and timely hardware implementation. The HQA aims to meet the hardware deployment and integration deadlines, fulfil all specifications, provide full functionality and user-friendly interfaces (for the pilots in particular).

5.3.1 HQA good practices for Pilot technical partners

There are four main phases of the hardware deployment process related to HQA procedures. During these phases, several HQA good practices are introduced (shown later in Table 2) to be followed by the pilot teams. Starting from the hardware deployment phases, these include the following procedures:

Phase 1 - Requirement and Selection phase: During the hardware requirement specifications (HRS) process, the technical team has to prescribe each of the essential requirements that are supposed to be satisfied by the hardware, propose the methodology to ensure that the intended product's functionality is elucidated, and keep refining the HRS until the requirements are clearly described to all partners involved. Once this listing is completed, more information related to the above-mentioned features will be gathered based on the work allocated in each respective system module in WP7 "Development of TwinERGY system Modules" and the appropriate working groups of the project. This information will set the basis for searching and selecting one or preferably multiple suitable hardware products that fulfill all these requirements.

Phase 2 - Tender phase: This phase in hardware deployment involves the actions related to singling out the product that can be acquired fast and economically. This includes looking for vendors and putting out tenders to acquire the desired products without exceeding the intended budgets or time constraints. Ideally, multiple offers are invited, documented and the most suitable selected for actual purchase.

Phase 3 - Hardware Commissioning, Testing and Documentation phase: During this phase, the acquired Hardware is installed in the field. Subsequently, each partner Quality Control Plan is anticipated to prove its potential in practice, involving manual and automated tests and informal reviews. Test cases are proposed to be developed for internal hardware validation aiming at providing fully functional operation. Along with that, all hardware entities will be accompanied by commissioning documents, i.e., internal documents describing the technical aspects of the hardware and user manuals. The manuals will provide information related to implementing the hardware in the field, the interfaces and limitations, describe actions and functions available for use, and provide a detailed documentation in relation to the general hardware operation and maintenance. Each of these documents, while not mandatory unless the condition of being publicly available as a deliverable, has to comply with the QA instructions provided in D1.3 "Quality Assurance Plan" related to project deliverables.

Phase 4 - Hardware release: The final phase of the deployment process incorporates the hardware release step. The fully commissioned hardware is put into final operation and is integrated with all other TwinERGY software and hardware components specific to that pilot. The final hardware release is done in two forms and time spots, an early operation mode for internal interoperability and pilot testing purposes initiated three months ahead of the task due date and a fully operational prototype at the task end. These fully functional hardware entities, when released either for internal use in pilot testing activities or as final public deliverables, have to obtain the approval (internal informal procedure) of the partners involved in each production process, who will validate the functionality according to the specifications involving technical and non-technical tests. The finally deployed hardware entity will be a full prototype release accepted by the involved partners.

5.4 Public Events Procedures

Unlike most TwinERGY meetings that have been organized online due to the geographical distances between project partners, public pilot meetings shall be held preferably in person, where conditions and safety considerations make that feasible (for instance, restrictions in attending face-to-face meetings have been set due to Covid-19 pandemic). To ensure and maintain high consumer participation within pilots, it is essential to keep a high level of in person meetings. These foster high engagement and attendance levels as physical events are more likely to be noticed and attended by the consumers within their respective pilot locations. If physical meetings are not possible, meetings will be held on-line via secure free video conferencing software. For both online and in person meetings, common procedures for adding and sharing agenda items and for documenting the respective meeting minutes have been established. For internal pilot meeting among project partners, please refer to the guidelines and procedures established in D1.3 "Quality Assurance Plan".

5.4.1 Event Preparation

The leading partner of each pilot event must sufficiently advertise the event in advance through appropriate public channels, such as newspapers, local bulletin boards or newsletters and ensure all relevant pilot participants are directly or indirectly informed. In the same process or through additional means, the chairman of the event must prepare and distribute to invited event attendees a written (original) agenda no later than 7 calendar days preceding the meeting. The agenda should include all planned event activities as well as the order in which they are to be taken up. Due to the different potential media used to disseminate event information, the proposed agenda template in Annex 3 of D1.3 "Quality Assurance Plan" may be used as a base. However, the agenda design and format can be adapted to fit the underlying selected medium.

5.4.2 Event Minutes

The event minutes will be primarily used for internal documentation of the event. It shall be developed following the guidelines below:

- The chairperson of the event will produce written minutes and send it to all participating project partners within 15 calendar days following the meeting.
- The minutes will be considered as accepted if, within 15 calendar days from sending, no partner has sent an objection in writing to the chairperson with respect to the accuracy of the draft minutes.
- The chairperson will send the accepted minutes to all the members of the consortium body and to the coordinator, who will safeguard them. If requested, the coordinator will provide authenticated duplicates to parties.
- Within the minute's document, an attendance list shall be provided, including the names of the attending project members and their affiliation in participating in the event. Additionally, the number of attending pilot participants shall be documented.

- The meeting minutes should be kept in the TwinERGY Project Repository, under the respective Work Package and Task tag.

The minute template of Annex 4 of D1.3 “Quality Assurance Plan” may be used for documenting the event outcomes.

6. Conclusions

The Pilot Quality Assurance Guide is a detailed document describing quality assurance procedures and structures to guarantee sufficiency and efficacy of the pilot outcomes. The Guide describes the way that the pilot activities will be executed from a quality management perspective, ensuring that internal standards, processes, and procedures are defined, and their execution is continuously monitored, corrected, and improved, when necessary.

Initially, the pilot site characteristics, intended activities, and existing/planned processes and resources are briefly presented (chapter 2). Next, the main objectives of the Quality Assurance (QA) process are highlighted along with the quality assurance planning and control procedures, as well as the human resources (Quality Assurance Officers) that will be allocated to the pilot quality assurance management with their roles (chapter 3). For each pilot, a number of KPIs and relevant metrics have been identified to ensure the best possible quality of pilot outcomes (they can be found analytically in chapter 4). Among them, household engagement and participant responsiveness, demand flexibility, RES share in energy consumption and self-consumption levels, dynamic energy tariff penetration, participant comfort/well-being level are the main KPIs identified across pilot sites. The quality assurance process analysis (presented in chapter 5) has provided guidelines for identifying nonconformities and developing corrective actions, handling software and hardware quality assurance issues, and effectively planning and executing public event demonstration and dissemination activities related to the pilot work and outcomes.

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Annexes

Annex 1: Pilot Quality Assurance Assessment Reporting Template

<table>
<tr><th colspan="6">PILOT QUALITY ASSURANCE ASSESSMENT REPORT</th></tr>
<tr><td>Assessment No:</td><td></td><td>Date:</td><td></td><td>Document Ref:</td><td></td></tr>
<tr><td colspan="2">KPI/Process assessed:</td><td colspan="4"></td></tr>
<tr><td colspan="2">Assessor:</td><td colspan="4"></td></tr>
<tr><td colspan="2">Affiliation:</td><td colspan="4"></td></tr>
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<tr><td colspan="6">2.</td></tr>
<tr><td colspan="6">3.</td></tr>
<tr><th colspan="2">ACTION REQUIRED</th><th colspan="2">DUE DATE</th><th colspan="2">IMPLEMENTATION DATE</th></tr>
<tr><td colspan="2">1.</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2">2.</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2">3.</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><th colspan="6">RECOMMENDATIONS FOR PILOT QUALITY IMPROVEMENTS</th></tr>
<tr><td colspan="6">1.</td></tr>
<tr><td colspan="6">2.</td></tr>
<tr><td colspan="6">3.</td></tr>
<tr><td>Assessor:</td><td colspan="2"></td><td>Assessment date:</td><td colspan="2"></td></tr>
<tr><th colspan="6">FOLLOW UP ASSESSMENT – DETAILS OF ACTION TAKEN</th></tr>
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<tr><td colspan="6"></td></tr>
<tr><td>Assessor:</td><td colspan="2"></td><td>Assessment date:</td><td colspan="2"></td></tr>
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