Renewable Energy
for Self-Sustainable
Island Communities

WP3 – RES/storage enable infrastructure deployment

D.3.1 Deployment plan specification

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DISCLAIMER

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Executive Summary

Building upon the results of previously published studies within the scope of the REACT project and leaning mainly on Deliverable 1.3 Pilot specific demonstration scenarios, 2.2 RES/storage enabled infrastructure planning and 2.3 Techno-economic impact assessment.

This deliverable presents a technical deployment plan to be carried out throughout the three project pilot sites. REACT will be piloted on three demo islands: La Graciosa (Spain), San Pietro (Italy) and Aran Islands (Ireland). This document sets out the deployment specification for the necessary RES infrastructure, generation systems, energy storage systems, ICT and controls interfaces to provide optimal control and management strategies and demand response (DR) programs.

This deliverable started in November 2019 and will be finalized by June 2020.

In order to define which materials are to the installed in each of the three pilots it had to be taken under consideration the different laws and regulation in country.

In La Graciosa it has been decided to install Victron Equipment's since they comply with the local regulation in regard with grid connections and due to equipment efficiency. In total there will be 17 of these installations, the project plan is been prepared to be submitted to the local government.

In Italy the regulation states that the self-consumption with storage the inverter and the battery should be legalized together. The legalization process for MIDAC batteries is ongoing.

In Aran 4 public buildings have been selected where the SMA technology will be installed, with PV grid inverters and battery inverter.

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1 Introduction

1.1 Scope

This deliverable presents the deployment plan specification on each Demo Island and respective demonstration areas, considering each pilot´s topological, functional, technical and user requirements. This task will identify the energy monitoring needs and required measuring points of each pilot to conduct optimal energy dispatching and control action, and will allow the energy data acquisition and monitoring of targeted areas of demo sites to create a solid baseline for project results validation.

1.2 Audience

The intended audience of the deliverable 3.1 consists of members of REACT Consortium, the Project Officer and all interested people. This document is public.

1.3 Definitions / Glossary

Demand Response (DR) provides an opportunity for consumers to play a significant role in the operation of the electric grid by reducing or shifting their electricity usage during peak periods in response to time-based tariffs or other forms of financial incentives.

Demand Side Management (DSM) is commonly used to refer to demand side electrical load management. It involves actions that influence how much energy is used or when energy is used. The goal of DSM is to encourage users to use less energy during peak hours or to move the time of energy use to off-peak times such as night-time and weekends.

Demonstration scenario refers to the operational scenario (or use case), describing the key elements and actions (e.g. control strategy, target indicators, actors and equipment involved…), that will be carried out for **demonstration**/validation project purposes once the REACT technology (both HW and SW) is deployed.

Deployment plan refers to the specific energy system installation plan, comprised of the specific technical system details (e.g. topology, technology, sizing…), according to which the deployment of the mentioned energy system will be carried out at project demo sites.

Distribution Network Operators (DNOs) are often also referred to as Distribution System Operators (DSO). They are responsible for the transport of electricity at a regional level and as such they transport electricity at gradually reducing voltages from national grid supply points to final customers, both residential and none residential. Throughout the EU, electricity distribution is a regulated monopoly business.

Dwellings (also known as a residence or abode) are self-contained units of accommodation used by one or more households as a home - such as a house or an apartment. A dwelling may or may not contain a garage, which may or may not be adjacent to the unit of accommodation.

Dynamic electricity tariffs often referred to as real-time pricing. Prices change usually on an hourly basis reflecting the cost of generating and/or purchasing electricity at the wholesale level at the time of delivery.

Early adopters are the second fastest category of individuals who adopt an innovation. "These individuals have the highest degree of opinion leadership among the other adopter categories. Early adopters are typically younger in age, have a higher social status, have more financial lucidity, advanced education, and are more socially forward than late adopters" (Rogers, 2003, p. 267).

Electrical Load management, often referred to as simply load management, is achieved through controlling the power flow in the electric system at the generating end (supply side management) or the customer end (demand-side management).

Electricity self-consumption is when all of the power generated is used on-site and no surplus is injected into the grid. This means blocking surplus energy at certain times or storing it in a battery system.

Electricity Supply is the process of buying electricity in bulk and selling it on to the final customer. Electricity supply in most EU counties is a competitive market.

Energy autonomy or energy self-sufficiency refers to the ability to generate, distribute and store renewable energy so as to service the energy demand in real time of the energy autonomous area.

Energy performance contract (EPC) is a contractual arrangement between the beneficiary and the provider of an energy efficiency improvement measure, verified and monitored during the whole term of the contract, where investments (work, supply or service) in that measure are paid for in relation to a contractually agreed level of energy efficiency improvement or other agreed energy performance criterion, such as financial savings.

Energy Service Company (ESCO) is a company that offers energy services which may include implementing energy-efficiency projects (and other sustainable energy projects). The energy services supplied by ESCOs can include a wide range of activities such as energy analysis and audits, energy management, project design and implementation, maintenance and operation, monitoring and evaluation of savings, property/facility management, energy and/or equipment supply, provision of service (space heating/cooling, lighting, etc.) advice and training.

Energy Suppliers buy electricity and /or gas in bulk and sells it to final consumers.

Energy Supply Contract, the key element in this type of contract is the efficient supply of energy. The contracting partner provides products/services such as supplying electricity, gas, heat. Financing, engineering design, planning, constructing, operation and maintenance of energy production plants, as well as management of energy distribution,, are often all included in the complete service package. For example, district heating providers are the most widely implemented example of energy supply contracting in the residential sector.

Follower island is a term used in the REACT project to refer to the five islands for which plans for the large-scale replication of the implementation of the REACT solution will be developed as part of the project. These plans will be based on the findings from the pilots ran on the three islands on which the solution is being tested or piloted as part of the project. The REACT follower islands are Gotland (Sweden), Lesbos (Greece), Isle of Wight (UK), Majorca (Spain) and Reunion (France).

Island territories are defined in the REACT project as geographical islands that have: a minimum surface of 1 km²; a minimum distance between the island and the mainland of 1 km; a resident population of more than 50 inhabitants; no fixed link (for example, a bridge, a tunnel, or a dyke) between the island(s) and the mainland.

Mainland is the main part of a country or continent, not including the islands around it

Pilot island is a term used in the REACT project to refer to the three islands on which the REACT solution will be piloted/demonstrated during the lifetime of the project. These are; La Graciosa (Spain), San Pietro (Italy) and Aran Islands (Ireland).

Pilots are experiments or tests conducted prior to the technology or system being introduced more widely.

Pilot focus areas are the areas that have been defined on the REACT pilot islands for the implementation of the REACT solution during the lifetime of the project. These are, Caleta del Sebo in La Graciosa (Spain), Carloforte in San Pietro (Italy), Kilronan, on Inis Mór one of the Aran Islands (Ireland).

Renewable energy is energy from a source that is not depleted when used, such as wind or PV power.

Renewable Energy Systems are energy systems that rely on renewable forms of energy generation.

Smart devices or appliances can connect to a network via wi-fi so you can control them when you are away from home using a smart phone or tablet (i.e. iPad).

Smart grid technologies include but are not limited to, Home Energy Displays, Home Energy Management Systems (HEMS), Smart Meters, Micro CHP, PV, Electric Vehicles, batteries, hot water storage and Smart household appliances.

Smart Grids are " electricity network[s] that can cost efficiently integrate the behaviour and actions of all users connected to it – generators, consumers and those that do both – in order to ensure economically efficient, sustainable power system with low losses and high levels of quality and security of supply" (EC – Directorate General for Energy, 2011).

Social media feeds are software that provide notifications when new items have been posted to a social medium, it includes Facebook twitter LinkedIn, WhatsApp etc.

Supply Side Management (SSM) is commonly used to refer to supply-side electrical load management. It refers to actions taken to ensure that energy generation, transmission distribution and storage are conducted efficiently, on the supplier's side of the energy supply chain.

Surveys (sometimes called questionnaires) is used to collect data from subjects (often called respondents) who respond to a series of questions about behaviours and opinions.

Technology Acceptance Models are models used to understand technology acceptance based on two primary factors (perceived ease of use and perceived usefulness) that influence an individual's intention to use new technology.

Time-based pricing is a pricing strategy where the provider of a service or supplier of a commodity, may vary the price depending on the time-of-day when the service is provided, or the commodity is delivered.

Transmission Network Operators (TNOs) are responsible for the bulk transport of electricity by high voltage power lines from power stations to grid supply points. The transmission system is generally referred to as the national grid. Throughout the EU Transmission is a regulated monopoly business.

Usability as defined by ISO 9241: extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.

User centred design: based on ISO 13407 User Centred Design calls for a collaborative design process where users deliver continual feedback based on their reactions to a product's prototype.

Utilities industry in its broad sense refers to electricity, gas and water supply companies and integrated energy service providers. The term is most often used to refer to the companies involved in the generation, transmission and distribution of energy.

1.4 Abbreviations

D#.#: Deliverable #.#. Eg: Deliverable 2.1

DSO: Distribution system operators

PV: Photovoltaic

RES: Renewable energy sources

WP#: Work Package #. Eg: Work Package 1

kW / MW / GW: kilowatt / megawatt / gigawatt

Wh / KWh / MWh / GWh: kilowatt hour / megawatt hour / gigawatt hour

GHG: Greenhouse gas

LV: low-voltage

MV: medium-voltage

TOU: Time-of use

1.5 Structure

- **Section 1:** contains an overview of this document, providing its Scope, Audience, Definitions, Glossary and Structure.
- **Section 2**: The site-specific requisites, requirements on the Island. The requisites to running the demonstration scenarios and the strategy to be implemented.
- **Section 3**: Technical deployment, technical size of RES, definition of material to be installed and the installation planning.
- **Section 4**: Technical characterisation Aran Islands, Ireland and its regulatory framework.
- **Section 5**: Conclusion

1.6 Aims and objectives

The aim of task 3.1 is to define REACT's deployment that will be followed in the second year through the deployment and integration activities. The deployment plan will be adapted to each demo Island and respective demonstration areas, considering each pilot's topological, functional, technical and user requirements. The deployment plan will be specified in accordance with the design of RES/storage enabled infrastructure delivered by WP2 and to meet the energy demand requirements at pilot sites. Furthermore, this task will identify the energy monitoring needs and required measuring points for each pilot to conduct optimal energy dispatching and control actions. To satisfy these needs, a measurement framework will be defined to support the collection of the minimal data set necessary in this regard. As a result, the deployment plan designed in this task will enable early deployment activities that will provide baseline period measurements on time (for WP6). Task 3.1 will deliver a plan for integration with energy assets and ICT systems, either existing or additionally installed at pilot sites during REACT. Task 3.1 activities will be conducted highly respecting the requirements defined in WP1 and fitting the needs of operation scenarios.

1.7 Contribution of the project partners

The following is a description of the partners' contributions to this report:

PARTNERS CONTRIBUTION TO TASK 3.1

Partner	Contribution	PM
VEO	Collecting data of pilot's topological, functional, technical and user requirements	3
NUIG	Specification of deployment plan for Aran Island	1
ESBN	Identification and possibly installation of energy monitoring for Aran Island	2
UNG	Support on the deployment plan for Aran Island	1
MITS	Input on deployment plan specification: ASHP control & monitoring	2
AIT	Support of deployment plan. Define control strategies for RES generation and energy storage assets	2
FEN	Identification of energy monitoring needs in La Graciosa	4
TEK	Support to specification of deployment plan for La Graciosa. Define system architecture specification and integration applied for improved energy efficiency, demand response	3
AIE	Identification of energy monitoring needs in La Graciosa	1
R2M	Specification of deployment plan for Carloforte	3
MID	Design storage System for Carloforte	4
CCF	Support the development of the deployment plan specification for Carloforte	1
AES	Data acquisition of the Pilot sites for the BOM definition and monitoring development. Define the optimal storage control and operation to ensure reliable quality of supply	4

Table 1: Partners related to this task

1.7.1 Relations to other activities in the project

The inputs of this task are coming from the deliverable 1.3 Pilot specific demonstration scenarios, the identification of demo scenarios and the technical characterization defined in task 1.3. Also from deliverable 2.2 RES/storage enabled infrastructure planning and deliverable 2.3 Techno-economic impact assessment.

The tasks depending on the outputs of this deliverable are all the following tasks within WP3, in particular Task 3.2 - Early deployment at pilot sites. Outputs from this deliverable are also required for all dependent tasks within WP5 - DR strategy and energy dispatching optimization, and Task 6.1 REACT platform architecture, within WP6.

2 Demonstration scenarios implementation strategy

The initial data evaluation of the feasibility of different implementation options, sometimes also referred as “configurations”, was provided in an earlier deliverable, D2.1 Assessment of RES potential at pilot sites. This document provides a holistic overview of what renewable technologies are deemed feasible from the standpoint of the REACT project to be deployed at both pilot and follower islands. This is done by looking at both the geographical and meteorological characteristic of the considered environment but also legislative framework, any potential legal issues as well as social limitations. For example, some of the sites might have exquisite potential in terms of hot water for geothermal, solar irradiance for PV installations and wind for wind turbines, but due to environmental, aesthetic and other constraints denoted in local regulation, in some cases having financial feasibility is simply not enough for a renewable generation solution to be deployed.

The results of D2.1 are then used as a basis for D2.2 RES/storage enabled infrastructure planning with these results morphed into theoretical scenarios for the assessment of whole-island renewable-powered grid’s performance, stability, sustainability, and other factors. Each island was considered separately, i.e. appropriate meteorological conditions for each island were taken into consideration when assessing potential renewable production. Also, with having different climates and different user profiles, each island exhibits a different load profile with daily, weekly and monthly variations between the islands. These differences were also taken into account by using island-specific demand profiles but also island-specific pricing profiles, feed-in tariffs, etc. Therefore, each island demonstrated some unique characteristics that show how well different renewable configurations perform both in terms of technologies (e.g. whether solar or wind is preferred) and capacities (e.g. if the grid is compromised by high renewable penetration or if an existing mainland connection can be potentially saturated). Also, use cases were discussed in which storage options (batteries) are analysed as supplements to renewable production with the main goal of balancing the additional benefit of storage with costs.

The analyses from D2.2 are using a variety of optimization algorithms in conjunction with grid monitoring parameters provided by related literature. Concretely, within specific constraints for each island as given by appropriate production, load, pricing and legislative constraints, different configurations of renewable sources and storages are either tested using the aforementioned grid interaction parameters, or the constraints are used in order to optimize the concreate use case and provide an "ideal" configuration in terms of a predefined criterion (usually minimizing cost).

As for the considered island, whole-island studies from D2.2 found that in the case of La Graciosa, significant LCOE reductions can be achieved with the inclusion of sufficient PV generation (with wind also being an option but being hindered by its installation complexity) with moderate amounts of generation (≤ 500 kWp of PV) not presenting an issue in terms of potential saturation of the mainland submarine cable. Given the presence of the connection, additional storage facilities are not necessary but can be used as an auxiliary system for finer load management, especially when the performance of a smaller system is to be analysed towards achieving high degrees of energy autonomy. Also, a hypothetical district cooling system is tested on two use cases with different numbers of users. Results for San Pietro also prove feasibility of renewable generation potential configurations containing PV generation only, a mix between PV and wind generation (through optimization of related capacities), but also a potential scenario of NASCA wind park redeployment. A focus level study was also presented with the implications of PV and storage sizing on LCOE. The third pilot site, Aran Islands, was analysed using optimization whereby an optimal configuration with 2.22 MWp of wind generation and 0.12 MWp PV generation with 0.3 MWh of storage was deemed most cost-effective. In addition, a balance between heat pump and thermal storage capacity is calculated with the main goal of satisfying all of Aran Islands' thermal demand by HPs by 2030. As for follower islands, the autonomous grids of Lesbos and La Reunion showed that higher penetration of renewable sources must be accompanied with adequate storage solutions or load management due to peaks in production and demand. Configurations tested for Gotland and Isle of Wight involving PV, WT and both in conjunction analysed mainland connection saturation while the analysis for Majorca provided results for renewable installations as a replacement for old thermal power plants with PV and wind generation in the first scenario and only PV in the second scenario. Finally, for each of the pilot islands, a small focus area is assumed where performances of small-scale renewable installations are analysed.

Finally, the analysis from D2.2 provides inputs for the following deliverables D2.3 Techno-economic impact assessment and D2.4 Environmental impact assessment that will in conjunction with D2.1 and D2.2 provide a comprehensive overview of theoretical potential benefits and drawbacks of the considered renewable technologies using measured historical and realistic predicted data from pilot sites. The results of these deliverables and WP2 as a whole is regarded as a theoretical analysis of feasibility and performance of different technologies in theoretical whole-island scenarios. Following this, different small-scale demo-site systems are to be deployed at each pilot island to demonstrate how the stability and sustainability of the islands can be improved using smart energy management in a controlled environment.

2.1 Site specific prerequisites

2.1.1 La Graciosa

2.1.1.1 Participant validation

When planning the intervention in La Graciosa, the aim was to test several storage technologies and different self-consumption methods and assess how each one of them adapt users with varied consumption profiles and the characteristics of the island. A previous characterization of the buildings of the island was performed and different scenarios were designed to cover as many possible combinations as possible, always fitting the available budget.

Three typologies of buildings were defined according to its usage: public buildings for community use, private buildings for commercial use and private buildings for residential use. The classification was intended to include all the existing demand profiles.

Aptitude criteria were defined for selecting users to participate in the project. As described at Deliverable 1.3, these criteria were:

- Continuous consumption along the year,
- Stable internet connectivity to assure data transmission to the platform,
- Availability of space for deploying the equipment,
- Entailment of benefit for the community,
- Potential of exemplariness to draw attention to and disseminate the project and raise awareness of the benefits of renewable energies,
- And availability of appliances to be operated in order to allow demand response actions.

By selecting public buildings, continuous consumption is guaranteed throughout the year, as well as benefit for the community and exemplariness criterion. In addition, this typology aims for a more pragmatic goal, to involve authorities in the project and get their collaboration in the development of it. The consumption of this kind of buildings is distributed over the central hours of the day because of its working schedule.

Private buildings for commercial use are related, most of them, to tourism sector, mainly restaurant and hotel businesses. These potential users demand energy along the year, serve as example for the rest of the community, and are the island's cover letter for the visitors, therefore engaging this type of buildings will improve the environmental consciousness perception. Their typical demand profile is distributed throughout the day.

Regarding private buildings for residential use, participation and representation of neighboring residences was searched in order to spread the word among the islanders. The ideal users should be involved in community activities and in the promotion of renewable energies. This way, their impact will be higher resulting in benefits for achieving the project's purposes.

Typical building in La Graciosa are one or two-story building with flat roof, ideal for installing photovoltaic panels. When engineering the final solution for installing photovoltaic panels two factors must be considered: one, current legislation impose severe conditions for granting the installation's license on area to be occupied, the environmental impact and aesthetic impact; two, the presence of high winds capable to pull up the panels from the roof, for which reason a special affixing solution is needed.

Common features of the island to be noted:

Gas supply is not available in the island, so all the appliances and equipment run with electricity. Electrical hot water heater is used for domestic hot water. There is no need for acclimatization devices due to the climatic conditions of La Graciosa.

High winds are responsible for the instability of data connectivity when blowing hard.

Storage technologies proposed for testing were lead-acid batteries, Lithium batteries and aluminum-carbon batteries. The first type is a well-known storage technology and its presence in the project is intended to set a reference for benchmarking the second type, aluminum-carbon batteries, still experimental and in development phase. Temporarily, aluminum-carbon batteries will be replaced by lithium batteries, with similar features. (HORIZON 2020, 2018)

Lastly, and regarding self-consumption methods, what was proposed for testing in La Graciosa, were the self-consumption with storage and self-consumption without storage. This selection pretends to be a testing ground for forecasting and optimizing models intended to be developed during WP5.

The main objective on participant validation is to try to include all the use technologies existents at the demo site.

React ID	Type of building	Usage	Built-up area (m_2)	Occupancy	Average daily consumption (kWh/day)
LG1	Community building	Touristic apartments (1/7)	563	Up to 6 (2 to 3 per apartment)	4.3 - 5.2 per apartment
LG2	Community building	Touristic apartments (2/15)	893	Up to 2-3 per apartment	3.0 - 5.9 per apartment

React ID	Type of building	Usage	Built-up area (m2)	Occupancy	Average daily consumption (kWh/day)
LG3	Community building	Commercial	89	Variable	70.6
LG4	Community building	Boarding house, residential and restaurant	445	Variable	50.3
LG5	Community building	Boarding house and restaurant	132	Variable	134.6
LG6	Community building	Touristic apartments and dwelling	196	Variable	25.8
LG 7	Community building	City hall offices	122	Variable	3.6
LG8	Community building	Fisherman house	284	Variable	49.2
LG9	Community building	School and sports centre	2092	Variable	18.9
LG10	Community building	Hardware store and residential	194	Variable	24.8 and 10.4
LG11	Community building	Residential	82	5	9.8
LG12	Dwelling	Residential	33	-	7.8
LG13	Dwelling	Residential	128	3	7.0
LG14	Dwelling	Residential	85	3	14.8
LG15	Dwelling	Residential	138	3	13.1
LG16	Dwelling	Residential	100	2	-

React ID	Type of building	Usage	Built-up area (m2)	Occupancy	Average daily consumption (kWh/day)
LG17	Community building	Residential and restaurant	215	5 (dwelling)	17.3
LG18	Dwelling	Residential	216	4	15.6
LG19	Dwelling	Residential	190	-	21.9
LG20	Dwelling	Residential	96	-	9.6

Table 2: Selected buildings of la Graciosa

Figure 1: La Graciosa REACT eligible buildings

2.1.2 San Pietro

The focus for the technology implementation in San Pietro is based on self-consumption, energy storage systems and heat pumps in both dwellings and public buildings. One of the main goals of San Pietro's pilot focus area is to optimise efficient energy dispatching by integrating the REACT solution with existing RES generation on the island. Ultimately reducing the island's dependency on energy transferred from mainland.

For San Pietro there are three technology configurations proposed, as presented in D1.3, section 5.2: (D1.3, Secction 5.2)

- Individual self-consumption: generation via community PV-wind power plant NASCA, storage and energy consumption (either electrical and thermal by including heat pumps) with a single supply delivering point;
- Individual self-consumption: PV generation, storage and energy consumption (including heat pumps) with a single supply delivering point (still not confirmed since initially there was no PV equipment allocated to this pilot focus area);
- Shared self-consumption: generation via community PV-wind power plant NASCA, centralized storage (located in a public building) and energy consumption in many supply points all connected to the same micro grid.

As NASCA power plant is owned by a third party no involved in the project, for the purpose of REACT it will be considered as part of the overall balance of the island. However, it will not be possible to physically install batteries on site but rather to consider the plant contribution in a virtual manner (through virtual power plant, VPP).

To kick off data collection and show active participation in the project, the Municipality of Carloforte made seven public buildings available as part of the demo sites (Social services and police, three schools, a sport facility, the Municipality and the local library). To include private dwellings in the project the Municipality launched a public call for collecting citizens' expression of interest. Before the 2020 lock-down due to COVID-19 the Municipality, together with the Pilot Coordinator, were surveying the interested buildings to identify the most suited to be included in the project.

At the time of submission of this report, 12 private dwellings have been surveyed and the activities will continue as soon as the restriction measures will ease up and technicians will be allowed again on the island. The following image shows where the 19 buildings currently under evaluation (7 public and 12 private) are located. Additional details on the different buildings can be found in D1.3.

Figure 2: Carloforte REACT buildings

To finalise the selection of the 30 buildings to be included in the REACT projects once all buildings interested in participating have been surveyed, the CFF cluster developed a set of selection criteria that will be used to score the properties. The criteria are based on technical requirements for the installation (e.g. enough space to store the battery) as well as requirements for the implementation of DR control strategy (presence of Wi-Fi connection).

<table>
<tr><th colspan="2">Selection Criteria</th></tr>
<tr><td colspan="2">Key criteria
Modern construction – more recent than 1980
Wi-Fi connection available on site</td></tr>
<tr><td colspan="2">Technical requirements</td></tr>
<tr><td>MIDAC
Indoor space for battery installation (approx. 1.5m)
Presence of on-site renewable (not installed with first Conto Energia incentives)</td><td>MERCE
Sufficient requirement for heating or cooling
Sufficient space for the proposed heat pump equipment
Minimum standards in terms of electrical wiring, building fabric and structure</td></tr>
<tr><td colspan="2">Additional considerations
Occupancy schedule - potential to pre-heat/pre-cool building
Proximity to other buildings in the project
Potential to replace existing fossil fuel boiler systems
Potential to replace existing heat pump systems using older refrigerants scheduled for phase out (or phase down) as part of the European F-gas regulations.</td></tr>
</table>

Table 3: Building selection criteria in Carloforte

To be able to collect information on the energy consumption and quantify the impact of the measures implemented once the REACT platform will be in place, all buildings will be fitted with smart meters directly connected to REACT. The installation is already completed for the public buildings and will be soon done for the private dwellings once the selection is completed.

2.1.3 Aran Island

2.1.3.1 General Information.

The planned technology implementation in Inis Mór is based on self-consumption through energy storage systems in dwellings, community buildings and any other facilities either being public or private as reported in D1.3, section 6.2. Those technology configurations are meant to match with DR strategies and DR concrete actions, allowing an optimal, effective and efficient energy dispatching to match RES generation with eligible buildings' energy consumption. A previous characterization of the buildings of the island was performed based on a scoring system. The system is much simpler than a flexibility analysis and not as detailed. The scoring system gave the possibility to filter and select the available buildings and included criteria such as technical, community, economical aspects. The complete list of the selected building is reported in D1.3, table 15. From the aforementioned list, a further screening of the feasible building to be involved in the REACT project was performed, since the REACT project is not only aiming to provide RES systems but also to engage end users in directly participating of their energy dispatching by using all resources provided. As local authorities are cooperating and have shared their building occupancy and consumption, the Irish cluster agreed to work with four out of those seven community buildings, expecting great results so that the REACT project solution can be replicated and escalated to many more buildings.

Four separate locations on Inis Mór have been chosen for the installation of solar Photovoltaic (PV) panels. The buildings include; the Community Offices (Ionad Fiontair Cholm Ó hIarnáin), Community Hall (Halla Rónáin), secondary school (Gairmscoil Naomh Éinne) and the Childcare facility (Naíonra Inis Mór).

It was felt that by choosing public buildings, it would result in greater community engagement with the REACT project – which, in turn, would achieves the project goals and help to promote and build a local sustainable energy community on Inis Mór.

In the following table, the updated table contained the current selected buildings, based on the assumption stated on previous paragraphs.

React ID	Type of building	Usage	Built-up area (m_2)	Occupancy	Average daily consumption (kWh/day)
AI1	Community building	Community Hall	400 m2	20-30 during events	16.25
AI2	Community building	Offices	380 m2	5-8	0.77
AI3	Community building	Secondary school	950 m2	50 students 10-15 staff	60.23
AI4	Community building	Childcare	250 m2	Childs 4 staff	43.6
AI5	Dwelling	Residential	110 m2	All year: 3 Summer: 6	10.77
AI6	Dwelling	Residential	165 m2	All year: 1 Occasional up to 20	16.63
AI7	Dwelling	Residential	110 m2	3	17.54
AI8	Dwelling	Residential	280 m2	All year 2 – occasional up to 12	18.85
AI9	Dwelling	Residential	110 m2	1	11.87
AI10	Dwelling	Residential	275 m2	2	No specified

Table 4: Building selected in Aran Island

2.1.3.2 Energy Monitoring (ESBN).

It is proposed to install energy monitoring devices at each of the four community buildings:

Community Offices (Ionad Fiontair Cholm Ó hIarnáin) – three phase supply

Community Hall (Halla Rónáin) – 1 phase supply (80A)

Secondary school (Gairmscoil Naomh Éinne) – three phase supply (80A)

Childcare facility (Naíonra Inis Mór) – three phase (100A)

Energy monitoring devices will be installed on the main incoming supply cables (after the meter) and it is anticipated that by installing these in advance of the installation of the PV panels, a profile of energy usage can be obtained both pre and post installation. This will allow an analysis of the renewable energy contribution to energy consumption at each of the buildings. This whole-energy data can be compared to data provided by the PV installation to confirm the analysis and to understand the effective proportion of the contribution given the sizing of the panels and the amount of energy consumption.

It is proposed to use an energy monitor that has two primary components:

Current sensors – split core CTs that can be installed without the need to disconnect cables

Voltage connection lead – so that an accurate voltage reading can be had from each phase – allowing dynamic and accurate power data to be collected

Communications capability to deliver the data to the REACT cloud.

While the equipment vendor offers a facility for storing and analysing the data collected, it is proposed to directly transfer the data produced to the REACT cloud database, using the MQTT protocol. The proposed device is capable of supplying data according to this protocol without the need for the use of an energy gateway or other 'translating' modem.

For the purposes of the REACT project, the data will be made available for largely manual analysis. It is not proposed to develop any 'front-end' or data interface as this is outside the scope of the project.

On completion of the project, it is possible to allow the power devices to remain, and to arrive at an arrangement between equipment vendor and building operators whereby the annual fees needed to store and present the data (using the vendor's own interface) can be taken up. Alternatively, the monitoring devices will be removed.

Installation of the monitors will need to be in compliance with the ETCI regulations for installations and the works are to be completed by a registered electrician who will certify the installation on completion.

2.1.3.3 Appointment of Project Manager

Údarás na Gaeltachta intends to appoint a Project Manager (PM) to oversee and manage the project on the Island. The PM will be responsible for the completion of the structural and electrical reports, the tender process and appointment of an installation contractor, and that the works are carried out safely, to the appropriate construction regulations.

2.2 Pre-requisites for running the demonstration scenarios

2.2.1 La Graciosa

2.2.1.1 Consent and agreement of the owners to join the project

The first step with the house owner is to get their consent to participate in the project and to collect their personal data (RGP). This document will inform potential participants of the following issues:

What does REACT offer Participants?

- Provision of a range of equipment to participating pilots.
- Installation, operation and maintenance of the equipment.
- Reduction of the electricity bills, through an increased fraction of electricity consumption met by renewable sources and optimization of energy management.

What are the Participants committed to with REACT?

- To take care of the equipment
- Provide data and information, upon request by REACT
- Actively participate in consultative processes for the optimization of the system.
- Actively participate, always in a consensual manner, in the management of the installed system.

What will happen when the REACT project is finished?

The objective of the project is that the benefits associated with the implementation of the system are maintained and improved over time. However, as the equipment is owned by REACT, the continuity of the service and the way it will take place must be defined and agreed between the Participants and REACT. To this end, REACT will propose alternatives, such as the establishment of an energy community, and promote participatory processes for the joint definition of post-project management alternatives.

As a second step, a visit will be made to the buildings by AIELPA to collect data for the technical project and the installation budget. The visit will allow a correct dimensioning of the solar panels.

Finally, an agreement that includes the detail of the installation will be signed with the owner: power, roof surface, list of equipment, etc.

2.2.1.2 Necessary permissions prior installation

Normally in Spain, the permission to start this type of work is easy to obtain: the electrician just has to make a technical report and inform the city council before starting the installation. However, "La Graciosa" is an island that has been declared a Protected Natural Area by Law 12/1987 (BOE Boletín Oficial del Estado) and this makes it very difficult to obtain permission to start the works.

To regulate this protected area, the Natural Resources Management Plan of the Natural Park of the Archipelago of Chinijo was approved in 2006. However, a private individual denounced this plan. The judge agrees and annuls it, giving more legal uncertainty and more complexity to carry out this type of installations.

The following describes what has happened since the judge's decision:

- On 17/12/2018, the agreement by which the commission of Territorial Planning and Environment of the Canary Islands in ordinary session takes cognizance of the judicial decision of definitive annulment was published in the Official Bulletin of the Canary Islands nº 243/2018. (BOC Boletin Oficial de Canarias)

- On 20/05/2019, the Head of the Planning Coordination Area of the Regional Ministry of Territorial Policy of the Canary Islands Government answers to the Teguise City Council (La Graciosa) regarding the law applicable after the nullification. In this communication, it is indicated that the law applicable is the subsidiary rules of municipal planning without prejudice to the submission of environmental assessment.

- On 20/07/2019, the Official Bulletin of the Canary Islands nº141 published the beginning of the approval process of a new Natural Resources Management Plan. In this same bulletin it is indicated that during the processing of this new plan, no acts may be carried out that involve a significant transformation of the physical and biological reality that could make it impossible or significantly difficult to achieve the objectives of the new Plan, and, specifically, it is indicated that, "the interested parties may not be recognised as having the power to carry out acts of transformation of the physical, geological and biological reality, without a favourable report from the acting Administration".

In addition, some buildings are located within the transit easement and coastal protection easement and therefore subject to Law 2/2013 on the protection and sustainable use of the coast. Therefore, in order to obtain work permissions, prior authorization from the Vice-Ministry of Territorial Planning and Ecological Transition of the Canary Islands is required (BOE Boletín Oficial del Estado).

Therefore, the steps to be followed in each of the self-consumption facilities to start the work are indicated below:

1. Development of technical project signed by an engineer according to the subsidiary regulations (approximately 90 pages of document per installation). It must include:
    - Calculation of electrical protections and electrical network.
    - Forecast of energy production.
    - Justification for compliance with subsidiary regulations: specifically, the non-occupation of 10% of the roof and the study of the visual impact of solar panels.
    - Environmental compliance.
    - Installations drawings.
    - Products datasheet.
    - Installation implementation planning.
    - Safety procedures planning for personal works.
    - Construction waste management
2. Request permission from Teguise council to carry out the project
3. Request a favourable report from the Department of the Government of the Canary Islands that drafted the new Natural Resources Management Plan.
4. Request to the Area of the Environment of the Island Council (Lanzarote) whether the action is considered evaluated or not environmentally, and if so, the corresponding environmental impact statement.
5. Authorization from the Vice-Ministry of Territorial Planning and Ecological Transition of the Canary Islands: only in the case that the homes are located within the transit easement and coastal protection easement and therefore subject to Law 2/2013 on the protection and sustainable use of the coast.
6. Pay if necessary, to the town hall for construction permissions and waste management.

2.2.1.3 Implementation of the installations

To carry out the projects there will be a competition among AIELPA's installers to choose the best economic offer. The project will be divided into several groups of dwellings and the installers will compete for all the groups or only for some of them.

Once the installers have been chosen, they will have to make a personal health and safety risk plan. This plan will be based on the safety procedures planning for personal works of the technical projects.

In addition, the installer will be asked for the regulatory documentation according to the Spanish law on subcontracting for construction.

2.2.1.4 Legalization of the installations

1. Request the distribution company for the Auto Consumption Code (CAU), which will uniquely identify the auto consumption. It will consist of the Universal Supply Point Code (CUPS) followed by the A code and three digits (Fenie Energía, 2019).
2. Installation Certificate:
   - If the nominal power of the installation is equal to or less than 10 kW, the certification of the end of the work is done by presenting the electrical installation certificate (CIE or electrical bulletin).
   - If the nominal power of the installation is greater than 10 kW, in addition to the electrical installation certificate, a certificate of project management signed by a competent technician is required.
3. Utility compensation contract:
   Finally, it will be necessary to sign a simplified compensation contract with electric utility company. If it were a collective self-consumption, the distribution agreement would also have to be submitted to the utility. In both cases, the utility company will carry out the corresponding procedure with the distributor (BOE Boletín Oficial del Estado, s.f.).

2.2.2 San Pietro

2.2.2.1 Consent and agreement of the owners to join the project

All dwellings currently under evaluation have participated in a public expression of interest published by the Municipality of Carloforte. Prior the final selection and the deployment on site all private participants will sign an agreement for the participation, which will specify:

- What REACT project is
- What is the commitment for the participants
- What will happen at the end of the REACT project

2.2.2.2 Necessary permissions prior to installation

San Pietro is part of a National Park and has to comply with several specific regulation regarding the installation of equipment. The procedure for the installation of HP and batteries is simplified compared to equipment such as PVs. For heat pumps, the Sardinian Regional regulation requires a landscape authorisation when elements of the installation can be seen from outside the building. The need for this authorisation will need to be evaluated on a case-by-case basis for the selected buildings. As the authorisation has to include both the technical specification and executive details of the system to be installed it cannot be asked until the design is completed. The authorization's item can last up to 60 days maximum.

For batteries there is no necessary permission required prior the installation however, the installation scheme has to be shared with "Enel Distribuzione" as part of the request to connect to the grid during the testing phase.

2.2.3 Aran Island

2.2.3.1 Consent and agreement of the owners to join the project

At the Aran Islands demo site, the community building selected has already singed a pre-agreenment of interest, the building are Community Offices (Ionad Fiontair Cholm Ó hIarnáin), Community Hall (Halla Rónáin), Secondary schoo (Gairmscoil Naomh Éinne) – 3 phase supply (80A), Childcare facility (Naíonra Inis Mór).

The document included the following information:

What does REACT offer Participants?

- It will provide a number of equipment to participating pilots.
- It will install, operate and maintain the equipment.
- Reduction of the electric bill, by the increase of the electric consumption provided by renewable sources and optimization in the energy management.

What are the Participants committed to with REACT?

- To take care of the equipment
- Provide data and information, upon request by REACT
- Actively participate in consultative processes for the optimization of the system.
- Actively participate, always in a consensual manner, in the management of the installed system.

What will happen when the REACT project is finished?

The objective of the project is that the benefits associated with the implementation of the system are maintained and improved over time. However, as the equipment is owned by REACT, the continuity of the service and the way it will take place must be defined and agreed between the Participants and REACT. To this end, REACT will propose alternatives, such as the establishment of an energy community, and promote participatory processes for the joint definition of post-project management alternatives.

Once the terms of participation of each pilot are defined, the interested party will sign a participation agreement as a pilot. By signing the agreement, they declared that they are interested in participating as a pilot in REACT project.

Regarding the residential dwellings selected and reported in table 4. They are currently participating to an H2020 project called RESPOND, the project will conclude in October 2020. In order to engage the potential REACT candidate, a visit on the island was cancelled due to Coronavirus restrictions in March 2020. The visit meant to explain to the potential participants:

- What REACT project is
- What is the commitment for the participants
- What will happen at the end of the REACT project

Due to the Coronavirus restrictions which are still in place in the Island, the mentioned dwellers has been contacted by RESPOND pilot manager, which is part of the RESPOND project consortium. Currently (23 June 2020), there are four confirmed houses (AI4, AI5, AI6, AI7), which verbally agreed to participate as a residential cluster in REACT project.

The AI5, AI6, AI7 houses has a mix of RES deployment including solar PV, and compatible existing heat pumps, which will be potentially fitted with Wi-Fi adapters to allow communication with the REACT platform via the via the “MELCloud” cloud-based control systems, allowing HP optimal control strategy with the aim of maximizing self-consumption within the buildings.

The islands will have voted by June 25th has to when they will be open to non/islanders. A potential future visit will include a technical analysis for installation of new energy meters or use pre-existing energy meters already in place from a RESPOND project.

2.2.3.2 Planning Permission Required from Local Authority (Galway County Council Planning Department).

The island of Inis Mór is designated a Special Area of Conservation (SAC) (site code 000213). This implies that any change to any building on the island requires planning permission from the Local Authority (Galway County Council Planning Department).

Planning documents were prepared as soon as it was made known to UnaG that solar PV panels were to be installed on the four community buildings. The planning application was lodged and validated on the 5th of May 2020. A decision is due on the four applications circa 20th of July 2020.

As set out in the Galway County Development Plan 2015-2021, it is a strategic aim of the plan to promote renewable energy policies and objectives. Objectives ER9 specifically relates to Oileáin Árann’s (Aran Islands) objective to develop the Islands to be energy independent into the future. ER9 states that Council shall continue to support this objective. On this basis, we are hopeful for a positive outcome for all four applications.

2.2.3.3 Visual Impact Assessment.

As part of the planning application, a Visual Impact Assessment was carried out on the four community buildings. The community offices are of concern due to the fact that they are located opposite a National Inventory of Architectural Heritage (NIAH) site (Reg. No. 30411104).

With respect to the NIAH site, which is located in front of Community Offices, the proposed solar PV panel installation is to the rear of this building and therefore will not adversely visually impact on the NIAH site.

As shown in Figure 1 below, the solar PV panels proposed are very discrete, slimline, shallow mounted, all-black units which blend in effectively against the plain roof tiles on each of the three public buildings (PV install at the school is on a flat roof). And as is evident also from the submitted drawings below, the panels are proposed to be only installed on the rear pitched roofs (or in the case of the school the flat roof). Therefore, the panels will not be visible from the front of the buildings and front access road. In some cases, the panels will be visible; however, given the discrete all-black nature of the panels blending into the existing plain roof tiles, it is opined that the visual impact will be limited.

In addition, as shown in the planning drawings, a clear minimum of 500mm is maintained from the roof edges to the outer edges of the panels and the distance between the plane of the roof and the top surface of the panel does not exceed 150mm. This is in-line with the solar PV panel Exempted Development requirements as set out in the Irish Planning and Development Regulations 2001–2019.

2.2.3.4 Glint and Glare Report.

Solar reflectance or reflectivity from solar panels, otherwise known as Glint and Glare, has historically been an issue with solar panel installations. Because the island has an airfield and the flight path runs directly over the village of Cill Rónáin this Glint and Glare Report is required.

Older solar panels used to reflect a lot of sunlight often causing Glint (defined as a momentary flash of bright light) and Glare (defined as a continuous source of bright light). However, the installation of the solar PV panels at the four locations will have negligible Glint and Glare effect on key receptors (e.g. local residents in surrounding dwellings, road users and aviation pilots) for the following reasons:

1. Modern–day solar PV panels are designed to absorb as much as sunlight as possible to generate maximum electricity – therefore, minimal sunlight is reflected from these PV units resulting in significantly reduced Glint and Glare effects.
2. Different materials reflect sunlight more than others do. Solar PV panels are shown as having one of the lowest solar reflectance levels (only reflecting

approximately 4% of sunlight), this is lower than water and significantly lower than aluminium, which is commonplace in the build-environment.

3. The solar PV panels proposed have an additional antireflective surface coating to reduce solar reflectance even more.
4. The airstrip on Inis Mór is located approximately 2km southeast of the village. We engaged with the Irish Aviation Authority (IAA) and Aer Arann in relation to the four proposed REACT locations on Inis Mór. Detailed mapping and PV panel information was provided to the IAA and Aer Arann. The IAA and Aer Arann / Inis Mór Aerodrome reviewed and confirmed that all four proposed REACT solar panel locations pose no perceived significant risk to aviation safety and that a specific Glint and Glare analysis is not required by them.

5. Finally, it is worth noting that Glint and Glare only occurs when the Sun directly shines on a solar panel. When it is overcast or raining, there can be no Glint and Glare. Based on 30-year averages between 1981–2010, Met Éireann's recorded average daily sunshine duration percentage at Shannon Airport (nearest main weather station to Inis Mór) is only 28% (Met Éireann, 2020). This means, on a daily average, there can be no potential for Glint or Glare for approximately 70% of the time during daylight hours.

2.2.3.5 Installation Considerations

As the data from the energy monitors, and the PV panels are to be uploaded to the project cloud platform there is a requirement for each community building to have Wi-Fi and internet access. Two of the four community buildings, the community hall and the childcare facility, do not have internet access / Wi-Fi network. Arrangements are currently being made to install a Wi-Fi system at the childcare facility and the hall committee are discussing their options regarding it. This will have to be in place in order for project information to be transmitted following installation. Signal strength may also be an issue at the two buildings that have internet access, the community offices and the school.

Another installation consideration is the cable route from the roof to the proposed location of the equipment. This will have to be determined and reported on in the structural and electrical surveys that is to be carried out.

2.2.3.6 Structural Survey Requirements.

A suitably qualified Structural Engineer will be required to undertake a structural survey on the four community buildings. The detailed report must focus on the ability of the roof to support the specified solar PV system and the connection equipment. Cable route to the equipment and access requirement to the roof / attic space will also need to be reported on.

2.2.3.7 Electrical Report.

A report is required to determine the capacity of each distribution board. The report must include high-level general arrangement drawings detailing (a) proposed location of PV plant and (b) route from the roof /attic space to the distribution board)

2.2.3.8 Programme of Works

Appointment process of an installation contractor will commence when the structural and electrical reports have been completed and a tender pack produced for potential contractors to price. It is anticipated that the installation of the equipment will occur at month 22.

A detailed programme will be required from the installation contractor once they are appointed.

Plans and Elevations of the Four Community Buildings.

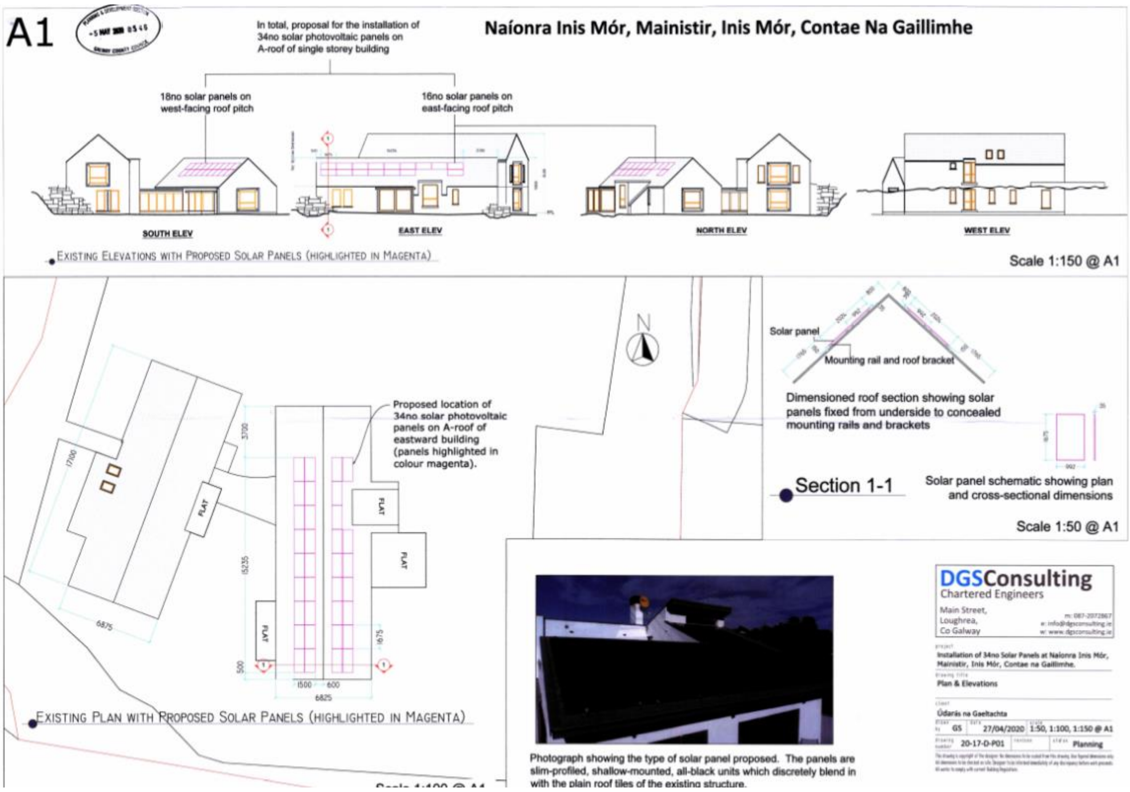


Figure 3: Plan and Elevation of the Childcare Facility

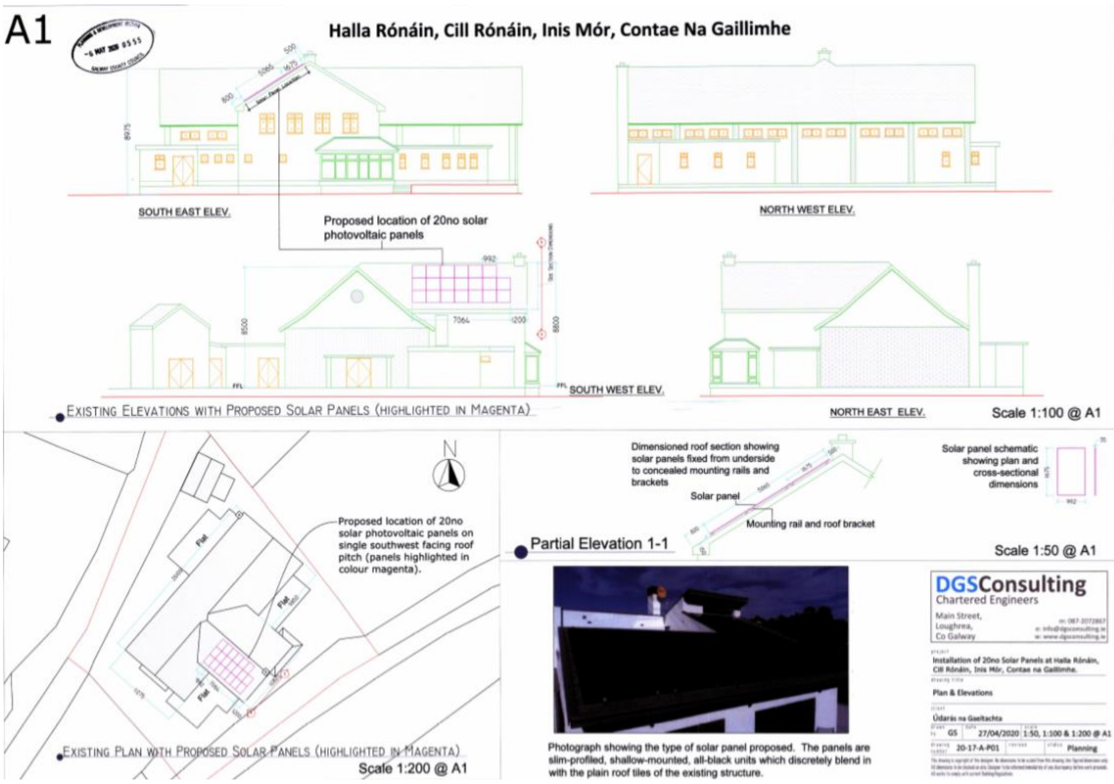


Figure 4: Plan and Elevation of the Community Hall

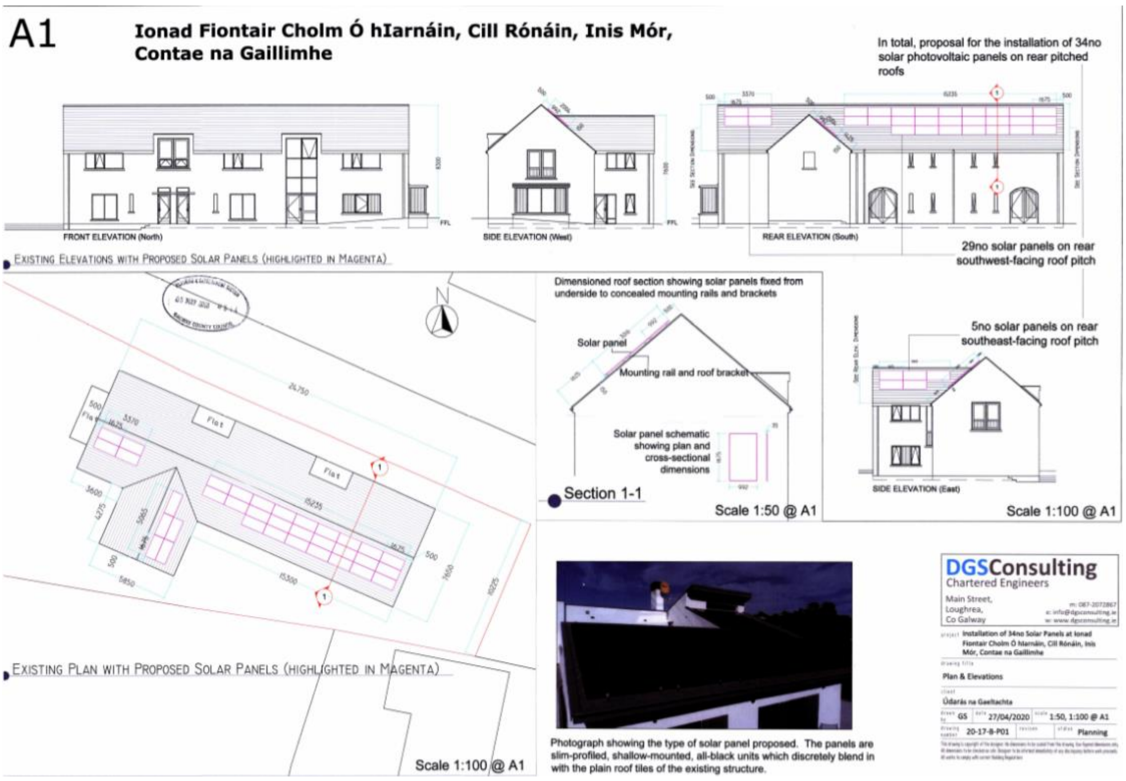


Figure 5: Plan and Elevation of the Community Offices

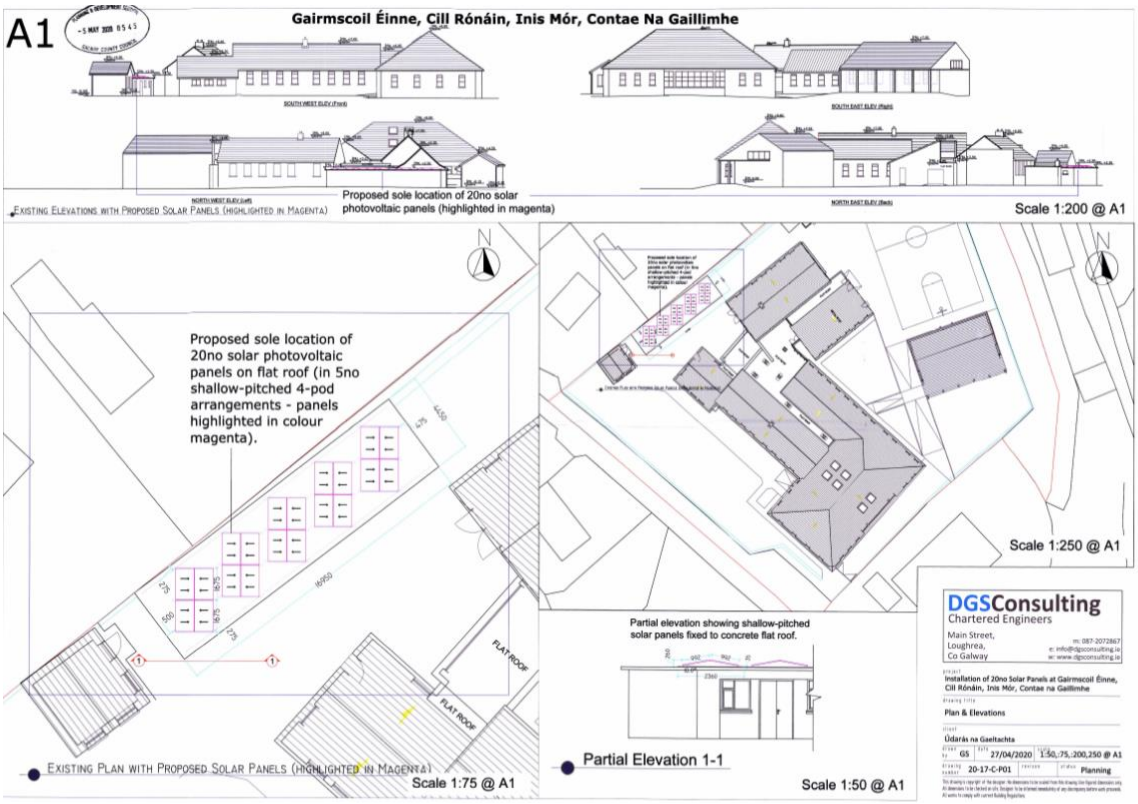


Figure 6: Plan and Elevations of the School

2.2.3.9 Installation Works

2.2.3.10 Appointment of an Installation Contractor.

Following the appointment of a project manager (PM) and in turn following the completion of the structural and electrical reports the PM must prepare tender documents in accordance with Irish Department of Finance Capital Works Management Framework in order to appoint an installation contractor.

The suite of documents include:

- Detailed scope of work;
- Structural Survey Report;
- Electrical Report;
- Installation instructions;
- instructions to Tenderer Documents (incl. award criteria);
- Conditions of Contract.

On receipt of the tenders from the various contractors, a Tender Assessment Meeting will take place. Tenders will be judged on the Most Economically Advantageous Tenderer (MEAT).

Following the appointment of the installation contractor we will require of him / her; a detailed installation programme, safety and health documentation and associated insurance documentation.

2.2.3.11 Safety Procedures.

Successful tenderer will be appointed as Project Supervisor Construction Stage – subject to verification of competency.

Appointed installer will be required to meet the Safety, Health, and Welfare at Work (Construction) Regulations 2013. Paying special attention to the working at heights regulations and the regulations on electrical works.

On appointment, the contractor will be required to produce a company safety statement and a method statement for each of the community buildings on how he/she proposes to install the PV panels safely.

A Completion Certificate will also be require and any other relevant documentation for the Handover/Safety file.

2.3 Implementation strategy

2.3.1 Overall strategy

Power systems worldwide are undergoing a deep transformation. Systems that traditionally had a centralised structure with large thermal and hydro generating units are shifting towards a more complex and decentralised system. The increasing penetration of renewable energy, the expansion of markets and the deployment of information and communications technologies (ICT) in the power sector are enabling the shift of generation towards smaller units connected to the distribution system and forming what is referred to as the smart grid. In this new grid paradigm, self-consumption of renewable energy at consumer level is one of the main innovations that can change drastically how the power system is structured and operated.

Self-consumption of renewable energy can be defined as electricity generated from renewable energy sources not injected into the distribution or transmission grid or instantaneously withdrawn from the grid, but instead consumed by the owner of the power production unit or by associates directly contracted to the producer (Dehler et al., 2017). Given the steep reduction in the cost of renewable energy (IRENA, 2018c), some consumers are finding it economically and technically feasible to install their own generation, and self-consumption is therefore starting to become a widespread concept. From the different renewable energy sources, solar PV is the most common for self-consumption given its low costs and modularity, among other features.

The main challenge for self-consumption of renewable energy is that solar PV and wind are variable resources and their production does not follow the consumer's demand. Thus, in some periods there will be an excess of energy while in others demand will not be met. For this reason, customers cannot solely rely on VRE to cover their demand. The most common solution to this has been to install, for instance, a solar PV panel to cover demand during the day, and at the same time have a connection to the electricity grid to draw electricity in case of shortages or to feed the grid with excess solar PV generation that would otherwise be curtailed.

Under this scenario, consumers are not totally independent and still rely on the electricity grid to cover their demand. If the objective is to gain independence from the electricity grid (off-grid system) or to maximise the economic benefit of the electricity fed into the grid, other solutions must be found. In this regard, electricity storage (e.g. a battery) could provide significant value to the owner of the decentralised renewable energy generation system (e.g. a rooftop PV), as well as to the electricity grid.

Electricity storage is capable of absorbing excess energy that cannot be used at a particular moment and making it available for use at a later stage when required. From a self-consumption perspective, electricity storage can be coupled with rooftop solar PV so that the excess of electricity during the day can be absorbed and used during the night, when the sun is not shining. This type of electricity storage is usually referred to as behind-the-meter (BTM) storage because it is located downstream of the connection point between the utility and the customer.

The main benefit of BTM storage for consumers is to maximise self-consumption of renewable energy. This means that the storage system absorbs any excess energy and uses it to cover demand when solar PV production is not available. In this case, if the storage system cannot cover demand, electricity can be still drawn from the grid. Other benefits of BTM storage according to IRENA (2019d) are also:

- Reducing the consumer's electricity bill by absorbing electricity when there is an excess of VRE generation or when electricity prices are low, and selling the absorbed energy to the electricity grid during periods when prices are high.
- Reducing demand charges, which are usually based on the consumer's highest electricity usage requirement.
- Providing backup power and increasing energy resiliency for the consumer.

If the consumer is connected to the electricity grid, BTM battery storage could also have benefits for the system operator. (IRENA The International Renewable Energy Agency, s.f.) shows that the main benefits of BTM storage for system operators are:

- Providing flexibility through frequency regulation and energy shifting (see the cases "Operating reserves" and "Energy arbitrage").

- Deferring network investment (see the case "T&D investment deferral").
- Deferring peaking plant investment (see the case "Peaking plant capital savings").

The role of aggregators and the value they can provide to BTM storage should be noted. Aggregators are new market participants that operate a virtual power plant, which is an aggregation of dispersed distributed energy resources with the aim of enabling these small energy sources to provide services to the grid (IRENA, 2019c). Aggregators allow enhanced participation of BTM storage in the different electricity markets, help decrease the marginal cost of power and optimise investment in power system infrastructure; however, they require a proper regulatory framework and advance metering infrastructure in order to exploit their full potential.

Apart of tariffs and pricing schemes, the main enablers that incentivise BTM deployment are:

- The regulatory framework, in particular a liberalised wholesale electricity market without price caps (e.g. NYISO).
- Advanced metering infrastructure.
- Better generation forecasting.

A consistent and well-designed regulatory framework is needed to keep incentivising BTM storage deployment. Such a framework has to allow:

1. The participation of aggregators, which can increase the value of BTM storage by providing services to the grid as a virtual power plant;
2. Time-of-Use tariffs that will indicate the most economical times for storage to charge from the grid;
3. And, net billing schemes, which will increase the revenues that BTM storage can obtain by charging to and drawing from the grid.

In this way, REACT project has been designed to include the necessary steps and tools to obtain a good understanding of the main parameters that influence the efficiency and optimal installation of VRE systems for self-consumption including energy storage in island structures, for individual houses and for small community cases.

In the next points, the different strategies related to equipment communication, training and testing will be developed in deeper details.

2.3.2 Communication strategy

Communication systems are indispensable for energy dispatching and control systems, they are the mean to allow, on one side data flow from the field level to the platform and control actions from the platform to the field level.

One-way communication allows the monitoring of the renewable equipment production and storage, and the consumption at the building level, to provide the baseline data for analysis at platform level. Two-way communication allows also, the control actions be applied to the assets and equipment at the field level.

The smart meters and gateways are a key element to enable data acquisition and control actions. The deployment plan for each installation must consider, if the devices installed or to be installed on site, can play the role for the two-way communication or if additional communications gateway is needed.

One of the most important requirements in the deployment plan regarding communication is that smart meter, PV inverter, battery inverter and gateways must be able to communicate between them to interchange data and commands.

For residential application, usually the communication network uses a home area network (HAN) to connect the equipment and smart meters installed in the building to the communication gateway. There are a range of different communication network technologies, the choice of the most suitable way will depend on the type of equipment and the installation distance between them, besides the characteristics of installation of the place and susceptibility to external noises.

The wired networks have been considered faster, more reliable and secured networks than the wireless ones. However nowadays wireless networks have evolved, the speed and robustness have been increased, with wireless standards, like the 802.11ac. An analyse of the router device installed in the building, that provides the internet connection, could arise which is the most suitable election in terms of performance in every specific building, but in any case, a wired network has enough performance in terms of the communication speed required for the REACT purposes.

An additional issue is related to the installation itself of the wired connections. When the distance between the router and the smart meters and equipment is high and this could imply additional works to improve connectivity inside the building. These works in the building could generate disruption and a negative impression on behalf of the occupants towards the REACT solution.

D1.4 (REACT D1.4, 2020) collects information related to the RES assets, smart meter and monitoring systems to be installed in the demonstration sites. The equipment to be installed is MIDAC battery and inverters, NesosNet meters, Victron meters and inverters and SMA meter and inverters; PV panels and batteries will be installed.

Midac and Nesosnet equipment provide integration at cloud level.

SMA and Victron equipment is not able to communicate directly with REACT cloud. Energy Gateway located at field level will be in charge of the communication between platform and equipment. SMA and Victron provide Modbus communication protocol, by this reason, at local network level, it will be enabled Modbus protocol to enable Energy Gateway for the communications at field level.

At cloud level the communication protocol provided by the REACT cloud is MQTT. The Energy Gateway will be in charge of the translation between both protocols, Modbus and MQTT.

The Energy Gateway will implement one application based on OpenMUC framework. This application will implement the publish/subscribe pattern for two main purposes. The first is the publication of data from field level to the REACT cloud under MQTT protocol. The second is the management of the control actions to be triggered to the equipment, published to the MQTT broker by REACT applications and Analytical Services.

The figure below shows the communication protocols that will be used, MQTT at cloud level and Modbus at field level.

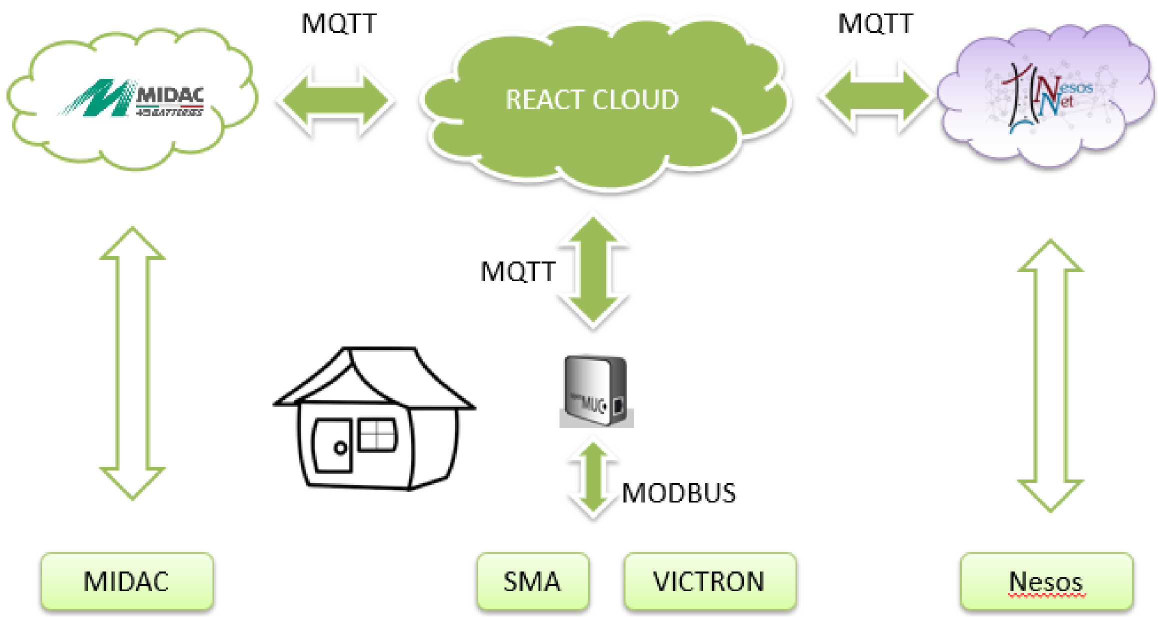


Figure 7: Communication protocols

In telecommunications, communication protocols are rules that determine the format and transmission of data. These protocols can be implemented via hardware devices, software, or both. The most recent protocols are assigned by the Internet Engineering Task Force (IETF) for Internet communications, and the International Telecommunication Union (ITU-T) for telecommunication protocols that run on the Public Switched Telephone Network (PSTN).

The Internet Protocol (IP) is defined as the protocol for sending data from one computer to another across the Internet, with each computer having at least one IP address that identifies it from all other computers on the Internet. This protocol is used with other protocols within the IP suite, most notable of which include:

- Transmission Control Protocol (TCP) – used for data transmission

- User Datagram Protocol (UDP) – used by programs to send short datagram messages
- Internet Control Message Protocol (ICMP) – messages used for diagnostic or error-generating purposes
- Hypertext Transfer Protocol (HTTP) – application protocol that uses hyperlinks between nodes containing text
- Post Office Protocol (POP) – used by local email clients to retrieve email from a remote server over TCP IP
- File Transfer Protocol (FTP) – protocol to transfer computer files from a server to a client and vice versa
- Internet Message Access Protocol (IMAP) – a communication protocol used by email clients to retrieve messages from a mail server over TCP IP

There are several type of internet connections available: ADSL, FTTH, 3G, 4G networks

- ADSL

ADSL is the acronym for "Asymmetric Digital Subscriber Line", it is a technology for transmitting digital information at a high bandwidth on existing phone lines to homes and businesses.

- FTTH

Also known as FFTX "Fiber to the x", which is a general term for various fiber-optic communication networks, where X represents the destination of the fiber-optic line. The FTTx network applications in GPON access have the following in common: The data, voice, and video signals of terminal users are sent to ONUs, where the signals are converted into Ethernet packets and then transmitted over optical fibres to the OLT using the GPON uplink ports on the ONUs. Then, the Ethernet packets are forwarded to the upper-layer IP network using the uplink port on the OLT.

- 3G and 4G

3G and 4G are the third and fourth version of generation of broadband cellular network technology. A 4G system must provide capabilities defined by ITU (International Telecommunication Union) in IMT Advanced (International Mobile Telecommunications Advanced). 3G and 4G technologies has been one of the basis of the success of the smartphones penetration in the global telecommunication market and they are a valid option when no wired internet connection in the building is present.

- Satellite Connection

Satellite is the most expensive communication solution, for setup and usage, with some delays due to the enormous distance the signals must travel. But sometimes this is the only solution to get an internet connection, mainly at remote locations. Most of the contracts have a data-limit, and the unlimited connections are still very expensive. This option for real-time data acquisition it is not economically profitable.

The availability of an internet connection is a mandatory requirement, and as faster communication speed is, better performance for the installation. The preferable network at router level is ADSL or FTTH, due has better performance and communication speed. If, in some case, the internet connectivity availability is only 3G/4G, it will be required to analyse if this could imply any potential problem, by the network coverage. By default, Energy Gateway installations also allow 3G network connectivity.

2.3.3 Training strategy

REACT platform interaction with the installed system is implemented in two ways, the first one is the data acquisition from the field level to the platform, and the second one is the control actions from the platform to the field level.

The gathered data at the field level, such as the electric consumption in the building, the state of charge and state of the health of batteries, the thermal storage level; plus additional information at platform level, some of them provided by analytical services, such as the energy demand forecast, the energy production forecast for the installed PV panels, the energy optimization parameters, the weather forecast, the energy prices, the optimal operation models from the battery, heat pumps and buildings, will deliver control actions in order to provide optimal control for the assets installed in the demonstration scenarios, maximizing the consumption of the renewable energy production and reducing the energy from the electrical grid.

The control actions to be delivered will depend on the topology of the assets installed in the building. There are two types of control actions; the first one is the automated DR, when there are assets able to be automatically controlled. The second one is when there aren´t assets able to be automatically controlled, and the DR actions requires manual intervention of participants. The potential DR actions are detailed in deliverable D1.3 (REACT D1.3, 2020)

The potential interactions with the assets installed at the field level will be related to PV panels, batteries, heat pumps and equipment controlled by programmable relays. The interactions would be, change the setpoint of temperature of heat pumps, set the operation mode of the heat pumps to "heating" or "cooling", set the operation mode of the batteries to "charging" or "discharging", switch "on/off" equipment controlled by programmable relays.

2.3.4 Testing strategy

Within the REACT project in the framework of T3.3 laboratory tests will be executed in order to prove the functionality of the interconnection of the REACT platform and the components it interacts with prior to the de-facto installation on the demonstration sites.

Therefore, the purpose of these tests is not to conduct component tests for the individual components but much more system testing in order to evaluate the total system behaviour.

This will be conducted via the execution of HIL Simulations were the energy infrastructure of the demo site is implemented as software framework which will interact with the components.

The potential control strategies that are developed in the REACT project (outside of T3.3) will be evaluated and different operation scenarios (also defined outside of T3.3) will be considered.

2.3.4.1 HiL-Environment

The HIL Environment that will be used is the Flexible Electric Vehicle Equipment Laboratory embedded within the SmartEST laboratory at AIT. This facility combines HIL and Co-Simulation approaches. This Laboratory infrastructure was created in the past prior to the REACT project focusing on the grid integration of electric vehicles. IT is very important to state clearly that although the following figures show EVs as DUT, the use of the laboratory is not restricted to EVs. Utilizing different Smart Grid components (PV, PV-Inverters, Batteries, Battery Inverters, and Heat Pumps) is in the same way shape and form possible. An overview of the facilities architecture is given in the following figure.

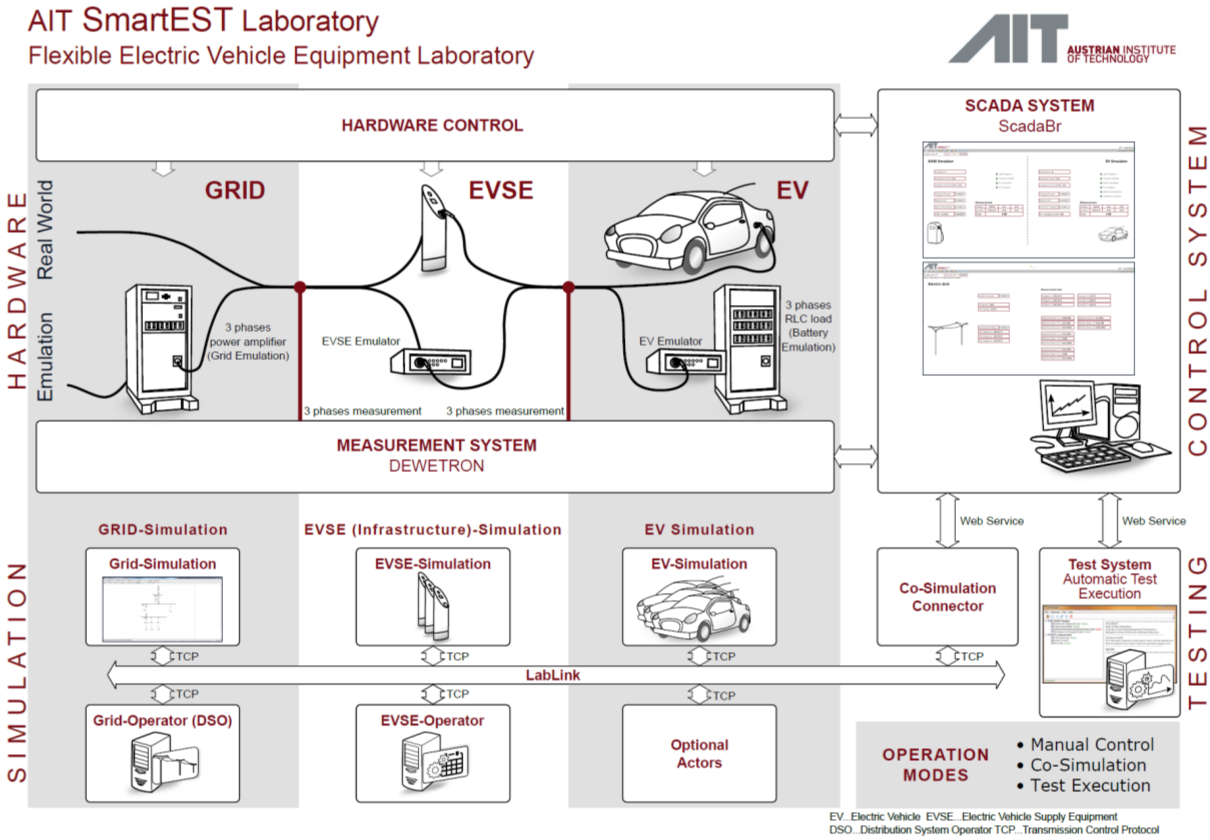


Figure 8: Architectural Overview of the FlexEVELab @ AIT SmartEst

The FlexEVELab consists out of three parts that are described subsequently: These parts are:

- The Hardware Part
- The Software Part
- And the SCADA system that interconnects the above two.

2.3.4.2 Hardware Part

The Hardware part enables to interconnect the grid the charging station and the EV as simulation, emulation and or as real hardware. The DUT being represented as an EV is due to the exemplification of the figure, different components can be utilized in the same manner. For the REACT project, these components will be the ones that are installed at the demonstration sites (PV and Battery Inverters and Heat Pumps).

The Electric grid can be either implemented using the grid connection of the laboratory itself or via a power amplification unit that allows to set different grid scenarios for the DUT. These grid scenarios are controlled via a real time system or (depending on the use-case) computation systems with similar functionality.

The EVSE and the EV in the figure represent the different components that will be evaluated for their behaviour in combination with the REACT platform

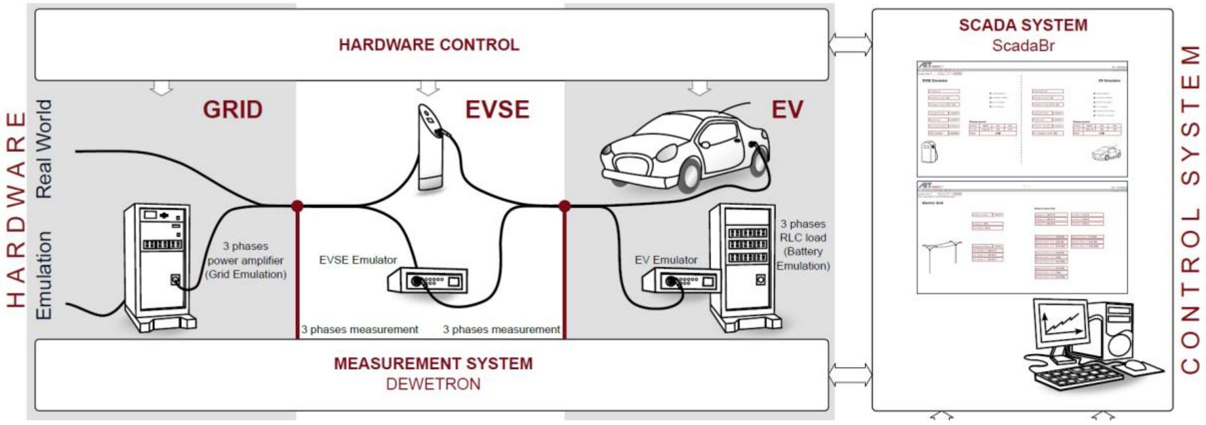


Figure 9: Hardware part of the FlexEVELab

2.3.4.3 Software Part

The software part enables the connection of multiple simulation tools. This is enables using the AIT developed LabLink Message bus. This message bus is an MQTT based software that allows for the communication between different simulations. As the LabLink does not require a specific communication structure but encloses the messages with an internal "envelope" in order to direct the messages correctly the simulation tools can interface with the protocol or standard that is required as needed by the use case.

The following figure shows the simulation part of the FlexEVELab:

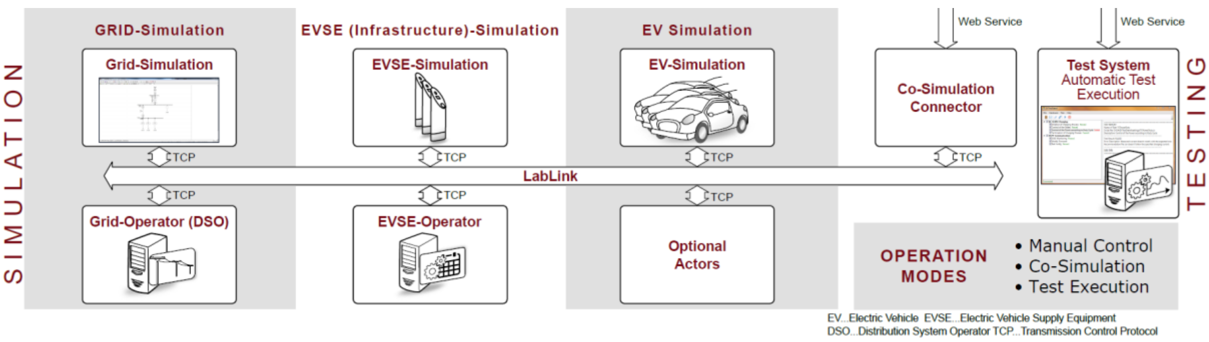


Figure 10: Software apRt of the FLexEVELab

2.3.4.4 HiL Test-Setup and requirements

The HIL Tests are currently scheduled to be executed in August 2020. Currently the planning is ongoing. This includes the data acquisition for the components as well as for the energy system that is at the demo sites.

The main aim of these tests is not to prove the functionality of single components but to show the functionality of the system as a whole. Thus, the interfaces between the REACT platform and the components are of key interest. Furthermore, the effects of the different control and optimization strategies that are being developed in the REACT project will be evaluated.

The cooperation of the different suppliers and grid operators is key to such an evaluation and has a direct impact on the results that can be achieved.

3 Technical deployment

3.1 Installation equipment

3.1.1 La Graciosa

3.1.1.1 Definition and scenario validation

In order to better define the materials, the buildings have been classified by their daily consumption profiles.

Based on these criteria there has been defined seven consumption profiles, and therefore each building is assigned to the corresponding profile. See table below.

Profile	Daily energy consumption(kWh)	Nº of buildings
1	4-6	1
2	6-10	4
3	10-15	4
4	15-25	2
5	Shared self-consumption	1
6	25-40	3
7	More than 40	2

Table 5: Technical scenarios

Therefore, taking into account the building characterization and the data collection of the deliverable 1.3, and in order to cover the needs of each profile and for the implementation of the different storage technologies three different technical scenario are defined:

- Self-consumption with energy storage

- Self-consumption without energy storage
- Shared self-consumption without energy storage

3.1.1.2 Self-consumption with storage in building with Lithium (Li) or Lead Acid (Pb)

In this specific scenario, the PV energy produced is consumed immediately and the surplus is stored in the batteries in order to be consumed during low PV production hours or when it is considered more appropriate, to optimize the energy efficiency.

Lead-Acid and Lithium batteries will be deployed. All installation at this scenario are configured in DC-Coupling mode, which means that the PV array goes to the battery through battery charger controller and from battery to inverter where is inverted to feed the loads. See figure 7.

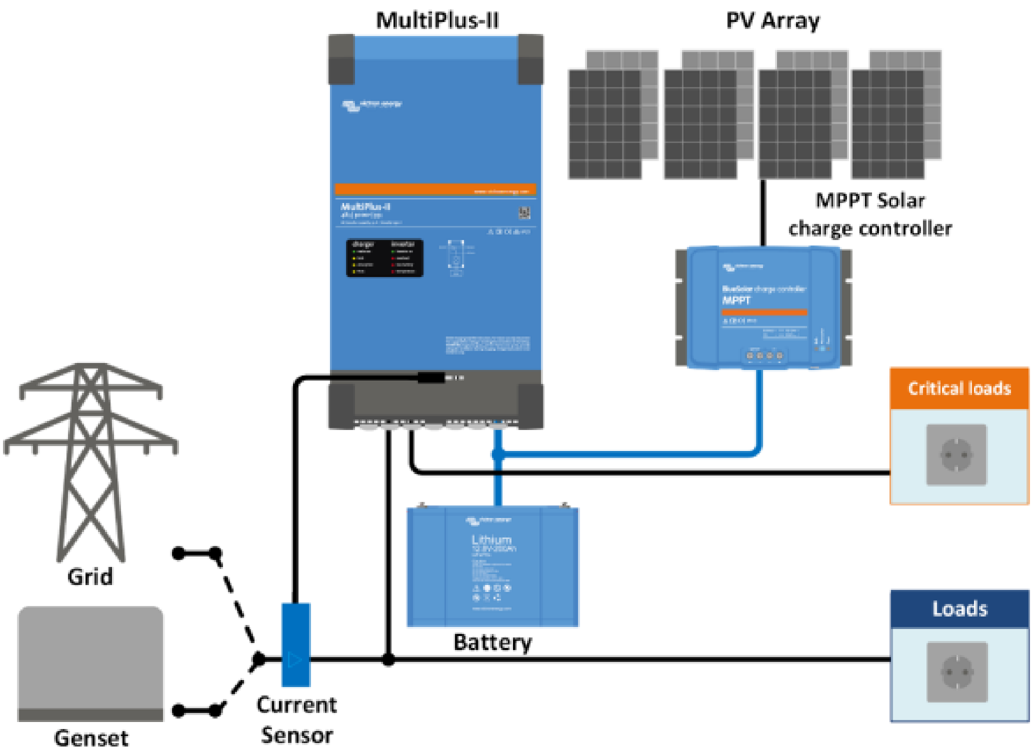


Figure 11: DC-Coupling configuration single-phase system

React ID	Daily Consumption (kWh)	Observations
LG 2	6	The DC-Coupling configuration applies to both single-phase and three-phase systems, for the last ones will be necessary three inverters
LG 2	4,8	
LG 3	37,87	
LG 3	70,55	
LG 4	50,3	
LG 5	134,6	

React ID	Daily Consumption (kWh)	Observations
LG 6	25,817	
LG 11	9,8132	
LG 12	7,8738	
LG 13	7,0557	
LG 14	14,87	
LG 15	13,1338	
LG 16		
LG 17	17,304	
LG 18	15,6899	
LG 19	21,9698	
LG 20	9,6649	

Table 6: Selected REACT buildings for self-consumption with energy storage

3.1.1.3 Self-consumption without energy storage

Technical scenario where PV energy production is directly consumed and the surplus energy is directly fed to the public grid, there will be no energy storage. The installation is done in AC-coupling, where the PV array is converted through the PV inverter and to the grid.

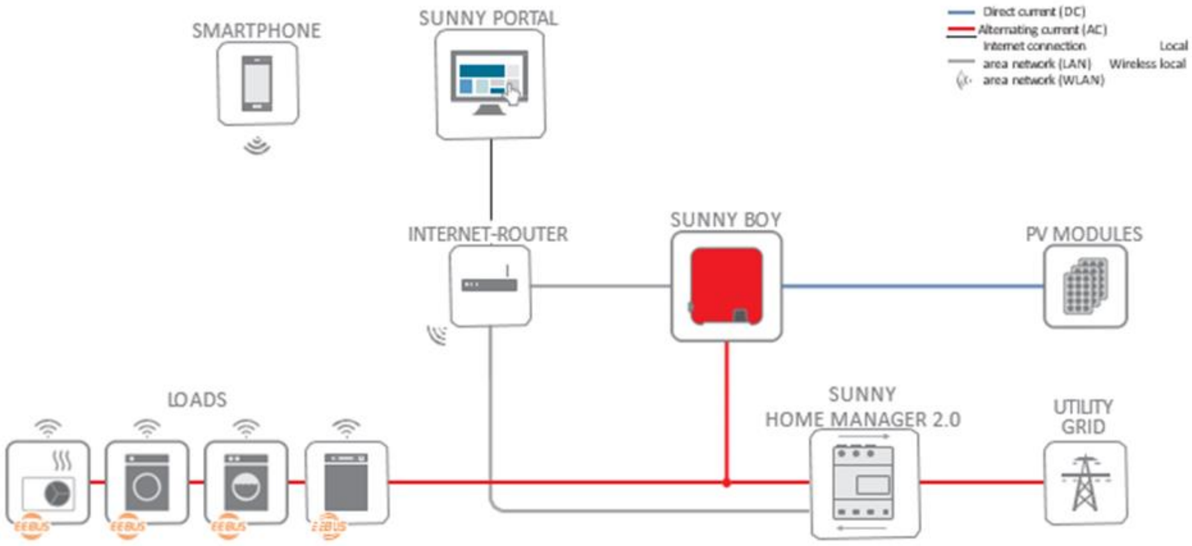


Figure 12: AC-Coupling configuration in self-consumption without energy storage.

The table below shows the buildings where PV system is already installed, so that we can make them part of the REACT project deploying control and monitoring systems for the REACT strategies.

React ID	Daily Consumption (kWh)	Observation
LG 7	3,6882	Buildings with PV, will only be installed monitoring devices to interact with React platform
LG 9	18,9368	
LG 10	10,431	
LG 10	24,8975	

Table 7: Selected building for self-consumption without storage

3.1.1.4 Shared Self-Consumption without Storage

Shared self-consumption is defined as the consumption of electrical energy from generation facilities connected inside a network of several consumers or through a direct line of electrical energy associated with a community of consumers. The energy storage is not implemented.

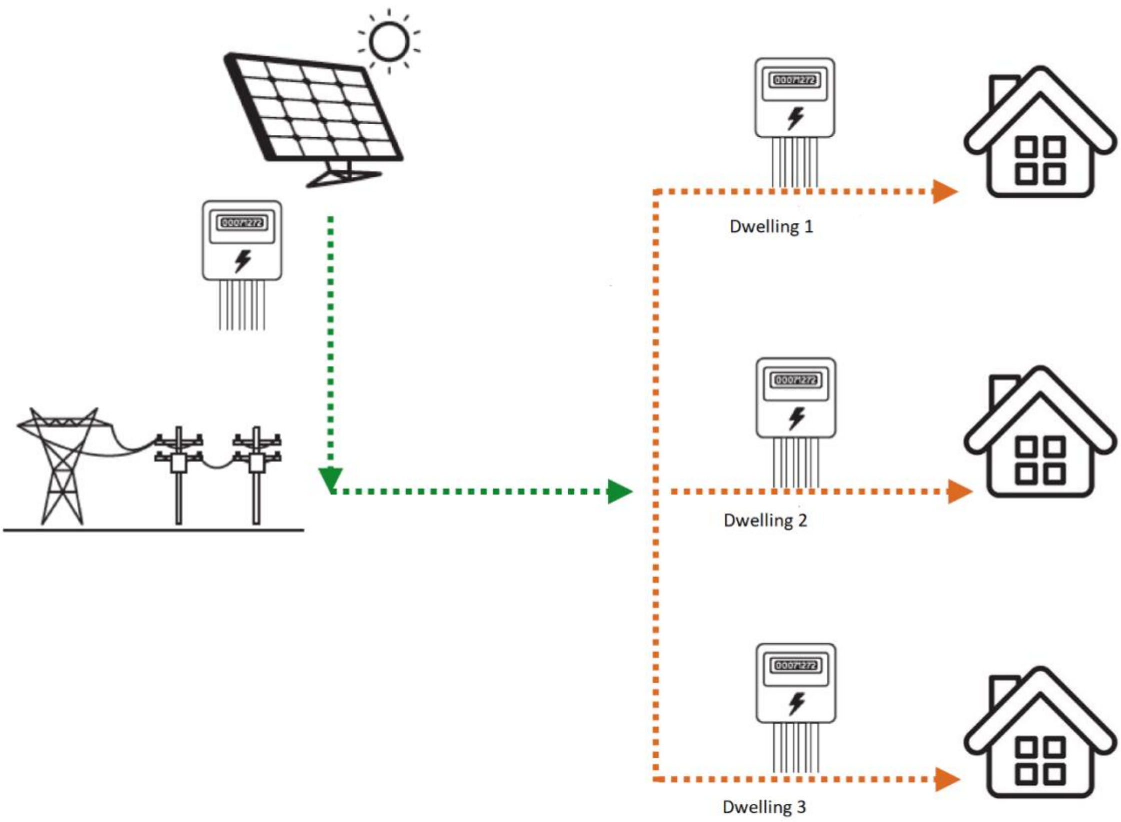


Figure 13: Shared self-consumption

React ID	Daily consumption (kWh)	Observations
LG 1	4,7	
LG 2	67	Technically not feasible

Table 8: Selected buildings for shared self-consumption

3.1.1.5 RES definition. PV and Storage

With the information of the daily consumption for each profile, the site solar radiation and taking in account the recommendation stated on the previous reports deliverables 2.2 and 2.3, has been calculated the PV array and the storage necessary to be installed in each building.

Profile	Daily consumption profile (kWh)	Battery		PV panels	
		Type		Nº panel	Wp
1	4-6	Lead acid	4kWh	4	1240
		Lithium	3,80kWh		
2	6-10	Lead acid	4kWh	6	1860
		Lithium	3,80kWh		
3	10-15	Lead acid	5,5kWh	8	2480
		Lithium	7,60kWh		
4	15-25	Lead acid	11kWh	12	3720
		Lithium	11,90kWh		
5	25-40	Lithium	16.6Kwh	18	5580
6	More than 40	Lithium	22.1kWh	24	7440
7	Shared self-consumption	No storage		18	5580

Table 9: PV and Energy Storage definition

The React buildings corresponding to consumption profiles 1, 2, 3 and 4, the existing electric system is a single-phase and the profiles 5 and 6 the electric system is in three-phase, will be carried out the self-consumption with storage.

The profile 7 are a group of dwellings in the same building with low daily energy consumption, will be carried out the shared self-consumption without storage.

3.1.2 San Pietro

3.1.2.1 Heat Pump Equipment

3.1.2.2 Residential buildings heat pump equipment

In the deployment works at the San Pietro demo site, new heat pump systems will be installed in the residential buildings. The majority of these systems will be Mitsubishi Electric Multi-split air-to-air (ATA) heat pumps for air conditioning (air cooling and heating), and will directly replace existing older air conditioning systems. Each Multi-split system consists of a single outdoor unit, with between two and six indoor units located in multiple rooms. Example specifications of indoor and outdoor units for the MSZ/MXZ Multi-split range are summarised in **Error! Reference source not found.** and **Error! Reference source not found.**, respectively. The detailed sizing and specification of all new heat pump systems is subject to a detailed survey of the buildings (see Section **Error! Reference source not found.**). In addition, the initial selection process has identified a small number of dwellings with gas boilers that may be suitable for replacement with air to water (ATW) heat pumps for hot water and space heating, subject to further inspection.

All new heat pump systems will have the capability for advanced monitoring and control from the REACT platform via the MELCLoud API. Each of the indoor units will be fitted with Wi-Fi adapters to allow communication with the REACT platform via the Mitsubishi Electric MELCloud cloud-based control system (Mitsubishi Electric, 2014). As part of the installation, each ATA heat pump will be fitted with a MELCloud MAC-557IF-E Wi-Fi adaptor, which is connected to the CN105 terminal on the indoor unit flow temperature controller (FTC) circuit board and paired with the local wireless internet router by WPS connection (NOTE - a professional installer is required to complete the installation of the MELCloud adapters) (Mitsubishi Electric, s.f.).

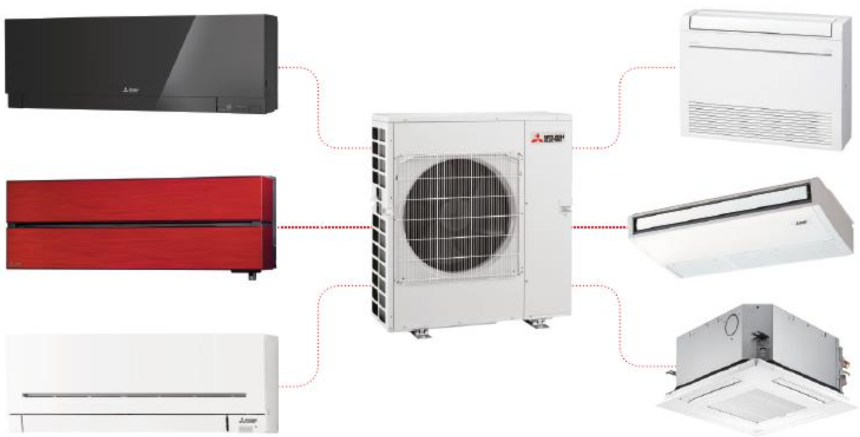


Figure 14: Example of Multi-Split system with MXZ-outdoor unit connected to multiple indoor units

INDOOR UNITS		MSZ-EF25VG B/S/W	MSZ-EF35VG B/S/W	MSZ-EF50VG B/S/W
CAPACITY (kW)	Heating (nominal)	3.2 (1.0-4.2)	4.0 (1.3-5.1)	5.8 (1.4-7.5)
	Cooling (nominal)	2.5 (0.9-3.4)	3.5 (1.1-4.0)	5.0 (1.4-5.4)
SHF (nominal)		0.97	0.8	0.7
COP / EER (nominal)		4.57 / 4.63	4.21 / 3.85	3.72 / 3.25
SCOP / SEER (BS EN14825)		4.7 / 9.1	4.6 / 8.8	4.5 / 7.5
ErP ENERGY EFFIcIENcY cLASS	Heating/Cooling	A++ / A+++	A++ / A+++	A+ / A++
AIRFLOW (l/s)	Heating/Cooling - SLo-Lo-Mi-Hi-SHi	67-77-103-148-198 / 67-77-105-138-175	67-77-103-148-212 / 67-77-105-138-175	107-120-150-185-243 / 97-113-132-153-188
PIPE SIZE mm (in)	Gas	9.52 (3/8”)	9.52 (3/8”)	9.52 (3/8”)
	Liquid	6.35 (1/4”)	6.35 (1/4”)	6.35 (1/4”)
SOUND PRESSURE LEVEL (dBA)	Heating/Cooling - SLo-Lo-Mi-Hi-SHi	21-24-29-37-45 / 19-23-29-36-42	21-24-30-38-46 / 21-24-30-36-42	30-33-37-43-49 / 30-33-36-40-43
SOUND POWER LEVEL (dBA)		60	60	60
DIMENSIONS (mm)	Width x Depth x Height	885 x 195 x 299	885 x 195 x 299	885 x 195 x 299
WEIGHT (kg)		11.5	11.5	11.5
ELECTRICAL SUPPLY		Fed by Outdoor Unit	Fed by Outdoor Unit	Fed by Outdoor Unit
FUSE RATING (BS88) – HRC (A)		6	6	6
INTERCONNECTING CABLE No. CORES		4	4	4
PRODUCT INFORMATION SHEET: https://library.mitsubishielectric.co.uk/pdf/book/MSZ-EF-VG_Product_Information_Sheet?model_query=MUZ-EF25VG#page-1 (Mitsubishi Electric, s.f.) INSTALLATION MANUAL: https://library.mitsubishielectric.co.uk/pdf/book/MSZ-EF25-50VG_MUZ-EF25-50VG_Installation_Manual__JG79J334H01_?model_query=MUZ-EF25VG#page-1				

Table 10: MSZ series indoor unit specifications for Mitsubishi Electric Multi-split system.

MXZ-F - OUTDOOR UNITS		MXZ-2F33VF2	MXZ-2F42VF2	MXZ-3F54VF2	MXZ-3F68VF2	MXZ-4F72VF2	MXZ-4F80VF2
NUMBER OF CONNECTABLE INDOOR UNITS		2	2	2-3	2-3	2-4	2-4
CAPACITY (kW)	Heating (nominal)	4.0 (1.0-4.1)	4.5 (1.0-4.8)	7.0 (2.6-9.0)	8.6 (2.6-10.6)	8.6 (3.4-10.7)	8.8 (3.4-11.0)
	Cooling (nominal)	3.3 (1.1-3.8)	4.2 (1.1-4.4)	5.4 (2.9-6.8)	6.8 (2.9-8.4)	7.2 (3.7-8.8)	8.0 (3.7-9.0)
COP / EER (nominal)		4.40 / 3.90	5.10 / 4.30	4.60 / 4.10	4.50 / 3.70	4.60 / 3.90	4.40 / 3.56
SCOP / SEER (BS EN14825)		4.16 / 6.13	4.60 / 8.69	4.61 / 8.52	4.12 / 7.96	4.07 / 8.13	4.07 / 7.55
ErP ENERGY EFFICIENCY CLASS	Heating/Cooling	A+ / A++	A++ / A+++	A++ / A+++	A+ / A++	A+ / A++	A+ / A++
MAX AIRFLOW (m3/min)	Heating/Cooling	33.7 / 32.9	33.3 / 27.7	43.0 / 42.1	43.0 / 42.1	43.0 / 42.1	42.7 / 35.4

MXZ-F - OUTDOOR UNITS		MXZ-2F33VF2	MXZ-2F42VF2	MXZ-3F54VF2	MXZ-3F68VF2	MXZ-4F72VF2	MXZ-4F80VF2
SOUND PRESSURE LEVEL (dBA)	Heating/Cooling	50 / 49	50 / 44	50 / 46	53 / 48	54 / 48	55 / 50
SOUND POWER LEVEL (dBA)	Cooling	60	59	59	63	63	65
DIMENSIONS (mm)	Width x Depth x Height	800 x 285 x 550	800 x 285 x 550	840 x 330 x 710	840 x 330 x 710	840 x 330 x 710	840 x 330 x 710
WEIGHT (kg)		33	37	58	58	59	59
ELECTRICAL SUPPLY		220-240v, 50Hz	220-240v, 50Hz	220-240v, 50Hz	220-240v, 50Hz	220-240v, 50Hz	220-240v, 50Hz
PHASE		Single	Single	Single	Single	Single	Single
POWER INPUT (kW)	Heating/Cooling (nominal)	0.909 / 0.846	0.88 / 0.98	1.52 / 1.32	1.91 / 1.84	1.87 / 1.85	2.00 / 2.25
STARTING CURRENT (A)		4.6	4.2	7	10.5	10	12.5
RUNNING CURRENT (A)	Heating/Cooling [MAX]	4.6 / 4.3 [10.0]	4.2 / 4.5 [12.2]	7.0 / 5.9 [18.0]	10.5 / 9.6 [18.0]	10.0 / 9.5 [18.0]	10.1 / 10.1 [18.0]
INTERCONNECTING CABLE No. CORES		4 Core	4 Core	4 Core	4 Core	4 Core	4 Core
TOTAL PIPE LENGTH (m)		20	30	50	60	60	60
MAX PIPE LENGTH PER INDOOR UNIT (m)		15	20	25	25	25	25
MAX HEIGHT DIFFERENCE (m)		10	15 (10 if OU higher than IU)	15 (10 if OU higher than IU)	15 (10 if OU higher than IU)	15 (10 if OU higher than IU)	15 (10 if OU higher than IU)
CHARGE REFRIGERANT (kg) /CO2 EQUIVALENT (t) - R32 (GWP 675)		1.00 / 0.68 (20m)	1.20 / 0.81 (20m)	1.40 / 0.95 (50m)	1.40 / 0.95 (60m)	1.40 / 0.95 (60m)	2.40 / 1.62 (60m)
MAX ADDITIONAL REFRIGERANT (kg) /CO2 EQUIVALENT (t) - R32 (GWP 675)		1.00 / 0.68	1.40 / 0.95	2.40 / 1.62	2.40 / 1.62	2.40 / 1.62	2.40 / 1.62
FUSE RATING (BS88) – HRC (A)		16	16	25	25	25	25
PRODUCT INFORMATION SHEET: http://library.mitsubishielectric.co.uk/pdf/book/MXZ-F_Product_Information_Sheet_2019#page-1 INSTALLATION MANUAL: http://library.mitsubishielectric.co.uk/pdf/book/MXZ-2F33-42VF_Installation_Manual__BH79A368H02?model_query=MXZ-2F33VF#page-1 http://library.mitsubishielectric.co.uk/pdf/book/MXZ-3F54-68VF_MXZ-3F72VF_Installation_Manual__BH79A372H01#page-1							

Table 11: MXZ series outdoor unit specifications for Mitsubishi Electric Multi-split system

3.1.2.3 Public buildings heat pump equipment

For the public buildings, air-to-air heat pump systems will be specified for the cooling and heating of larger communal spaces where appropriate (for example in school classrooms and assembly halls). These systems will also have the capability for advanced monitoring and control from the REACT platform via the MELCLoud

API. The detailed sizing and specification of the new heat pump systems is subject to a detailed building survey. New systems for the public buildings are likely to be packaged air conditioner (PAC) systems, each consisting of a single outdoor unit and between 2 and 4 ceiling-mounted indoor units. Example specifications of the Mr Slim PLA-M range of indoor and outdoor units are listed in **Error! Reference source not found.**11 and **Error! Reference source not found.**12, respectively. As is the case for the residential buildings, a further investigation is also planned of existing boiler systems in the public buildings to determine their potential suitability for replacement with ATW systems.

INDOOR UNITS		PLA-M35EA	PLA-M60EA	PLA-M100EA	PLA-M140EA
CAPACITY (kW)	Heating (nominal)	4.1 (1.0-5.0)	7.0 (1.6-8.0)	11.2 (2.8-12.5)	15.0 (4.2-15.8)
	Cooling (nominal)	3.6 (0.8-3.9)	6.1 (1.6-6.3)	9.5 (4.0-10.6)	13.4 (5.8-14.1)
SHF (nominal)		0.91	0.79	0.77	0.7
COP / EER (nominal)		4.20 / 4.00	3.80 / 3.30	3.71 / 3.50	3.41 / 2.70
SCOP (ηsh) / SEER (ηsc) (BS EN14825)		4.70 / 7.40	4.40 / 6.60	4.60 / 7.00	4.1 (161.3%) / 5.7 (232.7%)
ErP ENERGY EFFICIENCY CLASS	Heating/Cooling	A++ / A++	A+ / A++	A++ / A++	A+ / A+
AIRFLOW (l/s)	Lo-Mi-Mi2-Hi	183-217-250-267	200-233-317-350	317-383-433-483	400-433-483-533
PIPE SIZE mm (in)	Gas/Liquid	9.52 (3/8”) / 6.35 (1/4”)	15.88 (5/8”) / 6.35 (1/4”)	15.88 (5/8”) / 9.52 (3/8”)	15.88 (5/8”) / 9.52 (3/8”)
SOUND PRESSURE LEVEL (dBA)	Lo-Mi-Mi2-Hi	26-28-29-31	27-29-31-32	31-34-37-40	36-39-42-44
SOUND POWER LEVEL (dBA)		51	54	61	65
DIMENSIONS (mm)	Width x Depth x Height (Grille)	840 (950) x 840 (950) x 258 (40)	840 (950) x 840 (950) x 258 (40)	840 (950) x 840 (950) x 298 (40)	840 (950) x 840 (950) x 298 (40)
WEIGHT (kg)	Unit / Panel	19-May	21-May	24-May	26-May
ELECTRICAL SUPPLY		Fed by Outdoor Unit	Fed by Outdoor Unit	Fed by Outdoor Unit	Fed by Outdoor Unit
FUSE RATING (BS88) - HRC (A)		6	6	6	6
INTERCONNECTING CABLE No. Cores		4	4	4	4
GRILLE REFERENCE		PLP-6EA	PLP-6EA	PLP-6EA	PLP-6EA
WIRED REMOTE CONTROLLER REFERENCE		PAR-40MAA	PAR-40MAA	PAR-40MAA	PAR-40MAA

WIRELESS REMOTE CONTROLLER REFERENCE	PAR-SL100A-E	PAR-SL100A-E	PAR-SL100A-E	PAR-SL100A-E
PRODUCT INFORMATION SHEET: https://library.mitsubishielectric.co.uk/pdf/book/PLA-M_R32_Standard_Inverter_SP?model_query=PLA-M71EA#page-2 INSTALLATION MANUAL: https://library.mitsubishielectric.co.uk/pdf/book/PLA-M35-140EA_Installation_Manual__GG79D015W01?model_query=PLA-M71EA#page-8				

Table 12: PLA-M series indoor unit specifications for Mitsubishi Electric Mr Slim packaged air conditioner system.

OUTDOOR UNITS		SUZ-M35VA	SUZ-M60VA	PUZ-M100VKA	PUZ-M140VKA
SOUND PRESSURE LEVEL (dBA)	Heating/ Cooling	48 / 48	49 / 51	51 / 54	55 / 57
SOUND POWER LEVEL (dBA)	Cooling	59	65	70	73
WEIGHT (kg)		35	54	76	84
DIMENSIONS (mm)	Width x Depth x Height	800 x 285 x 550	840 x 330 x 880	1050 x 330 x 981	1050 x 330 x 981
ELECTRICAL SUPPLY		220-240v, 50Hz	220-240v, 50Hz	220-240v, 50Hz	220-240v, 50Hz
PHASE		Single	Single	Single	Single
SYSTEM POWER INPUT (kW)	Heating/ Cooling (nominal)	0.97 / 0.90	1.84 / 1.84	3.01 / 2.71	4.39 / 4.96
STARTING CURRENT (A)		5	9.3	13	21.5
SYSTEM RUNNING CURRENT (A)	Heating/Cooling [MAX]	5.0 / 4.1 [8.5]	9.3 / 8.4 [14.8]	13.0 / 11.7 [20]	19.0 / 21.5 [30]
FUSE RATING (BS88) - HRC (A)		10	20	32	40
MAINS CABLE No. Cores		3	3	3	3
MAX PIPE LENGTH (m)		20	30	55	65
MAX HEIGHT DIFFERENCE (m)		12	30	30	30
CHARGE REFRIGERANT (kg) / CO2 EQUIVALENT (t)	R32 (GWP 675)	0.90 / 0.61	1.25 / 0.84	3.10 / 2.09	3.60 / 2.43
MAX ADDITIONAL REFRIGERANT (kg) / CO2 EQUIVALENT (t)	R32 (GWP 675)	1.16 / 0.78	1.71 / 1.15	4.10 / 2.77	5.00 / 3.38
PRODUCT INFORMATION SHEET: https://library.mitsubishielectric.co.uk/pdf/book/PLA-M_R32_Standard_Inverter_SP?model_query=PLA-M71EA#page-2 INSTALLATION MANUAL: https://library.mitsubishielectric.co.uk/pdf/book/Installation_Manual_SUZ-M25-71VA_VG79A976H01?model_query=SUZ-M35VA#page-1 http://library.mitsubishielectric.co.uk/pdf/book/Installation_Manual_PUZ-M100-140V_YKA_VG79A991H01?model_query=PUZ-M100VKA#page-1					

Table 13: SUZ-M/PUZ-M series outdoor unit specifications for Mitsubishi Electric Mr Slim packaged air conditioner system.

3.1.2.4 Energy Storage Equipment

Technology configuration 1

Configuration suitable for buildings with single-phase systems on which to run an installation with individual energy storage systems. As stated previously, this configuration is based on integrating NASCA power planed with lithium batteries alongside renewable heat pump technology to supply electricity and thermal energy to eligible buildings.

- Sub configuration 1: buildings with consumption of 5-15 kWh / day
- Sub configuration 2: buildings with consumption of 15-25 kWh / day
- Sub configuration 3: monophasic facilities and buildings with previous RES generation installations.

The Nasca plant is owned by a third party not involved in the project. The project has considered it in the overall energy balance of the island, but it has to be in a virtual manner (through VPP) controlled by a central system. We will not be able to physically install a battery at Nasca so the technology configuration 1 should be considered as a potential one but due to the ownership limitation it cannot be pursued so.

Technology configuration 2

Configuration suitable for buildings with three-phased installations on which to deploy individual self-consumption installation with individual energy storage systems and renewable heat pump technology. The energy storage system is only based on lithium batteries.

- Sub configuration 1: buildings with consumption between 25-40 kWh / day
- Sub configuration 2: buildings with higher consumption to 40 kWh / day

Technology configuration 3

Configuration suitable for buildings, either one-phased or three-phased, to perform a collective/shared energy consumption with lithium batteries alongside renewable heat pump technology

- Sub configuration 1: self-consumption shared between 1 to 7 dwellings

Sub configuration 2: self-consumption shared between 8 to 15 dwellings

3.1.2.5 Residential buildings Energy Storage equipment

According to characterization, n.3 technology configurations have been defined for residential buildings with single-phase electrical distribution system, so each dwelling is assigned to the corresponding topology at San Pietro demo site.

These configurations are based on consumption level and the presence of previously installed PV plant:

Technology Configuration	Daily consumption (kWh)	PV Plant (kWp)	Battery (kWh)		Number of Dwelling
1.1	5-15		Lithium	4,2kWh	6
			Batteries	1 pcs	
			Inverter	1 pcs	
1.2	10-15		Lithium	8,4kWh	3
			Batteries	2 pcs	
			Inverter	1 pcs	
1.3	5-15	1-3	Lithium	8,4kWh	2
			Batteries	2 pcs	
			Inverter	1 pcs	

Table 14: San Pietro Storage system definition for residential building

Technology configuration 1.1 and 1.2 are characterized by n.1 or n.2 Lithium battery of 4,2 kWh and n.1 Storage inverter connected to the grid in AC coupling configuration.

Inverter can measure building electric consumption trough external AC current transformer.

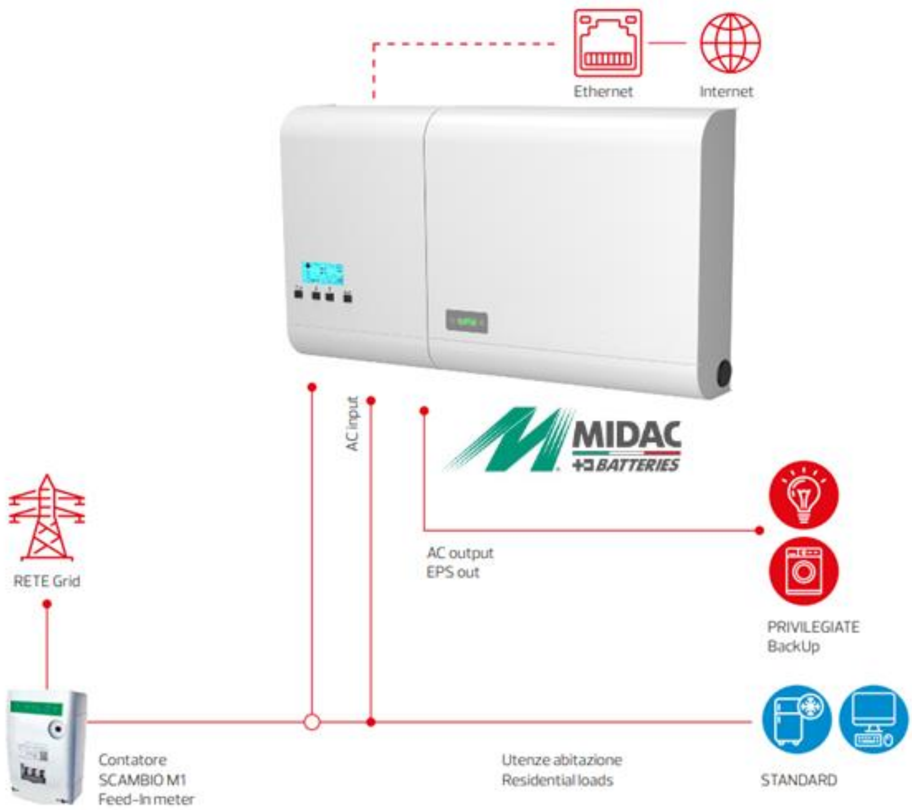


Figure 15: Configuration 1.1 and 1.2

Technology configuration 1.3 is characterized by n.2 Lithium battery of 4,2 kWh and n.1 Storage inverter connected to the grid in AC coupling configuration.

Inverter can measure building electric consumption trough external AC current transformer and PV production of existing plant.

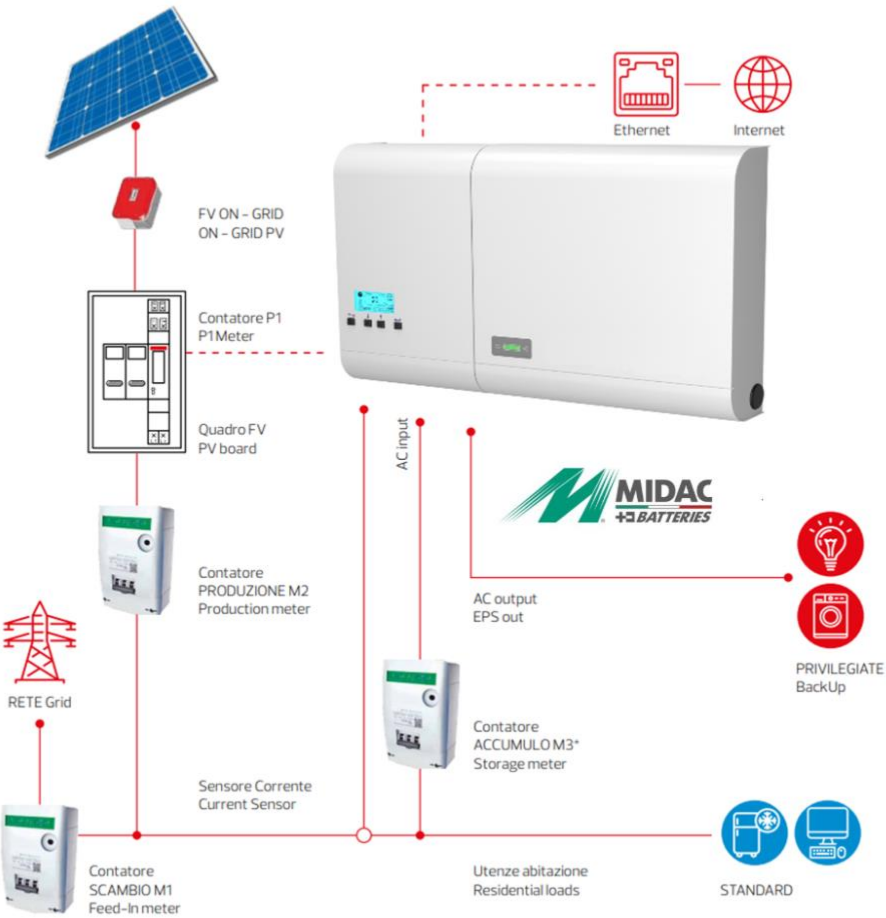


Figure 16: Configuration 1.3

Midac Lithium Battery for residential energy storage application is 4,2 kWh single unit capacity with modular function, you can connect up to 4 batteries in parallel in order to reach 16,8 kWh maximum energy capacity.

BATTERY	LMN 52,5V 80Ah
ENCLOSURE	
DIMENSIONS (mm)	443 x 501 x 143
WEIGHT (Kg)	34
ELECTRICAL CHARACTERISTICS	
NOMINAL VOLTAGE (V)	52,5
MAXIMUM VOLTAGE (V)	58,8
MINIMUM VOLTAGE (V)	40,6
CAPACITY (Ah) @ 1C 25°C	80
NOM. DISCHARGE CURRENT (A)	80
MAX DISCHARGE CURRENT – 2s (A)	160
NOMINAL CHARGE CURRENT (A)	40
MAX CHARGE CURRENT – 2s (A)	80
ELECTRICAL CONNECTIONS	
COMMUNICATION	CanBUS
OPERATING CONDITIONS	
OPERATING TEMPERATURE (°C)	-20°C/55°C
CHARGING TEMPERATURE (°C)	0°C/45°C
STORAGE TEMPERATURE (°C)	-10°C/35°C
MAX HUMIDITY (No condensation)	95%
MAXIMUM ALTITUDE (m)	2000
CALENDAR LIFE (Years)	10

Figure 17: Midac Lithium battery

Midac Battery Inverter for storage application is 3kVA inverter/charger; it can be connected to 48Vdc low voltage battery.

Inverter and Battery are certified to be connected to the Italian Grid, according to the grid code regulation CEI 0-21:2019.

Nominal power	Pnom	3kVA
Continuous power at 25° C	Pcon1	2.4kW
Continuous power at 40° C	Pcon2	2.2kW
Battery voltage	Vbat	48V
Battery voltage range	Vdc	40-66V
AC voltage and frequency	Vnom	230Vac – 50Hz
AC voltage range	Vac	187 – 265Vac
AC input current	Iac	32A
Harmonic distortion	Thd	<3%
Nominal power factor	Pi	1
Maximum efficiency DC-> AC	Eds	95%
Connectable load power on EPS out	Eps	2.4kW
EPS transfer time on grid blackout	Tsw	10ms
Power consumption in by-pass mode	Pbp	< 2W
Topology	Top	Toroidal isolation transformer

Figure 18: Midac Battery inverter

Inverter has Ethernet communication port for Internet connection, It sends data to the Midac CLOUD than data are formatted according CDM format and they are send to the REACT platform in order to have monitoring and DR control commands.

The energy capacity installed for single-phase residential dwelling will be 16 batteries of 4,2kWh for total 67,2kWh.

3.1.2.6 Public buildings & Hotel energy storage equipment

According to characterization, n.2 technology configurations have been defined for community buildings & Hotel with tree-phase electrical distribution system, so each Building is assigned to the corresponding topology at San Pietro demo site.

These configurations are based on consumption level:

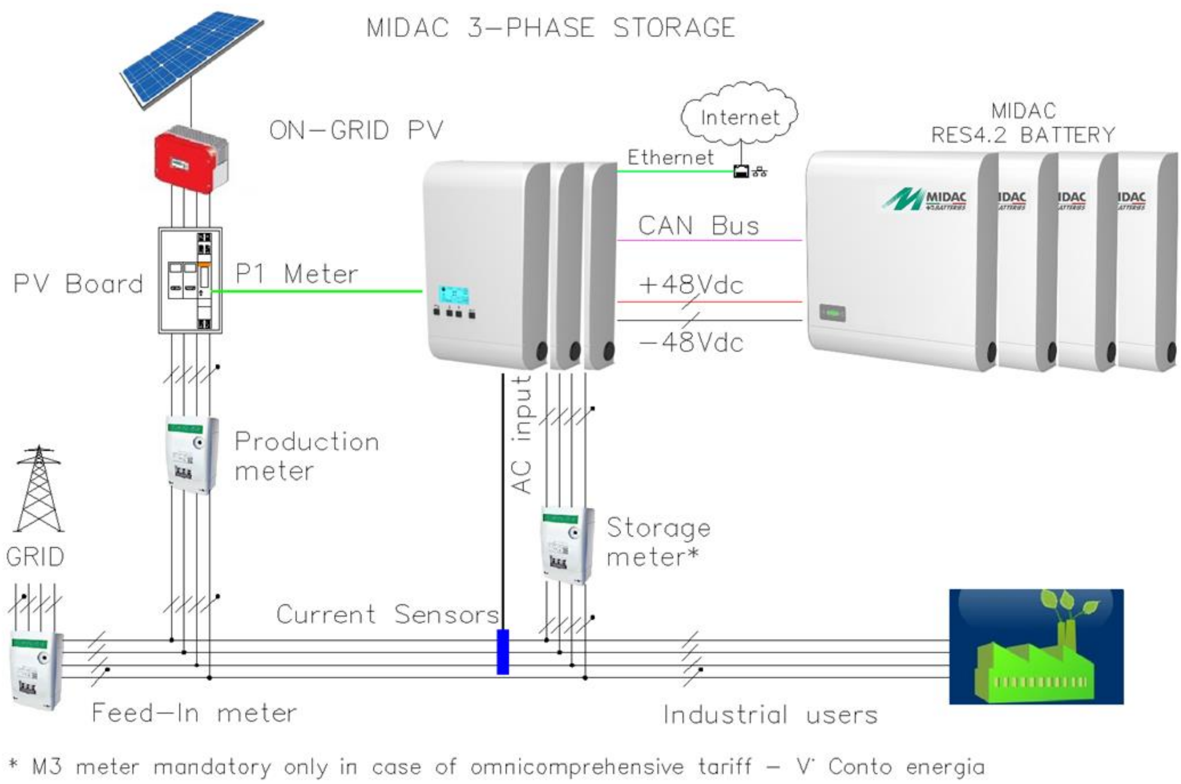
Technology Configuration	Daily consumption (kWh)	PV Plant (kWp)	Battery (kWh)		Number of Dwelling
2.1	25-40	1-20	Lithium	**16,8kWh**	**4 (1 Hotel)**
			Batteries	4 pcs	
			Inverter	3 pcs	
2.2	> 40	1-20	Lithium	**16,8kWh**	**4**
			Batteries	4 pcs	
			Inverter	3 pcs	

Table 15: San Pietro Storage system definition for public building and hotel

Technology configuration 2.1 and 2.2 are characterized by n.4 Lithium battery of 4,2 kWh and n.3 Storage inverter connected in three-phase configuration to the grid in AC coupling.

Inverter can measure building electric consumption trough external AC current transformer, it's also possible con measure the PV production of existing PV plant

Figure 19: Technology configuration 2.1 and 2.2



Inverter has Ethernet communication port for Internet connection, It sends data to the Midac CLOUD than data are formatted according CDM format and they are send to the REACT platform in order to have monitoring and DR control commands.

Inverter and Battery are certified to be connected to the Italian Grid, according to the grid code regulation CEI 0-21:2019.

The energy capacity installed for tree-phase public building & hotel will be 32 batteries of 4,2kWh for total 134,4kWh. The total energy capacity installed in San Pietro demo site will be 201,6kWh.

3.1.3 Aran Island

3.1.3.1 Heat Pump Equipment

<u>MELCloud adapters for residential buildings with existing ATW heat pumps</u>

In the deployment works at the Aran Islands demo site, residential buildings with compatible existing heat pumps will be fitted with Wi-Fi adapters to allow communication with the REACT platform via the via the Mitsubishi Electric "MELCloud" cloud-based control system (Mitsubishi Electric, 2014). As part of the installation, each ATW heat pump will be fitted with a MELCloud MAC-567IF Wi-Fi adaptor, which is connected to the CN105 terminal on the indoor unit flow temperature controller (FTC) circuit board and paired with the local wireless internet router by WPS connection (NOTE - a professional installer is required to complete the installation of the MELCLoud adapters). Existing dwellings already identified for MELCloud installation are listed in **Error! Reference source not found.**4.

BUILDING	EXISTING HEAT PUMP SYSTEM	HEATING CAPACITY
AI6	ECODAN PUHZ-W112VHA2	11.0 kW
AI7	ECODAN PUHZ-W85VHA2	8.3 kW
AI8	ECODAN PUHZ-W112VHA2	11.0 kW
AI9	ECODAN PUHZ-W85VHA2	8.3 kW
AI10	ECODAN PUHZ-W85VHA2	11.0 kW

Table 16: List of existing residential buildings at Aran Islands demo site with existing heat pump systems identified for MELCLoud installation.

<u>New ATW Heat Pump System for Community Development Offices</u>

As part of the deployment works, a new air-to-water (ATW) heat pump system will be installed in the Community Development Offices (CDO) building for the provision of space heating and domestic hot water. The detailed design of this system is subject to a detail survey of the building (see Section **Error! Reference source not found.**). In Task 1.3, the Community Offices building was selected as the most suitable candidate from the list of community buildings to receive a new heat pump system, based on its modern construction standards, regular usage and good quality of fabric insulation. The new heat pump system will partially or completely replace the existing heating system, which consists of electrical storage heaters for space heating and direct electric heating of domestic hot water via an immersion heater in the existing hot water storage tank. It is possible that some of the existing storage heaters will be retained as back-up.

From the initial building characterisation activities in WP1, the winter heat demand for the building was estimated to be approximately 20 kW (to be further verified in the detailed building survey, prior to the final detail design of the system). Based on this estimated heat demand, a preliminary proposal for the new heat pump system is a "cascaded" arrangement consisting of two outdoor units and one indoor unit. The principle of the cascaded arrangement is summarised in Figure 20. The two outdoor units will provide heating to a common hydronic circuit that will circulate heat to radiators/emitters in the individual rooms. The same circuit will also indirectly heat a 300 L domestic hot water tank integrated into the indoor unit, which replaces the existing 60 gallon hot water tank serving the building. Specifications of the proposed indoor and outdoor units are listed in **Error! Reference source not found.**25 and **Error! Reference source not found.**26, respectively (note that unit selection is subject to revision upon completion of the detailed design). The indoor unit consists of a pre-plumbed standard cylinder complete with integrated hydraulic components and advanced controls. The unit will be installed with the metering and monitoring services pack (MMSP) consisting of one heat meter, two electrical energy meters and the MELCloud Wi-Fi adapter. MMSP details are summarised in **Error! Reference source not found.**27.

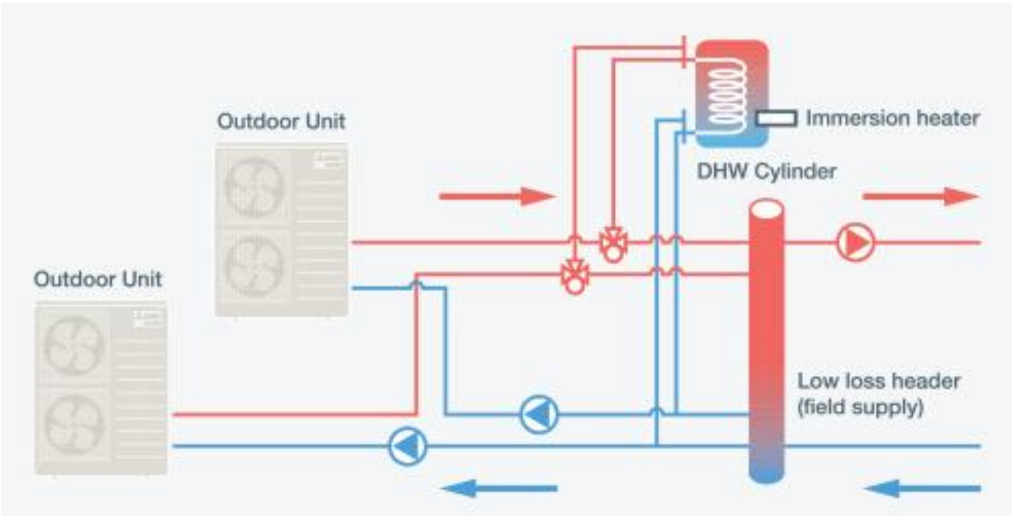


Figure 20: Schematic diagram illustrating typical "cascade" configuration of multiple heat pump units to provide a large space heating load (Mitsubishi Electric, 2019b).

INDOOR UNIT EHPT30X-UKHCW (PRE-PLUMBED CYLINDER) SPECIFICATIONS		
MODEL		EHPT30X-UKHCW
NOMINAL HOT WATER VOLUME (LITRES)		300
ErP RATING		C
HEAT LOSS (kWh/24hrs)		1.89
HEAT LOSS (W)		78.8
WATER	Flow Rate (l/min) with W112 outdoor unit	40.1
	Primary Pump	2x Grundfos UPS2 25-60
	Sanitary Hot Water Pump	Grundfos UPSO 15-60 CIL2

INDOOR UNIT EHPT30X-UKHCW (PRE-PLUMBED CYLINDER) SPECIFICATIONS			
		Connection Size (mm) Heating / DHW (mm)	22
		Primary Expansion Vessel (Litres)	24
		Charge Pressure (MPa (Bar))	0.35 (3.5)
WATER SAFETY DEVICES	Water Circuit	Control Thermistor (oC)	1 - 80
		Pressure Relief Valve (MPa (Bar))	0.3 (3)
		Expansion Relief Valve (Cold)	0.8 (8)
	DHW Cylinder	Control Thermistor (oC)	40-70
		High Limit Stat (oC)	Mechanical 80
		Temp and Pressure Relief Valve (oC / MPa (Bar))	90 / 1.0 (10)
DIMENSIONS (mm)		Width	712
		Depth	691
		Height	2057
WEIGHT EMPTY / FULL (kg)			87 / 387
CYLINDER MATERIAL	Cylinder	Cylinder Material	Stainless Steel
	Insulation	Insulation Type	CFC/HCFC-free flame-retardant expanded Polyurethane
		Insulation Thickness (mm)	60
		Standing Heat Loss (kWh/24hrs)	1.89
		GWP of Insulation	3.1
		ODP of Insulation	0
ELECTRICAL DATA	Control Board (optionally powered by outdoor unit)	Electrical Supply	22-240V, 50Hz
		Phase	Single
		Fuse Rating - MCB Sizes (A)*	10
	Immersion Heater	Electrical Supply	22-240V, 50Hz
		Phase	Single
		Capacity (kW)	3
		Max Running Current (A)	13
		Fuse Rating - MCB Sizes (A)*	16
MECHANICAL ZONES			DHW and 1 Heating Zone**
OPTIONAL SIMPLFIED WIRELESS ROOM THERMOSTAT AND WIRELESS RECEIVER			PAR-WT50-E Controller and PAR-W%51-E Receiver
PRODUCT INFORMATION SHEET: https://library.mitsubishielectric.co.uk/pdf/book/EHPT15-30X-UKHCW_PISheet?model_query=EHPT30X-UKHCW#page-2 INSTALLATION MANUAL: https://library.mitsubishielectric.co.uk/pdf/book/Pre_plumbed_Cylinder_Parts_Manual_Revision_B?model_query=EHPT30X-UKHCW#page-2			

* MCB Sizes EN60898-2 & EN60947-2.

** Optional 2-zone accessory pack available.

Table 17: EHPT30X-UKHCW pre-plumbed cylinder indoor unit specifications for Mitsubishi Electric ECODAN air-to-water heat pump system.

OUTDOOR UNIT PUHZ-W112VAA(-BS) SPECIFICATIONS		
MODEL		PUHZ-W112VAA(-BS)
HEAT PUMP SPACE HEATER 55 $_o$C	ErP Rating	A++
	η_s *1	133%
	SCOP	3.4
HEAT PUMP SPACE HEATER 35 $_o$C	ErP Rating	A++
	η_s	170%
	SCOP	4.34
HEAT PUMP COMBINATION HEATER - Large Profile *2	ErP Rating	A++
	η_{wh} *3	100%
HEATING *4 (A-3/W35)	Capacity (kW)	11
	Power Input (kW)	3.73
	COP	2.95
OPERATING AMBIENT TEMPERATURE ($_o$C DB)		-20 (min) +35 (max)
SOUND DATA *5	Pressure Level at 1 m (dBA)	47
	Power Level (dBA) *6	60
WATER DATA	Pipework Size (mm)	28
	Flow Rate (L/min)	32.1
	Water Pressure Drop (kPa)	24.4
DIMENSIONS (mm) *7	Width	1050
	Depth	480
	Height	1020
WEIGHT (kg)		118
ELECTRICAL DATA	Electrical Supply	220-240V, 50 Hz
	Phase	Single
	Nominal Current (A) / Maximum Current (A)	10.9 / 28.0
	Fuse Rating - MCB Sizes (A) *8	32
REFRIGERANT CHARGE (kg) /CO2 EQUIVALENT (t)	R410A (GWP 2088)	3.3 / 6.89
PRODUCT INFORMATION SHEET: https://library.mitsubishielectric.co.uk/pdf/book/PUHZ-W85-112VAA_-BS__Installation_Manual__BH79D674K0?model_query=PUHZ-W112VAA#page-1 INSTALLATION MANUAL: https://library.mitsubishielectric.co.uk/pdf/book/Ultra_Quiet_Ecodan?model_query=PUHZ-W112VAA#page-1		

*1 η_s is the seasonal space heating energy efficiency (SSHEE)
*2 Combination with EHPT20X-MHCW Cylinder
*3 η_{wh} is the water heating energy efficiency
*4 Under normal heating conditions at outdoor temp: -3°CDB / -4°CWB, outlet water temp 35°C, inlet water temp 30°C.
*5 under normal heating conditions at outdoor temp: 7°CDB / 6°CWB, outlet water temp 55°C, inlet water temp 47°C as tested to BS EN14511.
*6 Sound power level tested to BS EN12102.
*7 Flow Temperature Controller (FTC) for standalone systems PAC-IF062B-E Dimensions WxDxH (mm) - 520x150x450
*8 MCB Sizes BS EN60898-2 & BS EN60947-2.

Table 18: PUHZ-W12VAA outdoor unit specifications for Mitsubishi Electric ECODAN air-to-water heat pump system.

ECODAN Energy Metering and Monitoring Service Pack (MMSP)	
Pack Code	EMP3-M (Energy Monitoring Pack Three – Monobloc)
Heat Meter Details:	
Heat Meter Model	Sontex SuperStatic 440
Integrator Model	Sontex Supercal 531
Measurement type	Fluid oscillation
Connection	3/4 inch Male
Dimensions (mm)	110 (L) x 125 (w) x 79 (h)
Weight (kg)	2.5
Power supply	Battery
Output signal	1 pulse per kWh
Thermistors	2m PT500, flow and return
Additional fittings	2 no. T-piece 28 mm x 28mm x 1/2 inch female 2 no. 1/2 inch thermister pockets, male
Electrical Energy Meter Details:	
Model	Elster A100C
Dimensions (mm)	130 (w) x 97 (h) x 47 (d)
Weight (g)	345
Output signal:	1 pulse per Wh
Quantity	2*
MELCCloud Wi-Fi Interface:	
Model	MAC-567IF
Connect to	Indoor Unit
Compatibility	Ecodan FTC5/FTC6
Power supply	From Indoor Unit
Dimensions (mm)	79 x 18.5 x 44
APPLICATION GUITDE AND INSTALLATION DETAILS: https://library.mitsubishielectric.co.uk/pdf/book/Ecodan_MMSP_Application_Guide#page-1	

*First electrical meter measures consumption of Ecodan unit. Second electrical meter measures consumption of cylinder immersion heat and FTC indoor unit.

Table 19 EMP3-M Energy Metering and Monitoring Service Pack (MMSP) specifications for Mitsubishi Electric ECODAN air-to-water heat pump system.

3.1.3.2 Definition and scenario validation

Based on the characterization works, two different consumption profiles have been determined and the four planned buildings have been assigned to the corresponding topologies as follows:

Profile	Daily energy consumption(kWh)	Nº of buildings
1	5 - 9	2
2	9 - 13	2

Table 20: Aran scenario validation

For these scenarios, it has been decided to implement the self-consumption with energy storage in four cases. In the buildings with profile 1 are single-phase system and building profile 2 are three-phase configutation.

In this specific scenario, the PV energy produced is consumed immediately and the surplus is stored in the batteries in order to be consumed during low PV production hours or when it is considered more appropriate for optimizing the energy efficiency. Lead-Acid batteries will be installed in a first phase to be replaced by Aluminium-Carbon in a two years period time.

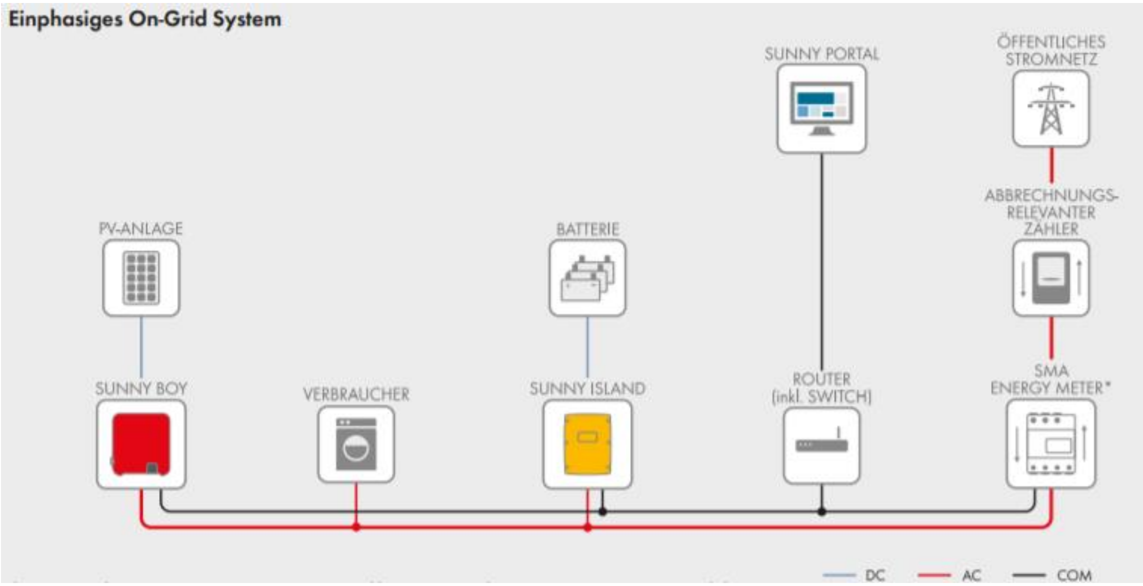


Figure 21: Single-phase system

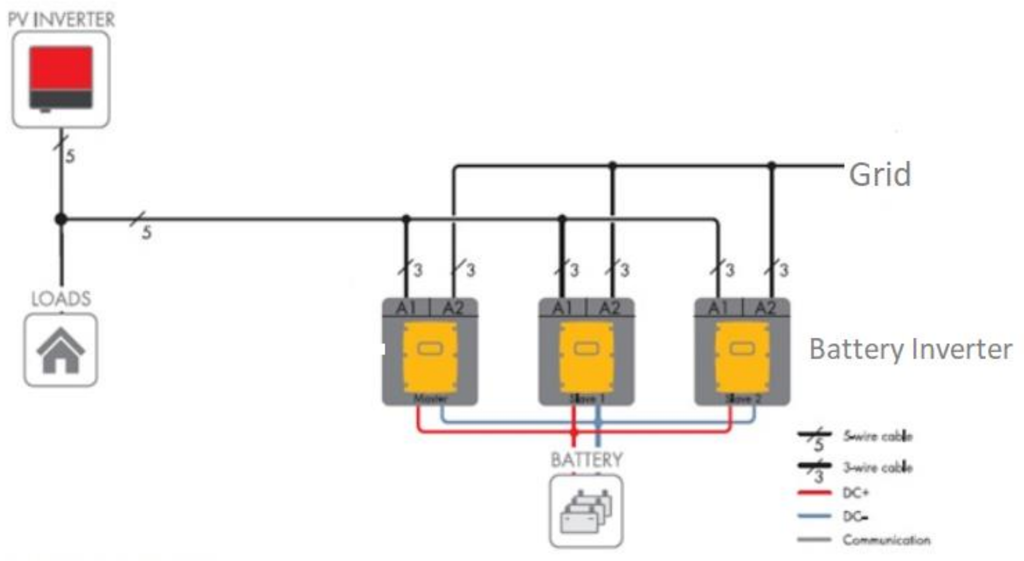


Figure 22: Three-phase system

3.1.3.3 RES definition. PV and Storage

After the requirements and different consumption profiles and scenarios were defined for each building, the sizing of the PV and storage was performed.

On Inishmor the configuration of the installation will be DC Coupling, which means that the energy generated from the PV will flow to the battery and then to the inverter (SMA, s.f.).

Profile	Daily consumption profile (kWh)	Battery		PV panels	
		Type		Nº panel	Wp
1	5-9	Lead-acid VRLA	13 kWh	20	6,200
2	9-13	Lead-acid VRLA	20 kWh	34	10,540

Table 21: Aran PV and energy storage definition

3.2 Definition of installations equipment

3.2.1 La Graciosa

To the definition of technology to be implemented in La Graciosa, we consider all those aspects mentioned on deliverables 1.3, 2.2 and 2.3. Aiming to satisfy the demand needs and the React project specifications, allowing an optimal, effective and efficient energy dispatching to match RES generation with eligible buildings energy consumption.

Also taking in consideration the country legislation on grid connection (BOE Bolentín Oficial del Estado, s.f.), the local restriction as it is considered by UNESCO a Biosphere Reserve.

3.2.1.1 La Graciosa material

Profile 1		
Daily consumption between 4 y 6 kWh		
Battery	**Acid-Lead**	**Lithium**
Implementation	**QTD**	**QTD**
PV panels REC310TP2M Twinpeak 120 half-cut mono	4	4
Renusol PV mount system	4	4
Energy Meter ET112 – 1 phase - max 100A	1	1
Victron Inverter MultiPlus-II 48/3000/35-32	1	1
Victron Charger Bluesolar MPPT 150/35	1	1
BYD Lithium battery 3,8kWh		3
Victron Cerbo GX	1	1
AC protection box	1	1
Battery Acid-Lead 4kWh	4	
Communication cables		1

Table 22: Material to be installed to buildings of Profile 1

Profile 2		
Daily consumption between 6 y 10 kWh		
Battery	**Acid-Lead**	**Lithium**
Implementation	**QTD**	**QTD**
PV panels REC310TP2M Twinpeak 120 half-cut mono	6	6
Renusol PV mount system	6	6
Energy Meter ET112 – 1 phase - max 100A	1	1
Victron Inverter MultiPlus-II 48/3000/35-32	1	1
Victron Charger Bluesolar MPPT 150/45	1	1
BYD Lithium battery 3,8kWh		3,80
Victron Cerbo GX	1	1
AC protection box	1	1
Battery Acid-Lead 170Ah	4	
Communication cables		1

Table 23: Materials to be installed in buildings of profile 2

Profile 3		
Daily consumption between 10 y 15 kWh		
Battery	**Acid-Lead**	**Lithium**
Implementation	**QTD**	**QTD**
PV panels REC310TP2M Twinpeak 120 half-cut mono	8	8
Renusol PV mount system	8	8
Energy Meter ET112 – 1 phase - max 100A	1	1
Victron Inverter MultiPlus-II 48/3000/35-32	1	1
Victron charger BlueSolar MPPT 150/60	1	1
BYD Lithium battery 7,6kWh		7,60
Victron Cerbo GX	1	1
AC protection box	1	1
Battery Acid-Lead 230Ah	4	
Communication cables		1

Table 24: Materials to be installed in buildings of profile 3

Profile 4		
Daily consumption between 15 y 25 kWh		
Battery	**Acid-Lead**	**Lithium**
Implementation	**QTD**	**QTD**
PV panels REC310TP2M Twinpeak 120 half-cut mono	12	12
Renusol PV mount system	12	12
Energy Meter ET112 – 1 phase - max 100A	1	1
Victron Inverter MultiPlus-II 48/3000/35-32	1	1
Victron charger BlueSolar MPPT 250/85	1	1
BYD Lithium battery 11,9kWh		11,90
Victron Cerbo GX	1	1
AC protection box	1	1
Battery Acid-Lead 230Ah	8	
Communication cables		1

Table 25: Materials to be installed in buildings of profile 4

Profile 5	
Daily consumption between 25 y 50kWh	
Battery	**Lithium**
Implementation	**QTY**
PV panels REC310TP2M Twinpeak 120 half-cut mono	18
Renusol PV mount system	18
Energy Meter	1
Victron MultiPlus-II 48/3000/35-32 Inverter	3
Victron Charger Bluesolar MPPT 250/100	1

BYD Lithium battery 16,6kWh	16,60
Victron Cerbo GX	1
AC protection box	1
Communication cables	1

Table 26: Materials to be installed in buildings of profile 5

Profile 6	
Consumption higher than 40kWh	
Battery	**Lithium**
Implementation	**QTD**
PV panels REC310TP2M Twinpeak 120 half-cut mono	24
Renusol PV mount system	24
Energy Meter	1
Victron Inverter MultiPlus-II 48/3000/35-32	3
Victron Charger Bluesolar MPPT 250/85	2
BYD Lithium battery 22,1kWh	22,10
Victron Cerbo GX	1
AC protection box	1
Communication cables	1

Table 27: Materials to be installed in buildings of profile 6

Profile 7	
Shared self-consumption	
Building with 7 dwellings	
Implementation	**QTY**
PV panels REC310TP2M Twinpeak 120 half-cut mono	18
Renusol PV mount system	18
SMA Energy Meter	1
Sunny Boy 5.0 Inverter	1
Data manager	1
AC protection box 32A	1
Moxa 6 relays	1

Table 28: Materials to be installed in building of profile 6

Dimensions	Width: 1.730mm, depth: 1.100 mm, height: 390mm
Roof slope	max. 5° without additional measures
Ambient temperature range	-30°C to +50°C

System properties

System orientation	East-West, South
Material	HDPE, aluminium and stainless steel
Module tilt	15°
System weight approx.	≈ 7,9 kg
Friction coefficient	μ =0,5 is to be determined and ensured upon installation surface.
Minimum edge distance	1,5 m

Figure 23: PV mounting for La Graciosa Buildings

MultiPlus-II	24/3000/70-32	48/3000/35-32	48/5000/70-50
PowerControl y PowerAssist	Sí		
Conmutador de transferencia	32 A		50 A
Corriente máxima de entrada CA	32 A		50 A
INVERSOR			
Rango de tensión de entrada CC	19 – 33 V	38 – 66 V	
Salida	Tensión de salida: 230 V CA ± 2% Frecuencia: 50 Hz ± 0,1% (1)		
Potencia cont. de salida a 25 ºC (3)	3000 VA		5000 VA
Potencia cont. de salida a 25ºC	2400 W		4000W
Potencia cont. de salida a 40 ºC	2200 W		3700W
Potencia cont. de salida a 65 ºC	1700 W		3000W
Balance neto máximo aparente (corriente retornada a la red)	2500 VA		4000VA
Pico de potencia	5500 W		9000W
Eficacia máxima	94%	95%	96%
Consumo en vacío	13W	11W	18W
Consumo en vacío en modo AES	9W	7W	12W
Consumo en vacío en modo búsqueda	3W	2W	2W
CARGADOR			
Entrada de CA	Rango de tensión de entrada: 187-265 V CA Frecuencia de entrada: 45 – 65 Hz		
Tensión de carga de "absorción"	28,8V	57,6V	
Tensión de carga de "flotación"	27,6V	55,2V	
Modo de almacenamiento	26,4V	52,8V	
Máxima corriente de carga de la batería (4)	70A	35A	70A
Sensor de temperatura de la batería	Sí		

Figure 24: Victron inverter

BlueSolar Charge Controller	MPPT 100/30	MPPT 100/50
Battery voltage	12/24V Auto Select	
Rated charge current	30A	50A
Nominal PV power, 12V 1a,b)	440W	700W
Nominal PV power, 24V 1a,b)	880W	1400W
Maximum PV open circuit voltage	100V	100V
Max. PV short circuit current 2)	35A	60A
Maximum efficiency	98%	98%
Self-consumption	12V: 30 mA 24V: 20 mA	
Charge voltage 'absorption'	Default setting: 14,4V / 28,8V (adjustable)	
Charge voltage 'float'	Default setting: 13,8V / 27,6V (adjustable)	
Charge algorithm	multi-stage adaptive	
Temperature compensation	-16 mV / °C resp. -32 mV / °C	
Operating temperature	-30 to +60°C (full rated output up to 40°C)	
Humidity	95%, non-condensing	
Data communication port	VE.Direct See the data communication white paper on our website	

Figure 25: Victron charger

Figure 26: Victron gateway monitoring system

BATTERY-BOX PREMIUM LVS

- Scalable from 4 kWh to 256 kWh
- Maximum Flexibility for any Application with up to 64 Modules Connected in Parallel
- Compatible with Market Leading 1 and 3 Phase Inverters
- Cobalt Free Lithium Iron Phosphate (LFP) Battery: Maximum Safety, Life Cycle and Power
- Capable of High-Powered Emergency-Backup and Off-Grid Function
- Patented Internal Plug Design Requires No Additional Wiring
- Self-Consumption Optimization for Residential and Commercial Applications

Figure 27: BYD Lithium battery

Specifications

Article number	V	Ah C5 (10,8V)	Ah C10 (10,8V)	Ah C20 (10,8V)	l x w x h mm	Weight kg	CCA @0°F	RES CAP @80°F	Terminals
BAT412015080	12	13	14	15	151 x 100 x 103	4,1			Faston
BAT412025081	12	22	24	25	181 x 77 x 175	6,5			M5 insert
BAT412038081	12	34	36	38	267 x 77 x 175	9,5			M5 insert
BAT412060081	12	52	56	60	224 x 135 x 178	14	300	90	M5 insert
BAT412110081	12	82	90	100	260 x 168 x 215	26	500	170	M6 insert
BAT412112081	12	105	114	125	330 x 171 x 214	33	550	220	M8 insert
BAT412117081	12	145	153	170	336 x 172 x 280	45	600	290	M8 insert
BAT412123081	12	200	210	230	532 x 207 x 226	57	700	400	M8 insert

Cycle life

≥ 300 cycles @ 100% DoD (discharge to 10,8V with I = 0,2C_{20}, followed by approximately two hours rest in discharged condition, and then a recharge with I = 0,2C_{20})
≥ 700 cycles @ 60% DoD (discharge during three hours with I = 0,2C_{20}, immediately followed by recharge at I = 0,2C_{20})
≥ 1000 cycles @ 40% DoD (discharge during two hours with I = 0,2C_{20}, immediately followed by recharge at I = 0,2C_{20})

Super Cycle Battery 12V 230Ah

Figure 28: Victron Lead-Acid Battery

3.2.2 Aran Island

3.2.2.1 PV Equipment to be installed

The definition of technology to be implemented in Aran is based on self-consumption and energy storage systems in community buildings and any other facilities either being public or private. Those technology configurations are meant to satisfy the needs described above and to match with DR strategies and DR concrete actions, allowing an optimal, effective and efficient energy dispatching to match VRE generation with eligible buildings energy consumption (SMA Solar Technology, s.f.).

Childcare Facility

Profile 2	
Implementation	QTY
PV Panel REC 310 N-PEAK - 120 half- cut mono-Black	34
PV Inverter SMA SUNNY TRIPOWER 10.0	1
SMA ENERGY METER-20	1
Battery Inverter Sunny Island SI4.4M-13	3
SMA Data Manager M	1
SMA MOXA E1242 For data Manager M	1
Battery Lead-Acid VRLA 12/270 Ah (13.8 kWh net 50% DOD)	8
Temperature sensor for Sunny Island	1

VS+ mounting rail 50 x 37 x 2100 mm	32
VS+ rail connector 50 x 37	24
Roof hooks for slates roof	48
Middle clamp (Black)	56
End clamp (Black)	18
End cap	18
Raspberry Pi 4 Modelo B - 2GB	1

Table 29: Materials to be installed in Childcare Facility building

Childcare Facility (Naíonra Inis Mór)

Figure 29: Childcare Facility building

Secondary School

Profile 1	
Implementation	QTY
PV Panel REC 310 N-PEAK - 120 half- cut mono-Black	20
PV inverter SMA SUNNY BOY 6.0	1
SMA ENERGY METER-20	1
SMA Data Manager M	1
SMA Data Manager M 24V DC/2.5A Power supply	1
SMA MOXA E1242 for Data Manager M Ethernet remote	1
Battery Inverter Sunny Island SI4.4M-13	1
Battery Lead-Acid VRLA 12V/200 Ah (9.20 kWh Net 50% DOD)	8
Temperature sensor for Sunny Island	1
Base rail connector	24
Roof protection pad 110x95x20mm standard	24

Eave support	24
Base rail FS10-EW2260 mm	12
End Clamp+	48
FS10-EW ridge support 10$_0$	12
Self drilling screw 4.8x19 A2	100
Socket bolt 6x110 mm	60
Raspberry Pi 4 Modelo B - 2GB	1

Table 30: Material to be installed in Secondary School building

Figure 30: Secondary School building

Community Offices

Profile 2	
Implementation	QTY
PV Panel REC 310 N-PEAK - 120 half- cut mono-Black	34
PV Inverter SMA SUNNY TRIPOWER 10.0	1
SMA ENERGY METER-20	1
Battery Inverter Sunny Island SI4.4M-13	3
SMA Data Manager M	1
Power Supply for Data Manager	1
SMA MOXA for Data Manager remote	1
Battery Lead-Acid VRLA 12/270 Ah (13.8 kWh net 50% DOD)	8

Temperature sensor for Sunny Island	1
VS+ mounting rail 50 x 37 x 2100 mm	38
VS+ rail connector 50 x 37	32
Roof hooks for slates roof	60
Middle clamp (Black)	62
End clamp (Black)	14
End cap	16
Raspberry Pi 4 Modelo B - 2GB (78€)	1

Table 31: Materials to be installed in Community Office building

Community Offices (Ionad Fiontar Cholm Ó hIarnáin)

Figure 31: Community Office building

Community Hall

Profile 1	
Implementation	QTY
PV Panel REC 310 N-PEAK - 120 half- cut mono-Black	20
PV Inverter SMA SUNNY BOY 6.0	1
SMA ENERGY METER-20	1
Battery Inverter Sunny Island SI4.4M-13	1
SMA Data Manager M	1
Power supply for Data Manager M 24V DC/2.5A	1
SMA MOXA E1242 for Data Manager remote	1
Battery Lead-Acid VRLA 12V/200 Ah (9.20 kWh Net 50% DOD)	8

Temperature sensor for Sunny Island	1
VS+ mounting rail 50 x 37 x 2100 mm	24
VS+ rail connector 50 x 37	18
Roof hooks for slates roof	36
Middle clamp (Black)	34
End clamp (Black)	14
End cap	14
Raspberry Pi 4 Modelo B - 2GB	1

Table 32: Materials to be installed in Community Hall building

Community Hall (Halla Ronáin)

Figure 32: Community Hall building

ELECTRICAL DATA @ STC	Product code*: RECxxxNP Black				
Nominal Power - P_{MAX} (Wp)	305	310	315	320	325
Watt Class Sorting - (W)	0/+5	0/+5	0/+5	0/+5	0/+5
Nominal Power Voltage - V_{MPP} (V)	33.3	33.6	33.9	34.2	34.4
Nominal Power Current - I_{MPP} (A)	9.17	9.24	9.31	9.37	9.46
Open Circuit Voltage - V_{OC} (V)	39.3	39.7	40.0	40.3	40.7
Short Circuit Current - I_{SC} (A)	10.06	10.12	10.17	10.22	10.28
Panel Efficiency (%)	18.3	18.6	18.9	19.2	19.5

Values at standard test conditions (STC: air mass AM 1.5, irradiance 1000 W/m², temperature 25°C), based on a production spread with a tolerance of P_{MAX}, V_{OC} & I_{SC} ±3% within one watt class. * Where xxx indicates the nominal power class (P_{MAX}) at STC above.

Table 33: Black PV Panel

Figure 33: Secondary School PV mounting system

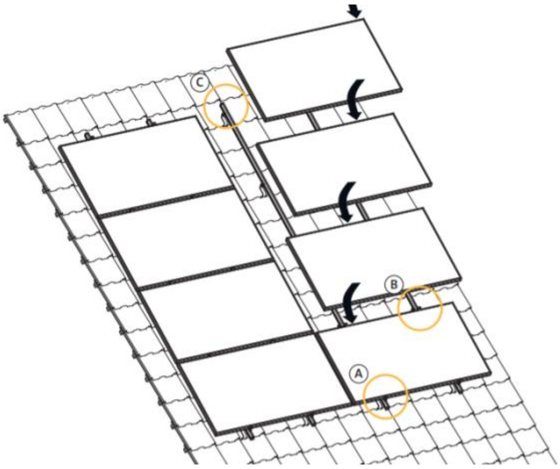


Figure 34: Pitched roof solar mounting system

Technical data	Sunny Boy 3.0	Sunny Boy 3.6	Sunny Boy 4.0	Sunny Boy 5.0	Sunny Boy 6.0
Input (DC)					
Max. generator power	5500 Wp	5500 Wp	7500 Wp	7500 Wp	9000 Wp
Max. input voltage			600 V		
MPP voltage range	110 V to 500 V	130 V to 500 V	140 V to 500 V	175 V to 500 V	210 V to 500 V
Rated input voltage			365 V		
Min. input voltage / initial input voltage			100 V / 125 V		
Max. input current input A / input B			15 A / 15 A		
Max. DC short-circuit current input A / input B			22 A / 22 A		
Number of independent MPP inputs / strings per MPP input			2 / A:2; B:2		
Output (AC)					
Rated power (at 230 V, 50 Hz)	3000 W	3680 W	4000 W	5000 W[1)]	6000 W
Max. apparent power AC	3000 VA	3680 VA	4000 VA	5000 VA[1)]	6000 W
Nominal AC voltage / range			220 V, 230 V, 240 V / 180 V to 280 V		
AC power frequency / range			50 Hz, 60 Hz / −5 Hz to +5 Hz		
Rated power frequency / rated grid voltage			50 Hz / 230 V		
Max. output current	16 A	16 A	22 A[2)]	22 A[2)]	26.1 A
Power factor at rated power			1		
Adjustable displacement power factor			0.8 overexcited to 0.8 underexcited		
Feed-in phases / connection phases			1 / 1		

Figure 35: Single-phase PV grid Inverter for the building profile 1

Technical data	Sunny Tripower 8.0	Sunny Tripower 10.0
Input (DC)		
Max. PV array power	15000 Wp	15000 Wp
Max. input voltage	1000 V	1000 V
MPP voltage range	260 V to 800 V	320 V to 800 V
Rated input voltage	580 V	
Min. input voltage / initial input voltage	125 V / 150 V	
Max. input current input A / input B	20 A / 12 A	
Max. DC short-circuit current input A / input B	30 A / 18 A	
Number of independent MPP inputs / strings per MPP input	2 / A:2; B:1	
Output (AC)		
Rated power (at 230 V, 50 Hz)	8000 W	10000 W
Max. apparent AC power	8000 VA	10000 VA
Nominal AC voltage	3 / N / PE; 220 V / 380 V 3 / N / PE; 230 V / 400 V 3 / N / PE; 240 V / 415 V	
AC voltage range	180 V to 280 V	
AC grid frequency / range	50 Hz / 45 Hz to 55 Hz 60 Hz / 55 Hz to 65 Hz	
Rated grid frequency / rated grid voltage	50 Hz / 230 V	
Max. output current	3 x 12.1 A	3 x 14.5 A
Power factor at rated power / displacement power factor adjustable	1 / 0.8 overexcited to 0.8 underexcited	
Feed-in phases / connection phases	3 / 3	
Efficiency		
Max. efficiency / European efficiency	98.3 % / 97.7 %	98.3 % / 98.0 %

Figure 36: Three-phase PV grid inverter

Technical data	Sunny Island 4.4M	Sunny Island 6.0H	Sunny Island 8.0H
Operation on the utility grid or generator			
Rated grid voltage / AC voltage range	230 V / 172.5 V to 264.5 V		
Rated grid frequency / permitted frequency range	50 Hz / 40 Hz to 70 Hz		
Maximum AC current for increased self-consumption (grid operation)	14.5 A	20 A	26 A
Maximum AC power for increased self-consumption (grid operation)	3.3 kVA	4.6 kVA	6 kVA
Maximum AC input current	50 A	50 A	50 A
Maximum AC input power	11500 W	11500 W	11500 W
Stand-alone or emergency power operation			
Rated grid voltage / AC voltage range	230 V / 202 V to 253 V		
Rated frequency / frequency range (adjustable)	50 Hz / 45 Hz to 65 Hz		
Rated power (at Unom, fnom / 25°C / cos φ = 1)	3300 W	4600 W	6000 W
AC power at 25 °C for 30 min / 5 min / 3 sec	4400 W / 4600 W / 5500 W	6000 W / 6800 W / 11000 W	8000 W / 9100 W / 11000 W
AC power at 45°C continuously	3000 W	3700 W	5430 W
Rated current / maximum output current (peak)	14.5 A / 60 A	20 A / 120 A	26 A / 120 A
Total harmonic distortion output voltage / power factor at rated power	< 5% / −1 to +1	< 1.5% / −1 to +1	< 1.5% / −1 to +1
Battery DC input			
Rated input voltage / DC voltage range	48 V / 41 V to 63 V	48 V / 41 V to 63 V	48 V / 41 V to 63 V
Maximum battery charging current / rated DC charging current / DC discharging current	75 A / 63 A /75 A	110 A / 90 A / 103 A	140 A / 115 A /130 A
Battery type / battery capacity (range)	Li-Ion1), FLA, VRLA / 100 Ah to 10000 Ah (lead-acid) 50 Ah to 10000 Ah (li-Ion)		
Charge control	IUoU charge procedure with automatic full charge and equalization charge		
Efficiency / self-consumption of the device			
Maximum efficiency	95.5 %	95.8 %	95.8 %
No-load consumption / standby	18 W / 6.8 W	25.8 W / 6.5 W	25.8 W / 6.5 W
Protective devices (equipment)			
AC short-circuit / AC overload	● / ●		
DC reverse polarity protection / DC fuse	– / –		
Overtemperature / battery deep discharge	● / ●		
Overvoltage category as per IEC 60664-1	III		

Figure 37: SMA Sunny Island battery inverter

3.3 Installation planning

3.3.1 La Graciosa

Once the installers are chosen, the approximate time and phases to perform each dwelling is shown below:

- Smart Meter installation and router connection: 0.5 days
- Collection of material and civil works: 2 days
- Panel installation: 1 day

- Wiring and Connections: 1 day
- Verification, legalization and Start-up: 1 day.

The installation of the material in La Graciosa is planned to start first with meters around W36 and is expected to end in W45

All these activities are depending on the evolution of the Covid-19 pandemic regarding movements restrictions and also the legalizing processes with the authorities.

2020	July				August				September				October				November			
Weeks	W 27	W 28	W 29	W 30	W 31	W 32	W 33	W 34	W 35	W 36	W 37	W 38	W 39	W 40	W 41	W 42	W 43	W 44	W 45	W 46
Task 1																				
Task 2																				
Task 3																				
Task 4																				
Task 5																				
Task 6																				

Table 34: Gantt Chart La Graciosa Deployment works

La Graciosa installation planning	
Task 1	Collect building information and make a tender for local installers
Task 2	Find local installers and choose the best offers
Task 3	Smart meters Installation. To allow data colletion before PV installation.
Task 4	PV/Storage installation
Task 5	System Commissioning
Task 6	React Platform communication commissioning
Milestone 1	Travel to the Island, Organize a meeting with participants and collect building information for the installers
Milestone 2	Approval of the legal process

Table 35: Task list and Milestone for La Graciosa

3.3.2 San Pietro

The timelines presented in this section are subject to the restrictions currently in place for travelling. Once it will be possible to travel the CFF cluster will visit the island to visit all the selected buildings and define the final design selection for both HPs and batteries. In the meantime, the Municipality of Carloforte and the PCC will install the smart meters in the selected private buildings and start collecting consumptions data. Installation should began early October and be concluded in approximately a month.

3.3.2.1 Heat Pump System Deployment

The time line for the deployment activities relating to the heat pump equipment at the San Pietro demo site is shown in table 24. The detailed design of the systems to be deployed is dependent on the final selection and detailed assessment of the buildings, which requires visits to the island by both the demo site coordinators and the heat pump system technical partners, which at present has not been possible due to the Covid-19 travel restrictions in place since March 2020. Thus the activity plan and timeline in table 24 is based on the anticipated schedule for resumption of travel and will be updated accordingly throughout the progress of the Task 3.2 deployment works period.

	July 2020				August 2020					September 2020				October 2020				November 2020			
Weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Task 1																					
Task 2																					
Task 3																					
Task 4																					
Task 5																					
Task 6																					
Task 7																					
Task 8																					
Task 8																					
Milestones	⊖						⊜							⊛				④			

Figure 38 Gantt chart showing heat pump system deployment works time line at San Pietro demo site. See table task and milestone descriptions.

San Pietro Heat Pump System Deployment - List of Tasks and Milestones	
Task 1	<u>Final building selections and preliminary data collection through site coordinator</u> Requested information to enable outline proposals for new heat pump systems in identified buildings. Requires site visit by pilot site coordinator. Information requested as follows: • Buildings identified with existing boilers for possible heat pump replacement: confirm current usage of boilers, i.e. space heating, hot water, or both space heat and hot water. • Where boilers are used for space heating, information requested on which rooms are heated, number and type of existing heat emitters. Approximate floor areas of each room to estimate heating loads. • Where boilers are used for domestic hot water heating, information requested on existing hot water storage – cylinder volume (if applicable). If no hot water, storage is currently used, then available space (floor area, height) for addition of a hot water cylinder.
Task 2	<u>Basic outline proposals for heat pump systems in suitable buildings based on preliminary data</u> Based on information gathered in Task 1, above, proposals will be made for new heat pump systems to be installed in suitable buildings.
Task 3	<u>Identification of suitable local installers</u> MERCE-UK linked partners Mitsubishi Electric Italy (MEU-IT) to identify approved installers local to demo site for installation of Mitsubishi Electric heat pump systems.
Task 4	<u>Site visits for detailed building surveys</u>

San Pietro Heat Pump System Deployment - List of Tasks and Milestones	
	Purpose of building surveys is to develop the outline proposal in Section 3.1.2.1 into a detailed design for each building and plans for installation works. Site visits to be attended by pilot site coordinator with heat pump installer (also representatives from MERCE-UK and/or MEU-IT).
Task 5	Detailed design of heat pump systems and installation planning Final selection of heat pump equipment and ancillary components based on building surveys. Detailed design of piped systems by installer, where necessary. MERCE-UK and MEU-IT to check compatibility of design with REACT platform DR objectives. Scheduling of on-site installation works in coordination with pilot site coordinator.
Task 6	Ordering and delivery of equipment and materials Ordering of equipment based on detailed designs. Procurement of heat pump systems through MEU-IT.
Task 7	Installation and commissioning of new heating systems. To be coordinated with other on-site deployment works (e.g. Midac battery systems)
Task 8	Testing of cloud-to-cloud communication between REACT platform and MELCloud. Testing methodology to be determined in Task 6.1 in order to check successful communication between REACT platform and heat pump systems. Likely to require a member of the REACT team to be present on site.
Task 9	New heat pump system / MELCloud system training for building users To be coordinated with user engagement plan and commissioning of new heat pumps systems.
Milestone 1	Easing of Covid-19 restrictions - Travel to island can resume.
Milestone 2	Site visits for building surveys and MELCloud installation
Milestone 3	Start of installation works
Milestone 4	Start of baseline data collection

Table 36: List of tasks and milestones for heat pump system deployment works and San Pietro demo site. See timeline in Figure 38.

3.3.2.2 Energy Storage System Deployment

Figure 4 shows the deployment activities for the energy storage equipment at the San Pietro demo site. The detailed design of the systems is dependent on the final selection of the buildings, which requires visits to the island by both the site coordinators and Midac technicians or qualified installers.

Until now, it was not possible due to the Covid-19 travel restrictions since March 2020.

	July 20				August 20					September 20				October 20				November 20			
Weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Task 1	■	■																		
Task 2		■	■	■																
Task 3				■	■	■	■													
Task 4				■	■	■	■	■	■	■	■	■	■	■						
Task 5														■	■	■	■			
Task 6																	■	■		
Task 7																		■		
Mile stones	⊖			⊖										⊛				④		

Table 37: Gantt chart showing Energy Storage system deployment at San Pietro demo site. See Table 30 for task and milestone descriptions.

San Pietro Energy Storage System Deployment	
Task 1	<u>Final building selection</u> Requested information for new energy storage systems in identified buildings. Requires site visit by pilot site coordinator and Midac technicians. Information to be request: • Buildings identified: confirm daily energy consumption and existing PV plant power • PV plants: request if there is any incentive mechanism in order to preserve plant configuration. • Request information on internet connection (ADSL) and Ethernet connection
Task 2	<u>Design for Energy Storage Systems</u> Based on information in Task 1, designs will be made for new energy storage systems to be installed in suitable buildings. Final selection of energy storage equipment and components based on building surveys.
Task 3	<u>Identification of suitable local installers</u> MIDAC identify approved installers local to demo site for installation of Midac energy storage systems. Scheduling of on-site installation in coordination with pilot site coordinator.
Task 4	<u>Ordering and delivery of energy storage equipment and materials</u> Ordering of energy storage equipment based on Design.
Task 5	<u>Installation and commissioning of new energy storage systems.</u> To be coordinated with other on-site deployment works (e.g. MERCE)
Task 6	<u>Testing of cloud-to-cloud communication between REACT platform and MIDAC Cloud</u> Testing methodology to be determined in Task 6.1 in order to check successful communication between REACT platform and MIDAC Energy Storage systems.

San Pietro Energy Storage System Deployment	
Task 7	New Energy Storage system training for building users To be coordinated with user engagement plan and commissioning of new energy storage.
Milestone 1	Travel to island for final building selection
Milestone 2	Order of Energy Storage equipment
Milestone 3	Start of installation works
Milestone 4	Start of baseline data collection

Table 38: List of tasks and milestones for Energy Storage system deployment at San Pietro site.

3.3.3 Aran island

3.3.3.1 PV and Storage Deployment

Transport Time Line

Transport timelines as follows:

Two-week delivery timeframe from date the order is placed, this includes the boat to the island.

3.3.3.2 Installation Schedule

Installation schedule to be provided by the installation contractor once they have been appointed.

Once agreed it is proposed to upload the information to a share site (Trello) to ensure the co-ordination of installation works on the island is achieved.

3.3.3.3 Heat Pump System Deployment

Error! Reference source not found. shows the Gantt chart for the deployment activities relating to the heat pump system deployment. As is the case with the San Pietro demo site, the time-line for the deployment works has been severely affected by the Covid-19 travel restrictions that came into place in March 2020. Site visits and building inspections originally planned for April 2020 (Tasks 2 and 3) have been delayed until August 2020, leading to subsequent delays in the design and installation of the heat pump systems and associated retrofit works. Table 37**Error! Reference source not found.** is based on the anticipated schedule for resumption of travel and will be updated accordingly throughout the progress of the Task 3.2 deployment works period.

	July 20				August 20				September 20				October 20				November 20		
Weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Task 1	■	■	■	■	■	■													
Task 2							■	■											
Task 3							■	■											
Task 4								■											
Task 5							■	■	■	■									
Task 6										■	■	■	■	■					
Task 7														■	■	■	■		
Task 8																	■	■	
Task 9																		■	
Milestones						⊖		⊜						⊛				④	

Table 39: Gantt chart showing heat pump system deployment works time line at Aran Islands demo site. See Table 32 for task and milestone descriptions.

Aran Islands Heat Pump System Deployment - List of Tasks and Milestones	
Task 1	<u>Identification of local installers</u> MERCE-UK linked partners Mitsubishi Electric Ireland (MEU-IRE) to identify approved installers local to demo site for design and installation of new heating system in Community Development Offices (CDO) building. Tendering process to be determined based on outline proposal in Section 3.1.3.1.
Task 2	<u>Site visit for building survey and energy audit of Community Development Offices (CDO) Building</u> Information collected in building survey will be used to develop the outline proposal in Section 3.1.3.1 into a detailed heating system design and plan for the required installation works. Building survey to be attended by pilot site coordinator and heat pump installer (representatives from MERCE-UK and/or MEU-IT).
Task 3	<u>Installation of MELCloud adaptors in residential buildings</u> MELCloud to be installed and set up for existing heat pump systems in residential buildings identified. To be attended by a qualified installer.
Task 4	<u>MELCloud training activities for building residents.</u> To be coordinated with user engagement activities.
Task 5	<u>Detailed design of new system for CDO building</u> Final selection of heat pump equipment and ancillary components based on detailed building survey in Task 2, above. Design of piped systems by installer, where necessary. MERCE-UK and MEU-IRE to check compatibility of design with REACT platform DR objectives. Scheduling of on-site installation works in coordination with pilot site coordinator.
Task 6	<u>Ordering and delivery of equipment and materials</u> Ordering of equipment and materials based on detailed heating system design. Procurement of heat pump systems through MEU-IRE.
Task 7	<u>Installation and commissioning of new heating system in CDO building</u> To be coordinated with other on-site deployment works.
Task 8	<u>Testing of cloud-to-cloud communications between REACT platform and MELCloud.</u>

Aran Islands Heat Pump System Deployment - List of Tasks and Milestones	
	Testing methodology to be determined in Task 6.1 in order to check successful communication between REACT platform and heat pump systems. Likely to require a member of the REACT team to be present on site.
Task 9	Heat pump / MELCloud system training for CDO building users. To be coordinated with user engagement planning and commissioning of new heating systems.
Milestone 1	Covid-19 roadmap Phase 5 - Non-resident tourist travel to offshore islands can resume.
Milestone 2	Site visits for building surveys and MELCloud installation
Milestone 3	Start of installation works
Milestone 4	Start of baseline data collection

Table 40: List of tasks and milestones for heat pump system deployment works and Aran demo site.

4 Conclusions

This report presents the design and configuration of the renewable energy systems that are to be deployed in the three REACT pilots. The implementation of different types of energy generation and different storage technologies are planned combined with innovative control and monitoring systems. These technologies have been adapted to each of the scenarios according to their characterization and consumption profiles. The existing renewable energy generation systems have been included in the REACT strategies.

In addition, referring to Aran, we are still missing data to deploy the heat pumps on the selected buildings.

The necessary documentation requested by the authorities in order to legalize the installations, contact all the selected participants, and schedule a new visit to the sites, are still in process.

Some hardware tests were performed such as reading and sending actuation orders from the React platform to the equipment that are going to be installed.

Finally, the work is progressing properly and all partners involved as well as the administration are collaborating so that when things return back to normal there will not be any more delays.

Therefore the baselines are created in order to achieve the REACT project and DR strategies and can be deployed as planned.

Amendments

Due to the actual situation, caused by the Covid-19 pandemic in Europe and worldwide, the industrial installations and visits to the pilot sites have been postponed.

This task was already affected by delays in building recruitment and associated data collection due the building selection had been suspended as the surveys were no longer possible. We already have collected information on dwellings and buildings and it should be used to create a baseline and estimations but the results should be reviewed once the surveys will be completed, especially in Carloforte.

Our planned deployment activities at the demo sites in coordination with local partners will not be possible while travel restrictions are in place. There is a potential delay on this task since originally the installation of the monitoring device was planned for May/June this year. It would be beneficial to have this data previous to any PV/Battery installations takes place, these installations will take a number of days when the installations do recommence. Installation depending on planning could be July – September 2020.

On the other hand there is an open request from the Project Officer (PO) to clarify the actual situation of the Italian Site. This is expected to be clarified by July.

References

BOC Boletin Oficial de Canarias. (s.d.). *BOC Nº 243. Lunes 17 de Diciembre de 2018.* Obtido de http://www.gobiernodecanarias.org/boc/2018/243/index.html

BOE Bolentín Oficial del Estado. (s.d.). *Real Decreto 842/2002, de 2 de agosto, por el que se aprueba el Reglamento electrotécnico para baja tensión.* Obtido de https://www.boe.es/boe/dias/2002/09/18/pdfs/A33084-33086.pdf

BOE Boletín Oficial del Estado. (s.d.). *Ley 12/1987, de 19 de junio, de declaración de Espacios Naturales de Canarias.* Obtido de https://www.boe.es/eli/es-cn/l/1987/06/19/12/dof/spa/pdf

BOE Boletín Oficial del Estado. (s.d.). *Ley 2/2013, de 29 de mayo, de protección y uso sostenible del litoral y de modificación de la Ley 22/1988, de 28 de julio, de Costas.* Obtido de https://www.boe.es/boe/dias/2013/05/30/pdfs/BOE-A-2013-5670.pdf

BOE Boletín Oficial del Estado. (s.d.). *Real Decreto 244/2019, de 5 de abril, por el que se regulan las condiciones administrativas, técnicas y económicas del autoconsumo de energía eléctrica.* Obtido de https://www.boe.es/boe/dias/2019/04/06/pdfs/BOE-A-2019-5089.pdf

D1.3, R. (Secction 5.2). *D.1.3 Pilot specific demonstration.*

Fenie Energía. (2019). *Base de datos de consumidores y puntos de suministro (SIPS).*

HORIZON 2020. (2018). REACT Proposal., (p. 18).

IRENA The International Renewable Energy Agency. (s.d.). *Renewable Capacity Statistics 2019*. Obtido de https://www.irena.org/publications/2019/Mar/Renewable-Capacity-Statistics-2019

Mitsubishi Electric. (s.d.). Obtido de Mitsubishi Electric Ecodan Metering and Monitoring Service Package (MMSP) Application Guide: https://library.mitsubishielectric.co.uk/pdf/book/Ecodan_MMSP_Application_Guide#page-1

Mitsubishi Electric. (2014). *MELCloud User Manual.* Obtido de https://library.mitsubishielectric.co.uk/pdf/download_full/1008

Mitsubishi Electric. (2019b). *Product Information Sheet: The Ecodan Cascade System.* Obtido de https://library.mitsubishielectric.co.uk/pdf/book/Ecodan-Cascade-Product-Information-Sheet?model_query=PUHZ-W50VHA2#page-1

Mitsubishi Electric. (s.d.). *Mitsubishi Electric. (2014). MELCloud User Manual.* Obtido de https://library.mitsubishielectric.co.uk/pdf/download_full/1008

SMA Solar Technology. (s.d.). *SMA Energy Systems Home*. Obtido de https://www.sma.de/en/home/sma-energy-system-home-overview.html

SMA. (s.d.). *Sunny Design*. Obtido de https://www.sunnydesignweb.com/sdweb/#/Home: https://www.sunnydesignweb.com/sdweb/#/Home

Victron Energy B.V. (s.d.). *https://www.victronenergy.com/upload/documents/Brochure-Off-Grid-backup-and-island-systems_EN_web.pdf.* Obtido de https://www.victronenergy.com/upload/documents/Brochure-Off-Grid-backup-and-island-systems_EN_web.pdf

Manuals

Mitsubishi Electric Ecodan PUHZ-W112VAA Installation Manual
https://library.mitsubishielectric.co.uk/pdf/book/PUHZ-W85-112VAA_-BS__Installation_Manual__BH79D674K0?model_query=PUHZ-W112VAA#page-1

Mitsubishi Electric Ecodan Pre-plumbed Cylinder Installation Manual:
https://library.mitsubishielectric.co.uk/pdf/book/Pre_plumbed_Cylinder_Parts_Manual_Revision_B?model_query=EHPT30X-UKHCW#page-2

Mitsubishi Electric Split-type Air-Conditioners MSZ-EF series Installation Manual:
https://library.mitsubishielectric.co.uk/pdf/book/MSZ-EF25-50VG_MUZ-EF25-50VG_Installation_Manual__JG79J334H01_?model_query=MUZ-EF25VG#page-1

Mitsubishi Electric Split-type Air-Conditioners MXZ-2F series Installation Manual:
http://library.mitsubishielectric.co.uk/pdf/book/MXZ-2F33-42VF_Installation_Manual__BH79A368H02?model_query=MXZ-2F33VF#page-1

Mitsubishi Electric Split-type Air-Conditioners MXZ-3F & MXZ-4F series Installation Manual:
http://library.mitsubishielectric.co.uk/pdf/book/MXZ-3F54-68VF_MXZ-3F72VF_Installation_Manual__BH79A372H01#page-1

Mitsubishi Electric Packaged Air Conditioners PLA-M.EA series Installation Manual:
https://library.mitsubishielectric.co.uk/pdf/book/PLA-M35-140EA_Installation_Manual__GG79D015W01?model_query=PLA-M71EA#page-1

Mitsubishi Electric Packaged Air Conditioners PUZ-M.KA series Installation Manual:
http://library.mitsubishielectric.co.uk/pdf/book/Installation_Manual_PUZ-M100-140V_YKA_VG79A991H01?model_query=PUZ-M100VKA#page-1

Mitsubishi Electric Mr. Slim SUZ-M.VA series Installation Manual:
https://library.mitsubishielectric.co.uk/pdf/book/Installation_Manual_SUZ-M25-71VA_VG79A976H01?model_query=SUZ-M35VA#page-1

Operating manual SUNNY BOY 3.0 / 3.6 / 4.0 / 5.0 / 6.0
https://files.sma.de/downloads/SBxx-1AV-41-BE-en-12.pdf

Operating manual SUNNY TRIPOWER 3.0 / 4.0 / 5.0 / 6.0
https://files.sma.de/downloads/STP3-6-3AV-40-BE-en-14.pdf

Operating manual SUNNY ISLAND 4.4M / 6.0H / 8.0H
https://files.sma.de/downloads/SI44M-80H-13-BE-en-11.pdf

Operating manual SMA DATA MANAGER M
https://files.sma.de/downloads/EDMM-10-BE-en-21.pdf

Operating manuals Victron Inverter
https://www.victronenergy.com/upload/documents/Manual-MultiPlus-II-24V-48V-3k-and-5k-230V-EN-NL-FR-DE-ES-SE-IT.pdf

Operating manuals Victron Charger controller
https://www.victronenergy.com/upload/documents/Manual-SmartSolar-charge-controller-MPPT-150-35-EN-NL-FR-DE-ES-SE-IT-.pdf

Operating manuals Victron monitor and control
https://www.victronenergy.com/upload/documents/Manual-Cerbo-GX-EN.pdf

APENDIX: Material Data sheets

La Graciosa Data sheet of materials

- PV Panels

https://www.recgroup.com/sites/default/files/documents/ds_rec_twinpeak_2_mono_series_iec_en_rev_e_web.pdf

- Solar mounting system

http://www.console.de/fileadmin/content/console/pdf/Renusol_CS__tecspec_0714_140715_01.pdf

- PV inverter

https://files.sma.de/dl/32724/SB30-60-DS-en-40.pdf

- Battery Inverter

https://www.victronenergy.com.es/upload/documents/Datasheet-MultiPlus-II-inverter-charger-ES.pdf

- Battery charger

https://www.victronenergy.com.es/upload/documents/Datasheet-SmartSolar-charge-controller-MPPT-150-45-up-to-150-100-ES.pdf

- Monitoring and Load control

https://www.victronenergy.com.es/upload/documents/Datasheet-Venus-GX-ES.pdf

https://files.sma.de/dl/30274/ENERGYMETER-DEN1903-V21web.pdf

Aran materials data sheet

- PV Panels

https://www.recgroup.com/sites/default/files/documents/ds_rec_twinpeak_2_mono_series_iec_en_rev_e_web.pdf

- Solar mounting system

https://www.renusol.com/files/content/Downloads/Installationsanleitungen/20200114_EN_VS%2B_Installationsanleitung.pdf

- PV grid inverter

https://files.sma.de/dl/32724/SB30-60-DS-en-40.pdf

https://files.sma.de/dl/33037/STP8-10-3AV-40-DS-en-20.pdf

- Battery Inverter

https://files.sma.de/dl/34578/SI44M_60H_80H-DEN1931-V20.pdf

- Monitoring and Load control

https://files.sma.de/dl/30274/ENERGYMETER-DEN1903-V21web.pdf