

Deliverable DT1.2.1

PILOT PROJECT PLANS

Activity A.T1.2: Detailed design of the pilot projects

St Julien and Val de Quint (FR)

Drôme (FR)

Savona (IT)

Thannhausen (AT)

W.E.I.Z. Campus (AT)

Selnica (SL)

Graing (DE)

Municipality of Udine (IT)

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This document presents the pilot project plans established within the ALPGRIDS project including local and legislative framework, technical details and the set-up of local energy communities.

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Pilot 1: St Julien and Val de Quint (FR)

1.1 Context and general objectives

1.1.1 Local context

The Val de Quint Valley is located in the south-eastern part of France, in the Drôme French department, in the Vercors Mountain southern foothills. Six villages can be found in the Val de Quint Valley: Saint-Julien-en-Quint, Saint-Andéol, Vachères-en-Quint, Sainte-Croix, Ponet-et-Saint-Auban and Marignac-en-Diois (see Figure 1).

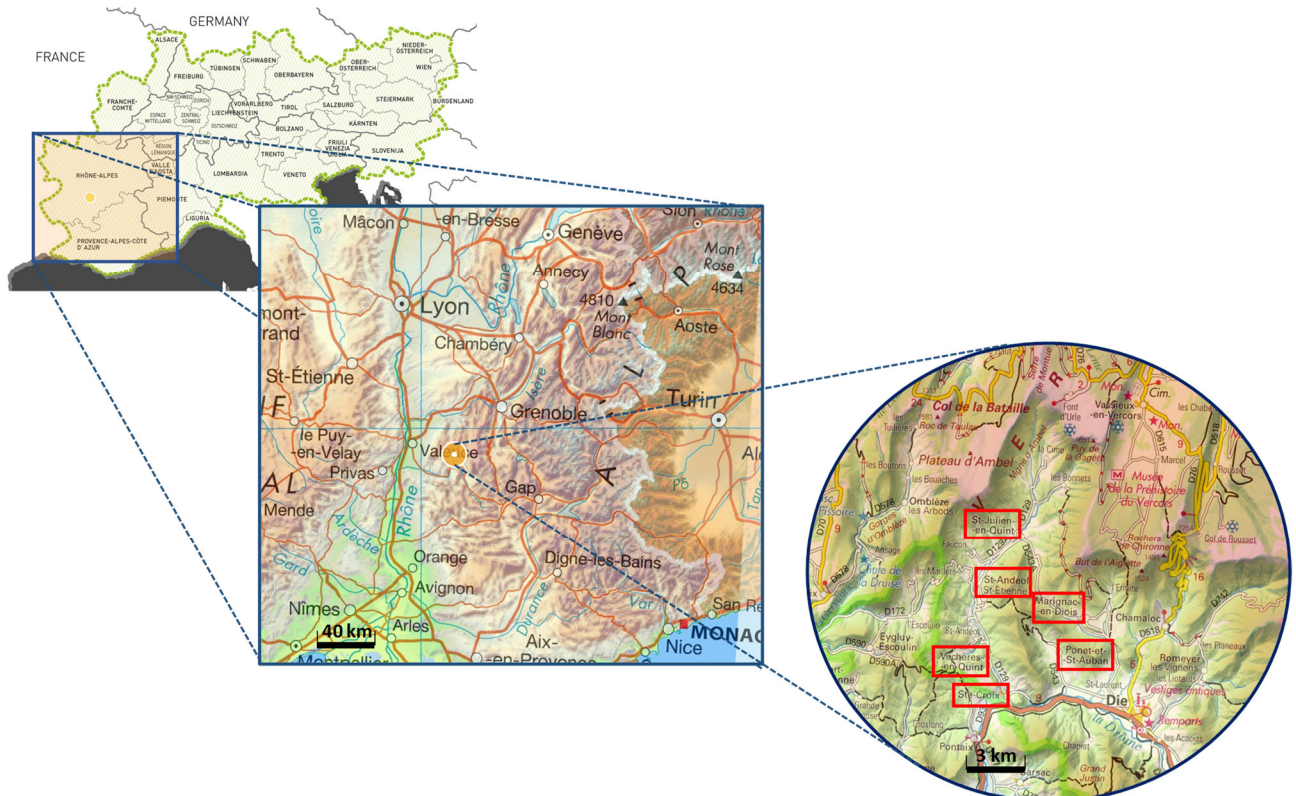


Figure 1 – Location of the Val de Quint Valley (sources : www.espacealpin.fr and www.geoportail.fr)

The Val de Quint is a rural area of approximately 760 people. Mostly a residential area, it is also concerned by agriculture activities and tourism as well as few very small enterprises.

The microgrid activities have begun in the Saint-Julien-en-Quint village, where a share self-consumption project has been developed prior to the ALPGRIDS project. This project gathers around 26 consumption points and one PV production facility. This already existing project constitutes one of the studied pilot sites: the Saint-Julien-en-Quint Pilot Site.

Furthermore, as the local stakeholders aim at extending the microgrid activities to the entire Val de Quint area, this will form an extended pilot site: the Val-de-Quint Pilot Site.

For both pilot sites, the common motivation of the stakeholders is to develop shared self-consumption, in order to

- develop a more resilient energy system, the area being at one end of the distribution network
- purchase renewable energy produced locally at an acceptable price

- provide support to local rural spatial development

1.1.2 Objectives

These pilot sites pursue two classical general objectives, which are (i) the evaluation of the impact of the regulatory framework in the economic value of a microgrid and (ii) the optimization of the configuration and dimensioning of the local shared self-consumption projects, in order to help the local stakeholders. Besides these general objectives, a more specific objective is defined: the evaluation of the additional economic value of the microgrid's local flexibilities related to the global grid actors' needs, by the mean of the use of **dynamic prices of complementary energy**.

The maximization of the self-consumption ratio is indeed a key point to maximize the economic value of a microgrid. The production of the renewable energy sources being intermittent and non-dispatchable, the only way to maximize the self-consumption is to use the microgrid flexibilities (load control, energy storage ...), in order to match energy consumption and production. Hence, microgrids usually include flexibilities and an Energy Management System (EMS) to operate these flexibilities.

These flexibilities are used considering only the economic value inside the microgrid. Yet, the global grid also needs flexibilities to be balanced and maximizing self-consumption in one area might not allow reaching an overall optimum. The local microgrid flexibilities might help global grid actors to be balanced, and thus it might gain additional economic value considering the needs of both the microgrid and the global grid. This way, microgrids will become factors that ease the integration of larger amount of renewable energy sources in the global grid thanks to its shared flexibility.

Dynamic prices of complementary energy may form the link between the microgrid's flexibilities and the global grid needs. Being a global grid actor, the energy supplier is indeed a balance responsible entity: it pays penalties in case of imbalance between its energy sales and production. The prices of the complementary energy it offers might then consider these penalties: prices will be cheaper if the supplier experiences an excess of production. Given these variable prices, the EMS microgrid can optimize the use of the microgrid flexibilities to minimize the energy cost for the microgrid consumers.

The specific objective of the pilot is then to assess the reality of this additional value of microgrid flexibilities. This study will be carried out considering two questions:

- How to set up the dynamical prices of complementary energy?
- What kind of flexibility is the most valuable?

This study will be supported by the analyses of different governance model allowing to provide such variable prices.

1.2 Technical description

1.2.1 Saint Julien en Quint

The Saint-Julien-en-Quint pilot site comprises 1 PV production facility (30 kWp capacity) and 26 consumption points, spread over two Low-Voltage substations (see scheme on Figure 2).

Some figures about the energy consumption and production estimations are displayed in the Table 1. The part of the consumption related to the hot water tanks (around 30 MWh/yr) is considered as flexible consumption, which can be controlled and time-shifted in order to optimize the microgrid operations.

The installation of smart meters (devices called 'Linky') by Enedis, the local DSO, was in progress during the first half of 2020 in Saint-Julien-en-Quint. These devices will allow real-time metering of energy consumption and load control of flexible consumption among other things.

Table 1 – Main figures concerning Saint Julien en Quint & Val de Quint

	Saint-Julien-en-Quint	Val de Quint
Number of delivery points	26	538
RES production capacity	30 kWp	1,600 kWp
Annual RES production	40 MWh/yr	2,000 MWh/yr
Annual energy consumption	178 MWh/yr	2,500 MWh/yr

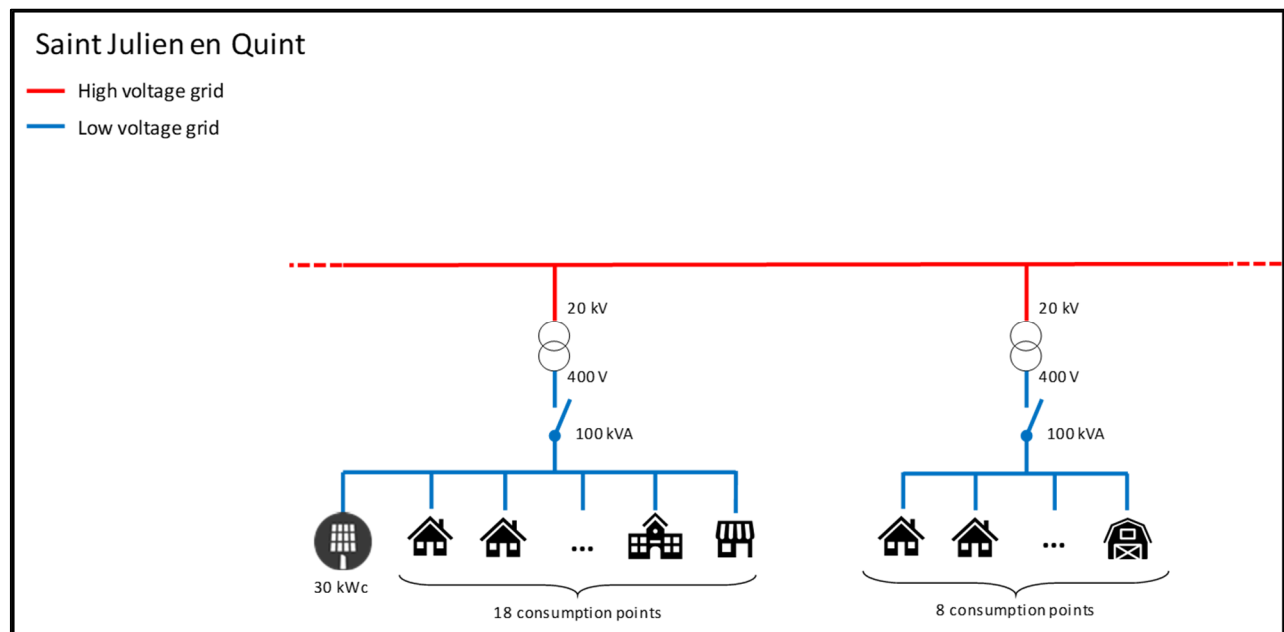


Figure 2 – Scheme of the Saint Julien-en-Quint microgrid configuration

1.2.2 Val de Quint

While the Saint-Julien-en-Quint pilot site already exists, the Val de Quint pilot site responds to the ambition of the local stakeholders to extend the microgrid activities to the entire Val de Quint area. It is a much larger project (see Table 1) which is still under study. It might include:

- **RES production:** The main energy production is fulfilled by PV facilities, but the addition of small amounts of micro-hydraulic and wind power might be considered.
- **Consumption:**
 - 538 consumption points with 2 bigger consumers:
 - “Old Sainte Croix Monastery” meeting & event center
 - Saint-Julien-en-Quint Town Hall
 - micro-electrolyser aimed at producing hydrogen for mobility
- **Load control:**
 - hot water tanks
 - heat production linked with small heating network
- **Energy storage:**
 - electrochemical batteries
 - hydraulic batteries (micro pumping-storage facilities)
 - hydrogen storage (electrolyser + storage + fuel cell) with heat cogeneration (fuel cell)

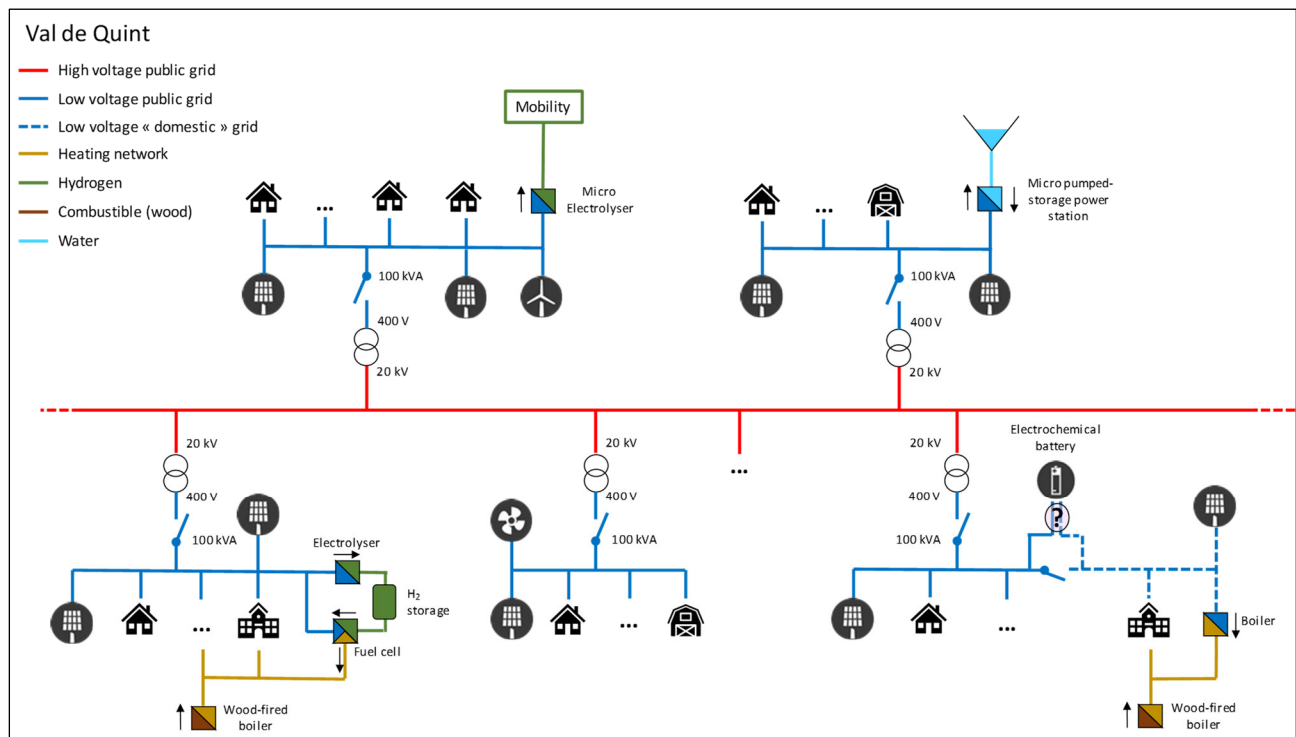


Figure 3 – Scheme of the Val de Quint microgrid configuration

The exact configuration of this pilot site and dimensioning of its elements is still to be defined. The scheme in Figure 3 represents the elements that are considered to date.

As in Saint-Julien-en-Quint, the installation of Linky smart meters was in progress during the first half of 2020 in the whole Val de Quint area.

1.3 Legislative framework

1.3.1 Extended collective self-consumption

For both pilot sites, the microgrid projects consist mainly of collective self-consumption operations, relying on the public grid for ensuring the energy exchanges. In France, such a kind of operation is defined by the article L315-2 of the Energy Code (Code de l'énergie) as "*extended collective self-consumption*" ("*autoconsommation collective étendue*"), the details of which are specified by Decree of 21 November 2019. This kind of collective self-consumption gathers one or several energy producers and one or several energy consumers bound together inside a legal entity (the "Personne Morale Organisatrice", PMO) and it must respect two criteria:

- Producers and consumers must be linked to the low voltage grid of a unique DSO, with a maximal distance between the two furthest participants of 2 kilometers.
- The cumulative power of the energy production sites must be lower than 3 MW (or 0.5 MW in the non-interconnected areas).

These criteria are respected by the Saint Julien en Quint pilot site, but not by the Val de Quint one: considering a self-consumption project spread over 6 villages, the distance between the participants exceeds largely the 2 km criterion.

A new Decree modifying these criteria is currently under study by the French Ministry of the Ecological Transition. It would allow, upon reasoned request, the possibility to override the criteria by

- increasing the maximal distance between the two furthest participants up to 20 kilometers

- increasing the cumulative power of the energy production sites up to 5 MW

In its Opinion of 11 June 2020 upon this draft Decree, the CRE (“Commission de Regulation de l’Énergie”), the French national energy regulator, gave a favourable opinion to the extension of the geographical criteria, provided it will concern only rural areas, and an unfavourable opinion to the increase of the cumulative power. Should this new decree be adopted, the Val de Quint project would meet the criteria to be allowed as an extended collective self-consumption operation. Otherwise, an application was submitted by Acoprev, the legal entity that lead the Val-de-Quint self-consumption project (as “PMO”) to “France Experimentation” to derogate to the geographical criteria.

1.3.2 Standing charge for use of the public electric network (TURPE)

In France, the standing charge for use of the public electric network is called TURPE (“Tarif d’Utilisation du Réseau Public d’Electricité”). The latest version of the TURPE is the version 5bis. A new version may come into effect during the duration of the ALPGRIDS project, but this will not necessarily be studied.

Since the CRE’s Advisement of 7 June 2018 and of 18 June 2018, the TURPE 5bis offers the possibility to apply specific tariffs when all consumption and production points of a same collective self-consumption operation are situated below the same Low-voltage sub-station:

- The variable component associated to the part of the energy consumption covered by the local energy production has been lowered, as the energy fluxes in that case do not pass through the high voltage grid.
- Conversely, the variable component associated to the part of the energy consumption that need complementary energy to be covered has been increased.

Should the self-production ratio be high, this optional tariff may be more attractive than the classical one. Yet, as the consumption and production points must be situated below the same low-voltage sub-station, this optional tariff will not be applicable to the Saint Julien en Quint and Val de Quint collective self-consumption operations.

In the pilot sites cases, we will then study how the spatial limitation of the applicability of the optional collective self-consumption TURPE tariff may affect the profitability of the microgrids, considering various optional TURPE hypothesis:

- no optional TURPE applicable (current situation)
- optional TURPE allowed between production and consumption sites located behind the same low-voltage sub-station and classical TURPE for energy exchanges between sites located behind different low-voltage sub-stations
- optional TURPE allowed for all sites included in the collective self-consumption operation, regardless to the low-voltage sub-stations involved

1.4 The energy community

1.4.1 Players involved, their roles and contractual relationships

The Val de Quint microgrid projects was initiated by a group of local people, both individuals and local municipalities. They gathered together in the **ACOPREV SAS**, in order to be able to make the investments for the development of the RES facility. The ACOPREV SAS roles are:

- The “Personne Morale Organisatrice” (PMO), as defined in the French laws governing the shared self-consumption: it defines the allocation key of the locally produced energy between the consumers. This allocation key is transmitted to the DSO.
- Seller of the local RES production to the consumers.

- Seller of the not consumed RES production (energy in excess) to a Balance Responsible Entity which includes these excesses in their balance group.

The **consumers** involved in the microgrid activities must be shareholder of the ACOPREV SAS, as the ACOPREV SAS is the “PMO”. They receive two energy consumption bills:

- one corresponding to the part of their consumption provided by the ACOPREV local RES facility (the self-produced part), issued by ACOPREV SAS
- one corresponding to the remaining part of their consumption (the complementary energy part), issued by their individual energy provider

The **DSO** (Enedis) gathers all the energy data. It measures the detailed energy consumption of each consumer, thanks to the “Linky” smart meters, as well as the detailed energy production of the ACOPREV production facilities. With these data, Enedis

- calculates the self-produced part and the complementary part of the consumption of each consumer, given the allocation key established by ACOPREV, and transmits these data to ACOPREV and the complementary energy providers
- calculates the part of the local production that is not self-consumed (the energy in excess) and that must be included in the balance group of the Balance Responsible Entity

The part of the consumption of the microgrid that is not covered by the ACOPREV facilities production (the complementary part) is supplied by **energy suppliers**. Every consumer has a contract with the energy supplier of their choice. These contracts do not involve ACOPREV.

The **Balance Responsible Entity** (BRE) chosen by ACOPREV to manage the energy in excess for its Saint-Julien-en-Quint production facility is CNR. There is no link between the BRE and the consumers.

Figure 4 provides a schematic representation of the relationship between the stakeholders involved in the Val de Quint microgrid project.

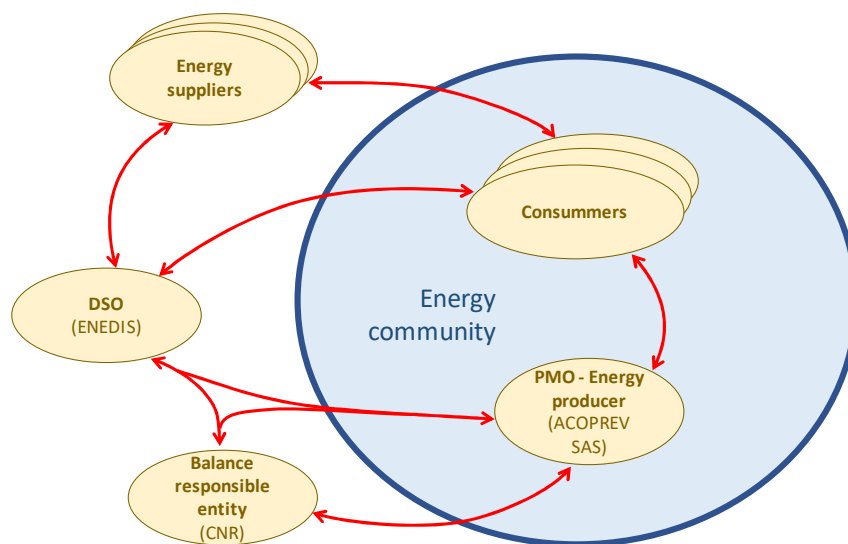


Figure 4 – Scheme of the relationship between the stakeholders involved in the Val de Quint microgrid project

1.4.2 Expected socio-economic outcomes

As a direct socio-economic outcome, the studies will help the local stakeholders to optimize the configuration and size of the Val de Quint shared self-consumption project. In the framework of the studies, different configuration and dimensioning hypothesis will then be considered to assess their respective

economic interest for the consumers. These various scenarios will be defined in collaboration with ACOPREV.

Although based on the particular framework of the Saint-Julien-en-Quint and Val de Quint pilot sites, some more general socio-economic outcomes are expected. The results of the studies are indeed aimed to constitute global guidance which are relevant for numbers of microgrid projects. These outcomes are:

- guidance on the use of variable prices of the complementary energy:
 - o economic interest for the microgrid consumers
 - o interest for the main grid balance
 - o ways to implement variable prices
- analyses on the linked use of Individual and shared self-consumption
- analyses on the grid fee regulation effects on the shared self-consumption in rural area

1.5 Implementation plan

The objectives assigned to the pilot sites will be fulfilled through numerical simulations of microgrid operations. Its principle is to simulate how the microgrid EMS (Energy Management System) will manage the energy exchanges/storages/loads within the microgrid, considering different situations (microgrid topology, storage capacity, grid fee policy, price structure of complementary energy...). The simulations will be run over a full year period. For each given situation, the overall energy cost for the sum of the microgrid consumers will thus be calculated, allowing to evaluate the economic interest of the different choices.

The different activities linked to the realization of the numerical simulations are:

- the **data collection**, to gather the input data needed
- the development of the **modelling tools** used to perform the numerical simulations
- the construction of the various **scenarios** that will be considered in the numerical simulations
- the realization of the **simulations** and the **interpretation** of the results

The numerical simulations will consider only the energy exchanges between the different components of the microgrids, and between the microgrid and the public grid. It will not consider the capacity of the transmission lines. The transitional impacts of the currents will not be considered neither, as the simulations will be run at an hourly time-step.

1.5.1 Data collection

Field investigation

A field investigation is needed in order to collect some information directly linked to the different consumption points as building information (usage, living area), grid access (energy provider, contract power, rate type, off-peak hours...), electric consumption (annual average consumption and detailed annual costs if available) and electrical equipments (heating, hot-water tank, household appliances, other...).

This kind of field investigation was already done over the Saint-Julien-en-Quint pilot site: the collected data will be provided by ACOPREV. It has still to be done over the rest of the Val de Quint pilot site. It will be carried out with the help of ACOPREV, which will make the link with the local people.

Input Data

The time series are defined at an hourly time-step. They cover a 1-year period, the *study period*, from 2017-08-01 to 2018-07-31, corresponding to the availability of detailed consumption measurements over Saint-Julien-en-Quint area.

The collection and calculation of some of the needed input data will be done by a service provider:

- **Electricity network topology**: defining which consumption point is connected to which low-voltage substation (does not include the cable capacities).

- **Load curves:** the consumption load curves will consider separately the flexible (e.g. hot-water tanks) and the non-flexible part of the consumption. The data will be spatially aggregated at the scale of the low-voltage substation sub-grid.
 - o Detailed observed consumption data are already available over Saint-Julien-en-Quint area. For some consumption points, the specific consumptions of flexible loads like hot-water tank are also available. A scaling-up of these data will be made to estimate the flexible part of the consumption over the whole pilot site.
 - o Concerning the Val de Quint consumption load curves, they will be extrapolated from the Saint-Julien-en-Quint observed data, given the information collected through the field investigation.
- **Production time series of RES facilities:** as the RES facilities considered as part of the pilot sites did not really exist during the study period, these time series need to be estimated. These production simulations will then be considered like “observed production data”. The considered RES facilities (PV farm, wind farm and micro-hydro generator) include already existing or design ones as well as the intended ones as part of the Val de Quint project by ACOPREV.

The forecast data (production and consumption) will be calculated by CNR’s team, with a +48h forecast horizon and a 1-hour time step.

- Forecasted consumption:
 - o based on the average monthly “observed consumption” and the real-time consumption data theoretically available at the forecast issue time
 - o updated every hour
- Forecasted RES production:
 - o based on Numerical Weather Prediction (NWP) models output and real-time production data theoretically available at the forecast issue time
 - o NWP models output updated every 6 hours (0hTU, 6hTU, 12hTU and 18hTU plus a 6h availability delay)

1.5.2 Modelling tools development

The simulations will be conducted with the help of two CNR tools, that are linked together: **Pommier Vx** (optimization tool) and **SPIDER** (simulation tool, developed with CEA). They are versatile tools dedicated to the energy systems that can consider various system configurations as well as various operating objectives. They rely on module libraries, allowing to define as many different cases as wanted.

A use case is defined with 3 types of modules:

- the **physical modules**, which model the energy production, storage and consumption facilities
- the **economical modules**, which model the economical rules of the energy market (selling of energy, grid access taxes, ancillary services if implemented...)
- the **objective function**, which define the objective of the optimization part (e.g. energy cost minimization, minimization of the energy exchanges with the public grid...)

Our optimization tool *Pommier Vx* performs MILP (Mixed-Integer Linear Programming) optimization: the optimization modules need to use linearized models. Hence, the module used for simulation may be simplified and linearized to be used for optimization, leading to two versions of the same module.

Physical modules

Some physical modules are already available in our module library:

- PV
- wind power
- consumption
- electrolyser, H2 storage and fuel cell
- electrochemical battery

- consumption with flexible load

Whereas some others will be developed at CNR:

- H2 consumption for mobility
- micro-pumped-storage power station
- wood-fired boiler

These modules will be based on simplified modelling: they will not model the physical processes, but rather their empirical effect over the energy system, considering aggregated effects like global energy transformation efficiency.

Economic modules

The objective of the economic modules is to calculate the total cost of the consumed energy for each consumption point. As different business cases will be studied, several economical modules concerning the energy cost will be considered:

- individual self-consumption
- collective self-consumption:
 - o with specific TURPE (grid fee):
 - A) as defined by TURPE 5bis rules
 - B) without the link to the same substation limitation
 - o without specific TURPE.

All these modules will allow considering variable prices for the supply of the complementary energy.

Objective function

For all the simulations, the objective function of the microgrid EMS is to minimize the total cost of the energy for the consumers, considered as a whole.

Yet, as the consumers may have different complementary energy contracts and different energy consumptions (both in quantity and in temporal distribution), they will experience different energy costs, depending on the allocation between them of the self-consumed energy. For diagnostic purposes, different alternative allocation keys may be considered in addition to the allocation key defined by ACOPREV (e.g. an allocation key designed to minimize the spread between the consumers). These alternative allocation keys will be defined in cooperation with ACOPREV.

1.5.3 Scenarios construction

Variable prices of complementary energy

A specific study will be carried out concerning the setting-up of the variable prices of the complementary energy.

Variables prices will be defined over the 1-year period covered by the simulation (2017-08-01 to 2018-07-31). Depending on their lead-time, they will consider two different frameworks:

- For **day-ahead** periods: They are based on forecasted energy market spot prices, taking also into account risk hedging fees.
- For **intraday** periods: They are based on the expected penalties due to the forecasted imbalances of CNR balance group.

The input data are the operational real-time data archived by CNR during the 1-year period: price forecasts, production forecasts, sales, penalties forecasts, etc.

Variable prices of energy may be difficult to take on for individuals, as one cannot calculate in advance what will be the cost of your energy consumption. Hence, a second version of the variable prices will integrate a maximum threshold that will limit the maximum prices. This way, it is possible for consumers to

know in advance what might be the maximum cost of their energy consumption: even with variable prices, their energy bill will be limited.

To evaluate the interest of variable prices, their effects on energy cost will be compared to the use of fixed prices. Fair fixed prices will also be estimated to allow this comparison.

The use of dynamic prices of complementary energy supposes that there is one single complementary energy supplier for the whole microgrid. Yet, this is not straightforward in legal terms. Thus, different governance models will be studied, both in terms of economic value and of legal framework for the implementation of complementary energy variable prices. These different models will be considered in view of the energy community status:

- Each microgrid consumer is free to choose their own energy supplier.
- The PMO (Personne Morale Organisatrice) organizes the energy supply via a call for tender, with two options to be considered:
 - o Every consumer is free to sign up to the group contract.
 - o The group contract is compulsory.
- The PMO is the unique final energy supplier and signs up with an energy supplier (hence the PMO handles the billing).

Depending of the results of this analysis, different variable price structures will be considered for the construction of the scenario to be run.

Regulatory framework analysis: grid fee impact

Concerning the grid fee impact on the economic interest of microgrids, three type of grid fees will be considered in the scenario construction:

- Use of the TURPE 5bis without application of the optional tariff specific to shared self-consumption,
- Use of the optional TURPE 5bis tariff specific to shared self-consumption. In this framework, the self-consumed energy (which benefits of reduced grid fees) is defined as energy produced and consumed downstream the same low-voltage substation. In case of microgrids covering several low-voltage substations, this specific tariff will benefit only to a small part of the self-consumed energy, when considered at the microgrid scale.
- Use of the optional TURPE 5bis tariff specific to shared self-consumption, but without considering the spatial limitation due to the same low-voltage substation criterion.

The aim is to evaluate if changes in the current grid fees may be of interest for microgrids development.

Regulatory framework analysis: link between Individual and Shared self-consumption

Some scenarios will be designed in order to consider if it is more valuable to consider all energy facilities of the microgrids (production, storage, load) being in a shared self-consumption framework, or to consider that some energy facilities are included in an individual self-consumption area, the excess or lack of energy taking part of the shared self-consumption.

An analysis of the current French legislation upon individual and shared self-consumption will then be carried out, to determine if it is possible to link individual and shared self-consumption and with which economic rules. The results of this analysis will constitute the inputs of the work on the development of the economical modules of the modelling tool.

Setting up the scenarios

Given the various modules and analysis developed so far, several scenarios will be simulated in order to fulfil the different pilot objectives:

- to assess the economic value of complementary energy variable prices
- to evaluate the impact of the regulatory framework concerning:

- the grid fees
- the link between individual and collective self-consumption
- to design the Val de Quint project

The first set of scenarios will concern the Saint-Julien-en-Quint pilot site, considering different battery storage capacity. The second set of scenarios will concern the Val-de-Quint pilot site, considering various microgrid configurations and sizing, according to the ACOPREV project.

1.5.4 Simulations and interpretations

The simulations are done with a two-step procedure:

- First, given forecasted input data concerning RES production and consumption, an **optimization step** defines the best microgrid operating “trajectory”.
- Then, a **simulation step** evaluates the application of the optimized trajectory given the real RES production and consumption data.

A new optimization step is launched every 6 hours (corresponding to the time-step of the meteorological forecasts updates). In between optimization steps, the simulation steps repeat itself with an hourly time-step, adapting the operations to real production and consumption data. If the differential between the optimized and the simulated trajectories exceed a given threshold, a new optimization step is launched, without waiting the end of the 6-hours period.

The simulations will be performed considering two different frameworks:

- A “**perfect prognosis**” framework, where the production and consumption data considered as input data for the optimization of the microgrid operations are the afterwards observed data. Given this framework, the simulated trajectories are the same as the optimized ones. It allows to evaluate the interest of the different simulations without taking into account the impact of the forecasting errors: it corresponds to the result obtained if one had the capacity of making perfect forecasts.
- A “**real operation**” framework, where these data are forecasted ones, implying differences between simulated and optimized trajectories.

The considered objective function relies on the total cost of the energy for the consumers of the microgrid: its minimization will lead the optimizations. Yet, for diagnostic purposes, other variables will be considered, as for example:

- the incomes of the energy supplier (even if dynamic prices of complementary energy are valubles for microgrid consumers, are they valubles too for the energy supplier?)
- the amount of energy exchanges between the microgrid and the public grid

All the results will be shared with ACOPREV. Their interpretations will be done with ACOPREV, considering the investment cost associated with the different simulations.

1.5.5 Timeline

The timeline of the pilot site activities (see Figure 5) takes into account the impacts of the Covid-19 health situation in France, as known so far. As of now, the main impacts on the pilot activities are:

- delays in the preliminary exchanges with the local partners to define the objectives and activities of the pilot sites, delaying the writing of the present document and the starting of the activities
- delays in the planning of the field investigation, which will be more complicated to organize without taking advantage of a Public Meeting, as it was initially planned

Should new restrictions linked to the Covid-19 health situation appear in France, this timeline (and the pilot activities as well) may be revised.

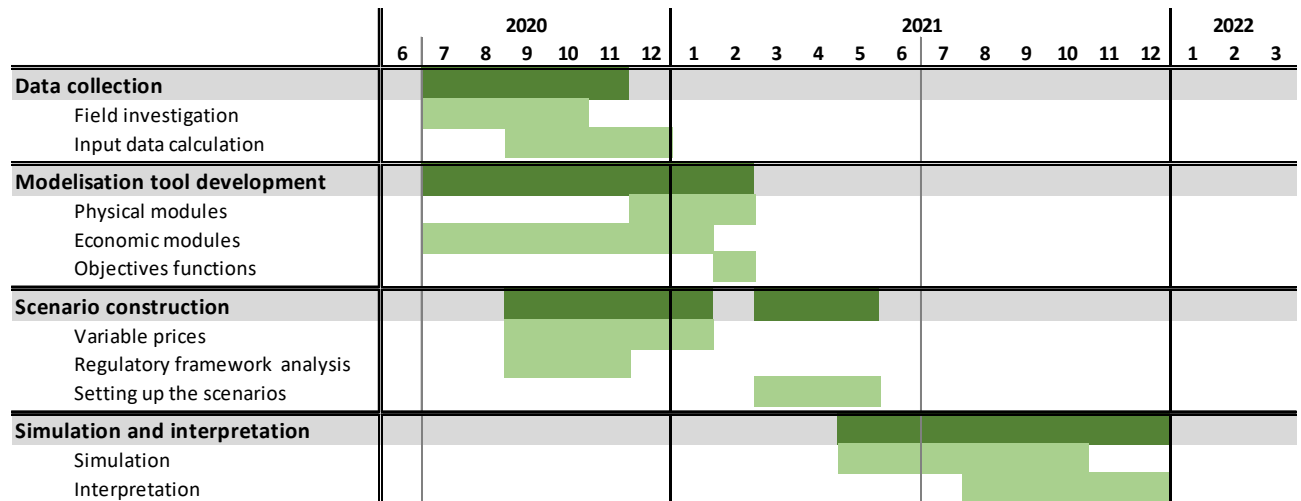


Figure 5 – Timeline of the St-Julien-en-Quint and Val-de-Quint pilot sites activities

Pilot 2: Drôme (FR)

AURA-EE has chosen to work on various pilot sites at all of which a collective self-consumption scheme will be set up. Actually, previous studies have shown that business models of collective self-consumption were difficult to implement, because their profitability is highly dependent on the load profile of the consumers involved. By working on a wide range of situations, AURA-EE hopes to identify the best conditions under which such projects can be implemented, so as to help municipalities and energy communities to develop more easily their future projects.

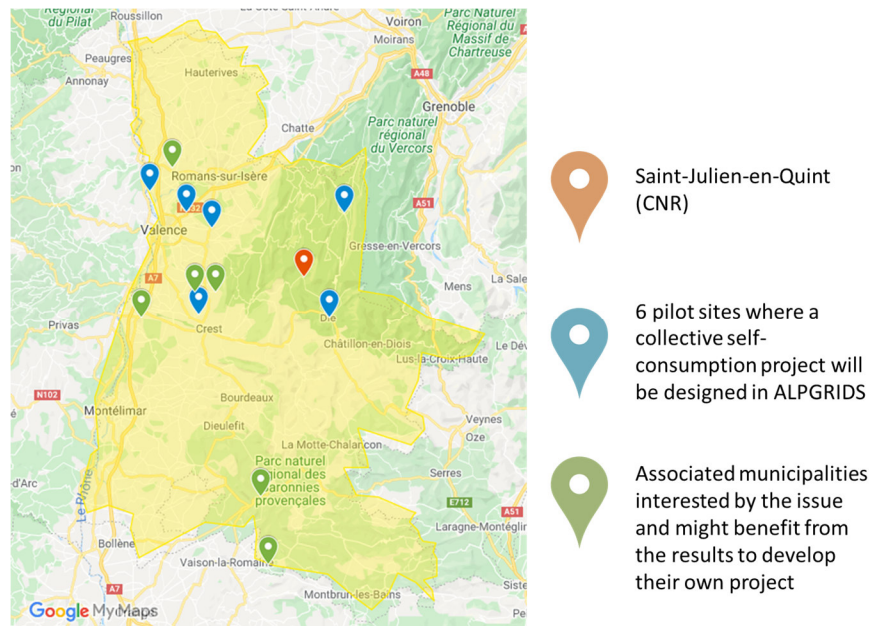


Figure 6 - Pilot sites in Drôme

Pilot 2.a: La Chapelle-en-Vercors (FR)

2.1 Context and general objectives

La Chapelle-en-Vercors is a rural village located in the Regional Nature Park Vercors in the Alps. An energy community exists already on this territory and operates several PV plants for 4 years. The aim of the pilot project within ALPGRIDS is to design a local collective self-consumption scheme where the local energy community directly sells electricity produced by its PV plants to the municipality for use in public buildings. Island operation of the local grid will not be studied since no specific need has been identified on this issue. Thus, the objective is to set up an efficient business and legal model where local consumers, in particular local public building operators, can have a better control of their bill thanks to the local provision of RES electricity.

2.2 Technical description

At this stage, a list of 10 public buildings has been identified as well as possible locations for new PV plants. See Table 2 and Figure 7. Smart meters have been installed in December 2019 and in collaboration with the municipality, AURA-EE has requested the automatic registration of the load curves (30 min timestep). This registration is operating since May 20th 2020, for all the Linky smart meters (≤ 36 kVA). For the swimming-pool, whose power consumption is higher, the detailed values are already being registered at a timestep of 10 min since May 2019. Among the 10 public buildings, only those which will prove to have „interesting“ load curves will be kept in the final project (i.e. buildings with consumptions occurring during peak PV

production, in summer and during day time). Two private buildings could be possibly added (retirement homes) in the study if we succeed in gathering their consumption data as well.

Table 2 - Buildings for possible new PV plants in Chapelle en Vercors (Drôme)

Building	Power subscribed	Annual consumption (kWh)	Load curve registration starting date
SWIMMING POOL	132 kVA	31500	28/05/2019
PUBLIC BUILDING	6 kVA	1700	28/05/2020
MUSEUM	9 kVA	800	28/05/2020
MAYOR HOUSE	12 kVA	9400	28/05/2020
MULTIPURPOSE ROOM	24 kVA	6784	28/05/2020
SOCIAL CENTER	24 kVA	24300	28/05/2020
MARKET PLUG	36 kVA	600	28/05/2020
CHURCH	36 kVA	10700	28/05/2020
CAMPING SITE	36 kVA	15300	
SCHOOL	36 kVA	16400	28/05/2020

Regarding PV production, all the electricity generated by the existing plants is presently fed into the public grid and sold to the grid operator at a feed-in tariff fixed by national legislation. It is not possible to break the feed-in tariff contract unless high indemnities are paid. Thus, the only possibility for a collective self-consumption project is to design new PV plants. Two locations have already been identified (capacity < 36 kVA, see map). The exact size will be calculated so as to reach an optimal balance with the local consumers.

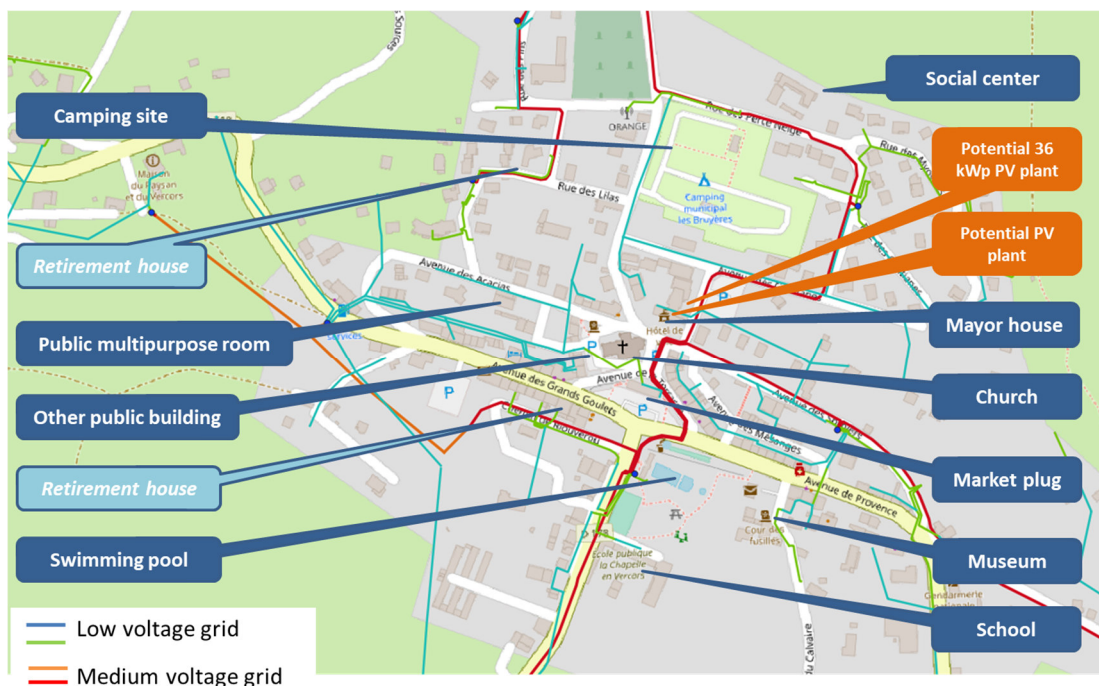


Figure 7 - Possible location of new PV plants for collective self-consumption in Chapelle-en-Vercors (Drôme)

2.3 Legislative framework

The project will be developed under the French framework for collective self-consumption, which was introduced by a new law in 2017 ([law 2017-227](#))¹, subsequently complemented by several decrees. This law has been converted into the Energy Code (article L315-2) and then completed by another law (2019-1147) which enlarges a bit the definition. This legal framework enables every electricity consumer to purchase electricity directly from a local RES producer, provided some conditions are respected:

- The distance between each other is less than 2 km.
- They are linked through a moral body.
- They are connected to the LV network.
- The total RES production is less than 3 MW.

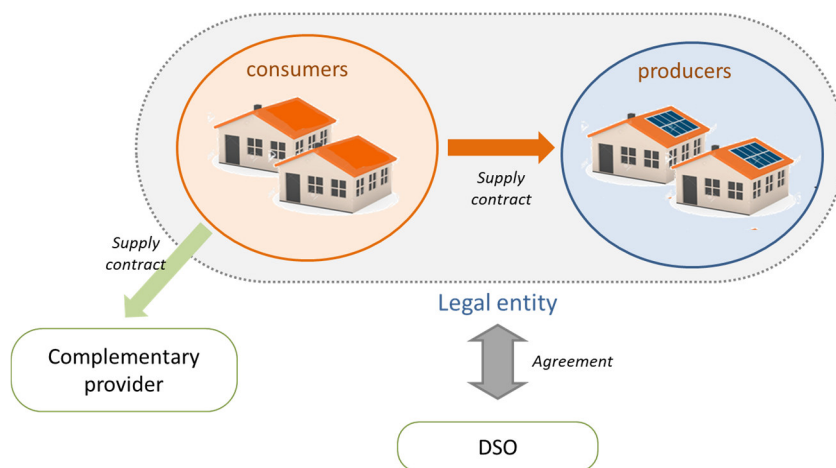


Figure 8 - Legal entities involved in collective self-consumption schemes in France

Consumers and producer need to establish a legal entity (Personne Morale Organisatrice, PMO, see 1.3). An agreement between the legal entity and the distribution grid operator (DSO) needs to be signed. It defines precisely how the RES production is shifted between the users (different repartition keys can be set up). Each consumer concludes two supply contracts, one with the PMO, and one with a complementary supplier for the residual electricity. The latter might be the previous supplier of the respective consumer and the new contract replaces the previous supply contract.

2.4 The energy community

The energy community chosen for the pilot project is VercorSoleil, a citizen-owned cooperative company which has been created in 2015 and presently operates 25 PV plants in 6 municipalities, including La Chapelle-en-Vercors. The aim of this energy community is to develop RES plants and to support the energy transition on the territory. Citizens, municipalities and local companies are shareholders of the company, which has a cooperative governance (1 shareholder = 1 voting right). They bring funds which serve to invest in RES plants and to operate them for several years. Till now, the energy community has only developed PV plants (through feed-in tariff contracts), but they are also involved in the development of e-mobility projects and try to develop projects with other renewable sources.

Within ALPGRIDS, they are in charge of the design of, and investment in, PV plants, and they will sell the generated electricity to the local consumers, among which are public buildings (a legal solution will have to be found to make it possible, as regards public procurement rules).

¹ <https://www.legifrance.gouv.fr/loda/id/JORFTEXT000034080223/2017-03-30/>

2.5 Implementation plan

The activities described above aim, within the ALPGRIDS project, at assessing and evaluating the options for the implementation of an energy community gathered around the operation of PV plants and local PV electricity consumption. In the end, the best option will be the one with the best price structure for the PV electricity produced and sold to the local consumers. This price structure will be determinant for the microgrid business model.

To this purpose, the activities which will be developed within ALPGRIDS will include:

- data collection
- data numerical modelling
- scenario construction
- data analysis

2.5.1 Data collection

We plan to collect the load curves of each building during one year. These load curves, that is the average power over short time intervals as a function of time, will be provided by the existing smart-meters at a 10 or 30 minutes timestep (depending on the power subscription).

The data collection started on May 28th, 2020.

We also plan to collect the electricity bills (€) during this same period, including the detailed price components per time of use.

2.5.2 Data numerical modelling

Since no PV plant exists yet, we plan to simulate the PV production curve at a 30 min timestep. A dedicated software will be used and will run the simulations on the basis of meteorological and satellite data registered during the same period as the data collection of the load curves. The power of the PV plant will be adjusted to the building perimeter (see below) so as to reach a high self-consumption rate (> 90%).

2.5.3 Scenario construction

Various scenarios will be built according to:

- Building perimeter: We might consider different use cases, among which a scenario where we would keep only the most relevant buildings for collective self-consumption (those who have most of their consumptions during summer and daytime).
- PV capacity: Various sizes can be proposed, in close relation to the building perimeter which is studied. The aim is to have a high self-consumption rate (>90%).
- Incentives: Different options can be subscribed for the network charges (TURPE) of the consumers. These time-of-use options will be taken into account. We will also include a scenario with a tax incentive to assess the impact of a more supportive policy.
- Collective self-consumption scheme: Two main schemes can be considered: (1) Either the whole production is shared among the members of the energy community depending on the instantaneous production and consumption of the different members or (2) a main self-consumer is identified and only the excess electricity which is not self-consumed by this consumer is shared with the other members of the energy community. These two schemes lead to 2 different economic models.
- Hypothesis on the evolution of the electricity price from the grid.

2.5.4 Data analysis

Starting from the data collection and the data modelling, and building on the different possible scenarios, the data analysis will first assess, for each consumer, what share of local production can be self-consumed and when. Then, adding a financial hypothesis (some of them depending on the time step), the aim will be

to find out the best PV electricity price structure, fitting both the producer and the consumers so that we get a well-balanced model over time.

2.5.5 Timeline

The implementation plan starts from the identification of different pilot sites and runs until the elaboration of an efficient business and legal model, based on the analysis of the ground data. See Table 3.

Table 3 : Implementation plan for pilot project in Drôme

	2020				2021				2022	
	T1	T2	T3	T4	T1	T2	T3	T4	T1	T2
Selection of pilot sites										
Start registration of smart meters (procedures with DSO)										
First analysis of collected data and modification of building perimeter										
Legal model (contract templates, legal scheme to sell electricity to public buildings, etc.)										
Completed analysis of collected data and PV design										
Final business and legal model										

Pilot 2.b: Saint-Marcel-les-Valence (FR)

2.1 Context and general objectives

Saint-Marcel-les-Valence is a semi-urban village, located close to Valence, the main city of the Drôme department. The municipality owns many public buildings, produces electricity with existing PV plants and plans to develop a new PV plant on a sports hall. The aim of the pilot project is to design a local energy loop, namely a collective self-consumption scheme, allowing the municipality to reduce its electricity bill. Island operation of the local grid will not be studied since no specific need has been identified on this issue. Thus, the objective is to set up an efficient business and legal model allowing the municipality to lower its electricity bill.

2.2 Technical description

At this stage, a list of 17 public buildings has been identified. Additional buildings might be added later. Smart meters are already installed and in collaboration with the municipality, AURA-EE has requested the automatic registration of the load curves (30 min timestep). This registration is operating since July 2020 for subscription contracts above 36 kVA and February 2020 for most of the others. Among these 17 buildings, only those which will prove to have „interesting“ load curves will be kept in the final pilot project (i.e. buildings with consumptions occurring during peak PV production, in summer and during day time). One private building could be possibly added (retirement home) in the study if we succeed in gathering their consumption data as well.

Table 4 - Buildings for possible new PV plants in Saint Marcel-les-Valence (Drôme)

Building	Power subscribed	Annual consumption (kWh)	Load curve registration starting date
SPORTS HALL	60 kVA	105 000	13/07/2020
TECHNICAL PUBLIC BUILDINGS	42 kVA	50100	13/07/2020
SCHOOL A	42 kVA	21100	13/07/2020
SCHOOL A RESTAURANT	72 kVA	35400	13/07/2020
STADIUM A	66 kVA	31800	13/07/2020
CULTURAL CENTER	60 kVA	31000	13/07/2020
MAYOR HOUSE AND SCHOOL B	42 kVA	69300	13/07/2020
THEATER	36 kVA	9200	20/02/2020
MULTIPURPOSE ROOM	36 kVA	12700	20/02/2020
REST AREA	18 kVA	t.b.d.	20/02/2020
STADIUM B	36 kVA	11400	20/02/2020
WASTE WATER PUMPS	6 kVA	1230	20/02/2020
MAYOR HOUSE	9 kVA	t.b.d.	20/02/2020
CHURCH	12 kVA	t.b.d.	20/02/2020
TENNIS CLUB	36 kVA	19600	20/02/2020
WATERING SYSTEM	12 kVA	5400	16/07/2020
YOUTH CENTER	24 kVA	12000	20/02/2020

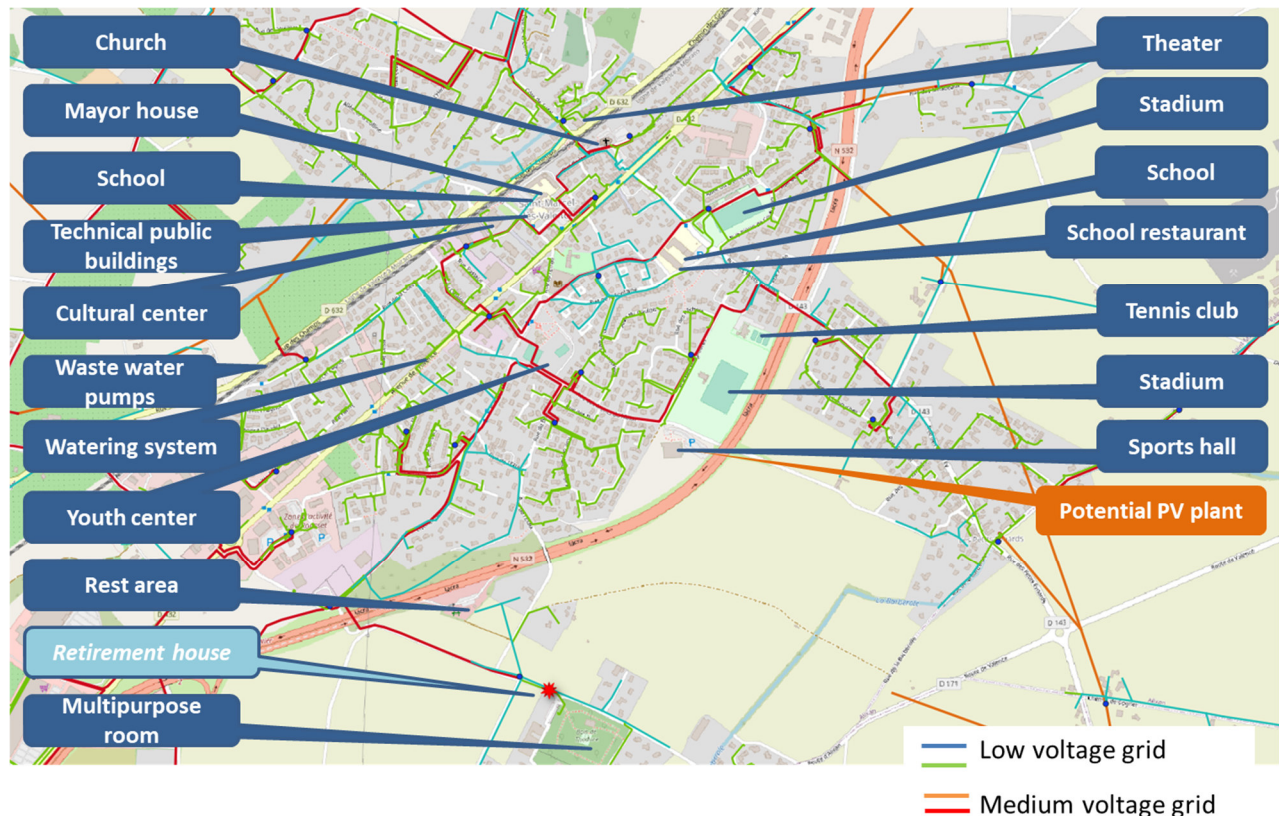


Figure 9 - Possible location of new PV plants for collective self-consumption in Saint Marcel-les-Valence (Drôme)

As location for a PV plant, the municipality considers the roof of an extension of the sports hall. This plant will be designed to provide electricity to the other buildings through the collective self-consumption scheme.

2.3 Legislative framework

The framework is the same as described for pilot 2.a.

2.4 The energy community

In this case, the energy community is identical with the municipality which is its only member. If additional private buildings are added in the consumption perimeter, a legal entity will have to be created which will gather the municipality together with all the private consumers.

2.5 Implementation plan

The schedule is the same as for pilot 2.a.

Pilot 2.c: Montélier (FR)

2.1 Context and general objectives

Montélier is a semi-rural village, located close to Valence, the main city of the Drôme department. The municipality owns many public buildings, produces electricity from existing PV plants and plans to develop a new PV plant on a sports hall. Aim of the project is to design a local energy loop where the municipality could directly deduce the electricity production of this new plant from its public buildings' consumption, through the scheme of collective self-consumption. Island operation of the local grid will not be studied

since no specific need has been identified on this issue. Thus, the objective is to set up an efficient business and legal model allowing the municipality to lower its electricity bill.

This study case is very close to pilot 2.b, but the consumer load profiles are different.

2.2 Technical description

At this stage, a list of 10 public buildings has been identified as well as possible locations for new PV plants. Smart meters have been installed in December 2019 and in collaboration with the municipality, AURA-EE has requested the automatic registration of the load curves (30 min timestep). This registration is operating since May 20th 2020, for all the Linky smart meters (≤ 36 kVA). For the swimming-pool, whose power is higher, the detailed consumptions are already being registered at a timestep of 10 min since May 2019. Among these 10 buildings, only those which will prove to have „interesting“ load curves will be kept in the final project (i.e. buildings with consumptions occurring during peak PV production, in summer and during day time). Two private buildings could be possibly added (retirement homes) in the study if we succeed in gathering their consumption data as well.

Table 5 - Buildings for possible new PV plants in Mont  lier (Dr  me)

Building	Power subscribed (kVA)	Annual consumption (kWh)	Load curve registration starting date
SPORTS HALL	36	t.b.d.	March 2020
MAYOR HOUSE	36	38300	June 2019
GARDEN FOUNTAIN	18	8200	June 2019
MULTIPURPOSE ROOM	12	12300	June 2019
SCHOOL RESTAURANT	36	24000	June 2019
CHURCH	12	t.b.d.	
TENNIS CLUB	24	t.b.d.	March 2020
TECHNICAL PUBLIC BUILDING	12	3600	June 2019
SPORTS HALL	30	18500	June 2019
SOCIAL CENTER	42	t.b.d.	April 2020
OFFICES	84	t.b.d.	April 2020



150 kVA power subscription and its consumptions are being registered at a 10 min timestep since several months.

Table 6 - Building for possible new PV plants in Die (Drôme)

Building	Power subscribed	Annual consumption (kWh)	Load curve registration starting date
WATER TREATMENT PLANT	150 kVA	340 000	May 2019

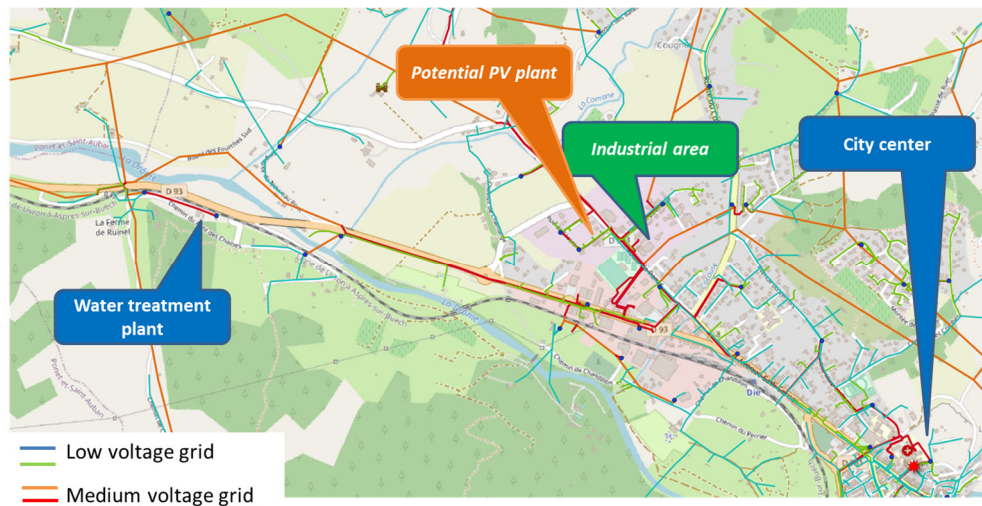


Figure 11 - Possible location of new PV plant for collective self-consumption in Die (Drôme)

2.3 Legislative framework

The framework is the same as for pilot 2.a.

2.4 The energy community

In this case, the energy community is a cooperative company based in Die which develops RES projects in the Drome river valley. It gathers 88 shareholders, among them inhabitants, municipalities, and local companies. The energy company, called DWATT, already operates PV projects, but also develops wood energy and wind energy plants.

2.5 Implementation plan

The schedule is the same as for pilot 2.a.

Pilot 2.e: Eurre (FR)

This site is still under definition. The aim is to supply several public buildings by PV electricity from one or more municipal PV plants. No smart meters have been installed so far. The aim is to install and start operating them before the end of 2020.

Pilot 2.f: La Roche-de-Glun (FR)

2.1 Context and general objectives

La Roche-de-Glun is a semi-urban village. The aim is to supply a retirement house by PV electricity from a PV plant about to be built by the municipality on a sports hall.

2.2 Technical description

The project is still under definition. At present, difficulties are encountered for obtaining data from the retirement house.

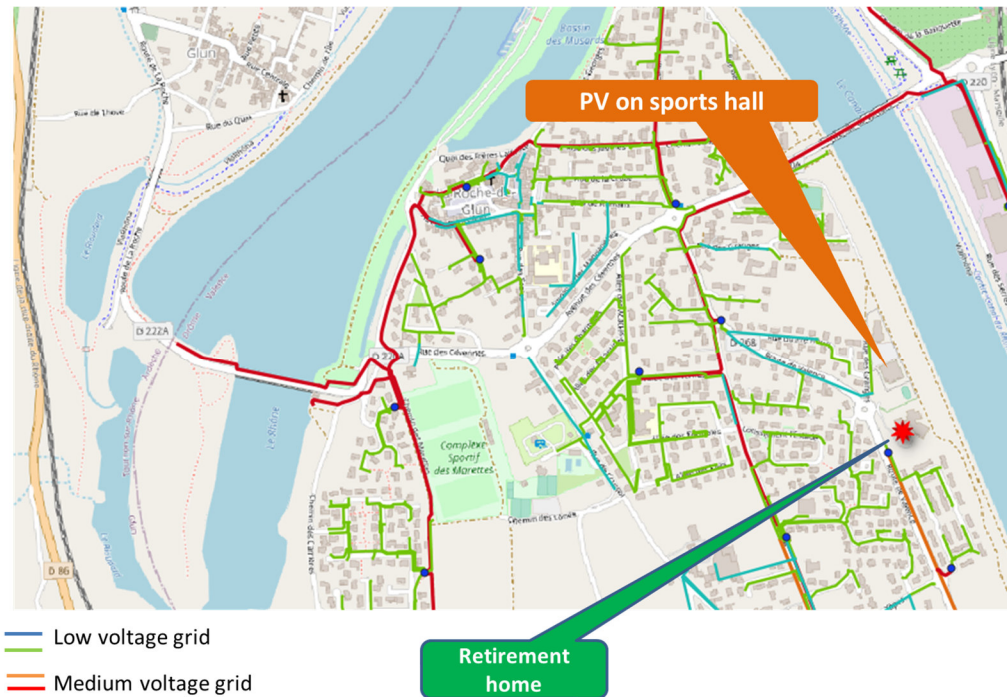


Figure 12 - Possible location of new PV plant for collective self-consumption in Die (Drôme)

2.3 Legislative framework

The framework is the same as for pilot 2.a.

Pilot 3: Savona (IT)

3.1 Context and general objectives

The University Campus of Savona is powered by a polygeneration microgrid developed by the University of Genoa and Siemens since 2014. The project has been awarded the European Electricity Grid Initiative EEGI Label, an important sustainability acknowledgement at international level. The goal within the ALPGRIDS project is to carry out a study on the further development of the existing microgrid concept and its application into a new district planned in the neighbouring Legino area.

The main objectives of the further development and expansion are:

- testing the application of a sustainable power system such as the existing polygeneration microgrid in the framework of a local energy community and virtual power plant scheme
- reaching a high degree of penetration of RES in a relevant portion of the urban territory, considering different types of buildings and different patterns of final energy use
- studying a carbon-free network scheme integrating innovative technologies such as hydrogen CHP units and wind turbine generation

The pilot project study will focus on meeting the high supply reliability requirements of research labs, the demand pattern of campus housing, presently high heating and cooling demand with large cost reduction potential, and the target of achieving very low greenhouse gas and other emissions.

In particular, the pilot project study will consider two new physical microgrids capable of operating in islanding configuration. In this regard, the microgrid of the Campus is already prepared for islanding in test mode and research on this field has been carried out since 2014.

3.2 Technical description

The available areas for the new district are highlighted in yellow in Figure 13, while the boundaries of the Savona campus are indicated with a red line. The new district has been included in the municipal urban plan in 2011, with the aim of creating new accommodations for students and social housing, thereby taking advantage by the nearby university campus to encourage the birth of a new modern urban site.

The pilot to be studied will be located in this new district. It is made up of 8 distinct main function areas as reported in the following list. The buildings are located as shown in Figure 14.

1. (1a,1b) public football stadium – main area (existing – subject to makeover)
2. (2a,2b,2c,2d) public football stadium – locker rooms, shops, workshops, grandstand (existing – subject to makeover); stadium microgrid control center (SMCC) (planned)
3. (3) Public outdoor sports (existing)
4. (4) University microgrid control centre (UMCC) and related plants (storage, Hydrogen CHP, vehicle to grid) (planned)
5. (5a, 5b, 5c) Student accommodation, university spaces (planned)
6. (6a, 6b, 6c, 6d) Social housing (planned)
7. (7) public park (existing)
8. (8) swimming pool (existing)

Apart from the swimming pool, the establishments are owned either by the Municipality of Savona or the University. The public football stadium needs a complete makeover. In this framework the coverage of the grandstand can be exploited to install a photovoltaic power plant with a maximum size of about 1.47 MWp. The spaces under the stands could be used for the location of commercial activities and offices.

The swimming pool is already heated with thermal power provided by a CHP plant (TOTEM 25) with rated electrical and thermal power, respectively, equal to 25 kWe and 57.6 kWt.

New buildings for social housing, student accommodation, offices for the University and private companies can be located in a nearby area (from 5a to 5c and from 6a to 6d in Figure 14), interconnected with the stadium area by cycle and pedestrian paths. The final location of these building is still under study.

The significant amount of energy produced by the new main PV power plant could be shared among the users of the new district as actors of the new energy community.

All the buildings are planned to be equipped with PV plants as required by national legislation for new installations. Their size will be maximized through architectural integration of the PV modules.

Further, the investigated solution comprises the installation of distributed electrical storage systems, in order to optimize the use of the electricity produced by the PV plants directly in each establishment.

The new buildings will be supplied with heat and cold produced by reversible electricity-driven heat pumps in order to completely avoid the use of gas. The domestic hot water will be mainly provided by thermal solar collectors coupled with thermal storage tanks. The considered heat pumps will be able to operate as backup for the domestic hot water production. Due to the large availability of renewable electrical energy from the main and the secondary PV power plants, it will be convenient to use induction plates for kitchen uses.



Figure 13 - Available areas and Savona Campus

As part of the investigated pilot project, two physical microgrids will be designed to provide the major part of the energy needed within the district: The first one will be used to power the new University buildings (hereinafter called “Mini-Campus” to distinguish it from the nearby main University Campus), the second one will power the stadium and all the related services.

The area number 4 in Figure 14 will be used for the location of a new building for the University Microgrid Control Center (UMCC). In the same area the following plants are planned to be installed:

- The production of hydrogen for supplying the CHP system will be done by an electrolyser fed by the exceeding electricity production from the PV plants within the district. In addition, the possibility to supply the electrolyser during the night by the power generated by nearby wind farms will be investigated, together with the optimal sizing of the hydrogen storage system. Another microgrid control centre (SMCC – Stadium Microgrid Control Centre) will be located inside the stadium building to manage the related physical microgrid.

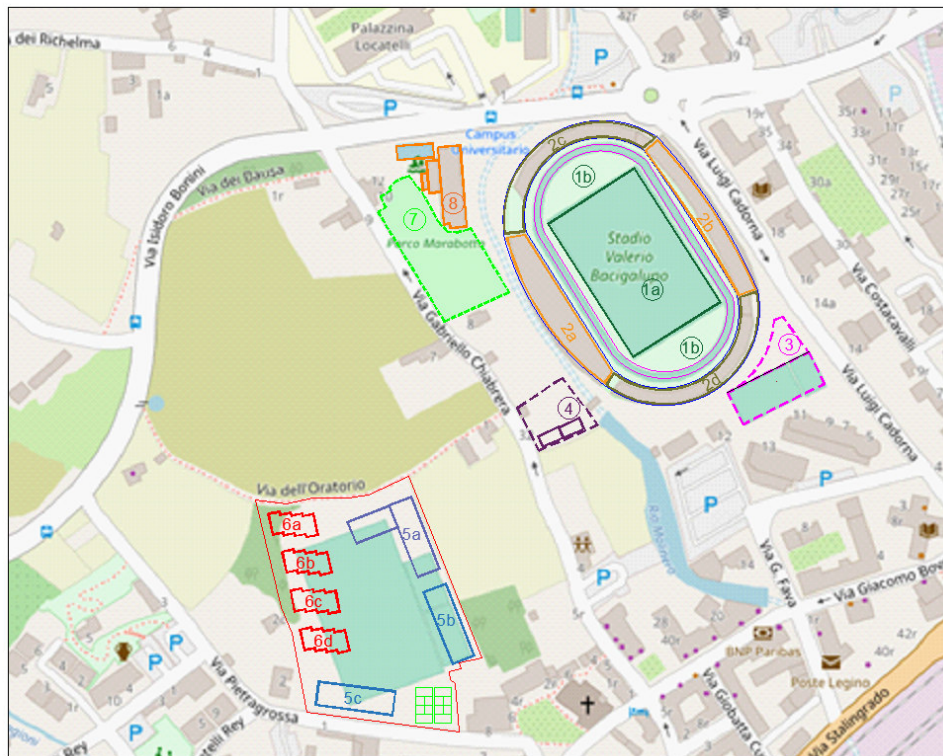


Figure 14 - Pilot Project Savona

The following tables show the electricity, heat and cold consumption, respectively, for the new buildings (forecast) and for the existing buildings operating in the new framework (data acquired from energy bills and forecasts) as well as the main generation data of power plants (future installations).

Table 7 - Electricity consumption and generation - forecast (Savona)

building	electricity consumption		PV plants		CHP plants	
	committed power [kWe]	energy consumption [MWhe/yr]	peak power [kWp]	generation [MWhe/yr]	peak power [kWp]	generation [MWhe/yr]
Football stadium (existing – subject to makeover)	740	1173	1470	1658		
Social housing (planned)	73	116	112	126		
Student accommodation (planned)	86	137	80	90		
University, offices (planned)	182	388	120	135		
Microgrid Control Center (planned)	18	46	30	34	25	75
Public park and green areas (existing – subject to expansion)	48	80				
Heat pump (planned)	436	324				
Total	1583	2264	1812	2043	25	75

Table 8 – Thermal energy consumptions and generation (Savona)

building	thermal load		heat pump	CHP plants	solar collector	thermal generation [MWht/yr]
	energy consumption [MWht/yr]	committed power [kWt]	peak power [kWt]	peak power [kWt]	gross surface [m²]	
Football stadium (existing – subject to makeover)	116	593	4x165	X	60	140
Social housing (planned)	33	156	16x11.7	X	16x3.4	36
Student accommodation (planned)	39	184	1x185	X	15	45
Microgrid Control Centre (planned)	5	28	1x30	1x25	X	6
University, offices (planned)	46	233	2x133	X	15	53
Total	239	1194	1328	25	144	280

Table 9 - Cooling energy consumptions and generation - forecast (Savona)

building	cooling load		heat pump	absorption chiller	cooling generation [MWhc/yr]
	energy consumption [MWhc/yr]	committed power [kWc]	peak power [kWc]	peak power [kWc]	
Football stadium (existing – subject to makeover)	70	284	4x131	X	84
Social housing (planned)	37	149	16x16.7	X	41
Student accommodation (planned)	44	143	1x150	X	51
Microgrid Control Centre (planned)	7	26	1x35.5	1x30	8
University, offices (planned)	55	216	2x110	X	63
Total	213	858	1351.2	30	247

The pilot project conceptual scheme is shown in Figure 15.

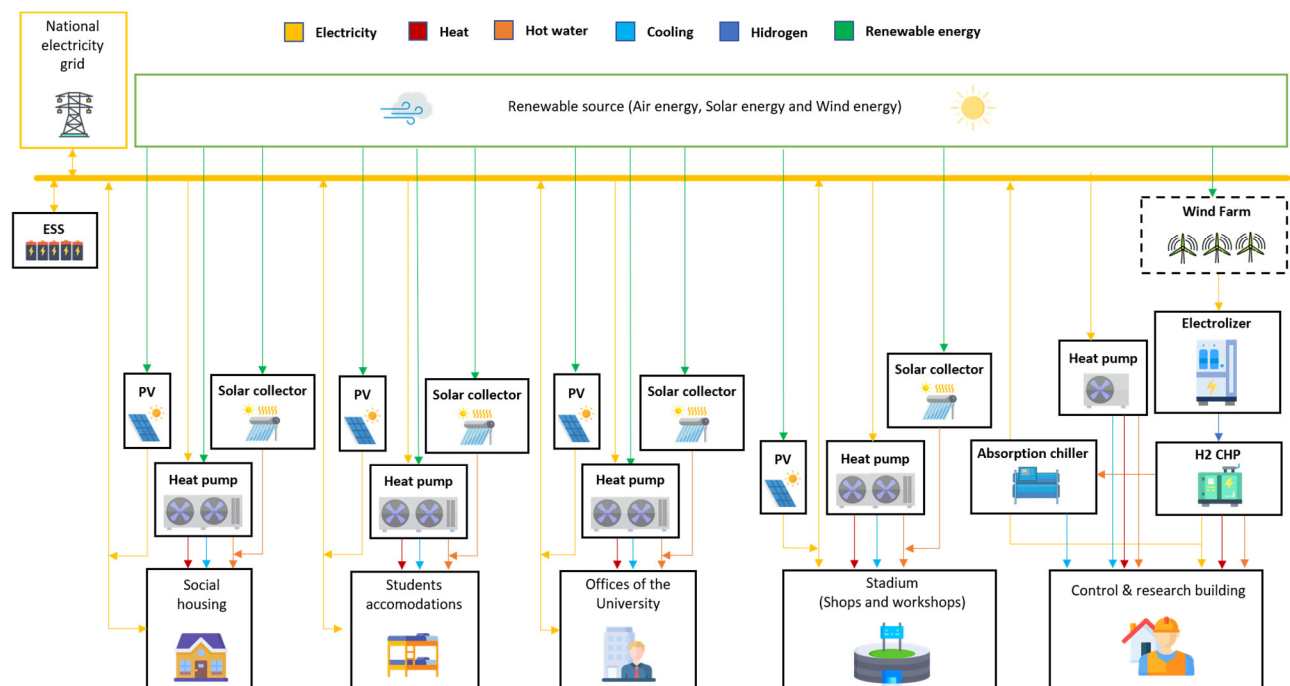


Figure 15 - Energy flow scheme (Savona)

The total yearly electric energy production from renewables is about 2 GWh.

The size of the generation units here presented are approximated since they have been estimated based on a preliminary study of electrical and thermal loads.

The final asset of the generation plants will be evaluated by using optimal planning tools based on load profile simulation.

The microgrids will be continuously monitored and controlled by SCADA systems (System Control and Data Acquisition). The SCADA will be designed by referring to the most advanced technologies. When implemented, they will help researchers to perform comparative studies with that already installed in the existing microgrid of the Savona Campus.

All the new buildings will be equipped with a BMS (Building Management System). Such systems offer the possibility to check the operational status of all the devices installed within the buildings (generation plants and loads) and to execute commands (start up and shut down of plants, power regulation, demand response strategies, etc.). They have a fundamental role to support ordinary and extra-ordinary maintenance processes, being able to report anomalies and faults. The actual management of the energy flows of the existing microgrid (that of the Campus) is done by the software DEMS (Decentralized Energy Management System), which can provide load forecasts, the optimal scheduling of dispatchable sources and storage systems, and finally, monitor and control the power exchange with the external distribution network.

The main architecture of the SCADA System is shown in Figure 16 .

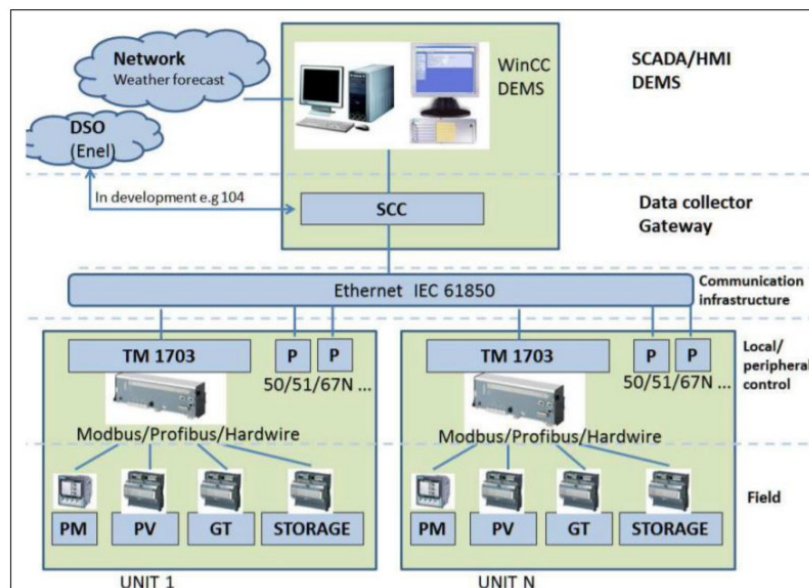


Figure 16 - SCADA Sytem Architecture (Savona)

3.3 Legislative framework

For the present work several legislative and regulatory measures are being evaluated to investigate their possible application to the ongoing pilot project.

With regard to energy communities in Italy, only the EU's Renewable Energy Directive (RED II) has been implemented by LAW 28/02/20 n.8 introducing the concept of renewable energy community, while the transposition of the Electricity Market Directive (EMD II) is still pending. The Italian implementation of REC tends to follow the cited European directive with some minor specification. More in details, the proximity constraint concept is implemented by allowing all the members of the same low voltage (LV) portion of the grid connected to the same secondary transformation substation to join into the same renewable energy community. In this way the concept of local energy community is addressed to maximize the local self-

consumption of renewables sources. Moreover, only electric renewable generation units are considered, and the sharing of electricity is obtained by exploiting the already existing distribution network.

On 5 August 2020, ARERA, the national authority for the regulation of energy grids and the environment, has published the document titled “REGOLAZIONE DELLE PARTITE ECONOMICHE RELATIVE ALL’ENERGIA ELETTRICA CONDIVISA DA UN GRUPPO DI AUTOCONSUMATORI DI ENERGIA RINNOVABILE CHE AGISCONO COLLETTIVAMENTE IN EDIFICI E CONDOMINI OPPURE CONDIVISA IN UNA COMUNITÀ DI ENERGIA RINNOVABILE” which defines the guidelines for the relationship between the energy community and the GSE, the Italian energy services manager. The main key relations are:

- All the members of the community maintain the relationship with their energy provider.
- The energy community is a juridical entity such as a consortium, a cooperative or an association.
- The maximum size of RES plants managed by a single energy community is presently limited to 200 kW (the limit applies to the sum of nominal power of all plants managed by the energy community), but this upper bound is expected to be cancelled in of the near future by new laws that will definitively implement di European Directive by 2021.
- All the members of the community must be physically connected to the LV distribution network and powered by the same MV-LV substation. This constraint could be maintained by the future legislation to implement the concept of “proximity” from the RED II.
- The energy shared by the community is defined for each hour as the minimum between the net renewable energy injected into the grid and the overall energy absorbed from the grid by the members of the community.
- The shared energy is incentivized at 11 c€/kWh by the GSE (Gestore Servizi Energetici – the national energy services operator).
- The shared energy is also incentivized by a reduction of transmission (referring to the TRASE tariff) and distribution (referring to the highest value of the BTAU tariff for the month considered) grid fees.
- The energy injected into the grid can be sold on the electricity market or can be purchased by GSE at a guaranteed price within the regulatory system of “Ritiro Dedicato” (dedicated withdrawal), according to the AEEG’s (Autorità per l’Energia Elettrica e il Gas – the Italian Regulatory Authority for Electricity and Gas) directive n°280/07.

Furthermore, the regional law 6th JULY 2020, n. 13 has introduced several legal obligations for the energy communities regarding the acquisition and the communication of periodic data to monitor the effectiveness and results of each initiative.

In accordance with the ARERA’s directive no. 422/2018/R/EEL referring to the EU Directive 25/10/2012 no. 27 on energy efficiency, a different framework for large groups of small-scale distributed generation producers and consumers is currently studied in Italy, through a pilot project concerning the so-called UVAM system shown in Figure 17 (Unità Virtuali Abilitate Miste – virtually aggregated mixed units). More precisely, the project aims to aggregate several stakeholders (operating within the Italian energy scenario) in clusters (called UVAM), to allow them to participate in the Dispatch Service Market (MSD) as a single collective unit. Each cluster is coordinated by a Balance Service Provider (BSP), that acts as a intermediary between the each UVAM member and the Transmission System Operator (TSO) during the ASM sessions.

The application of these possible schemes will be studied in the pilot project with reference to the peculiarities of the different buildings.

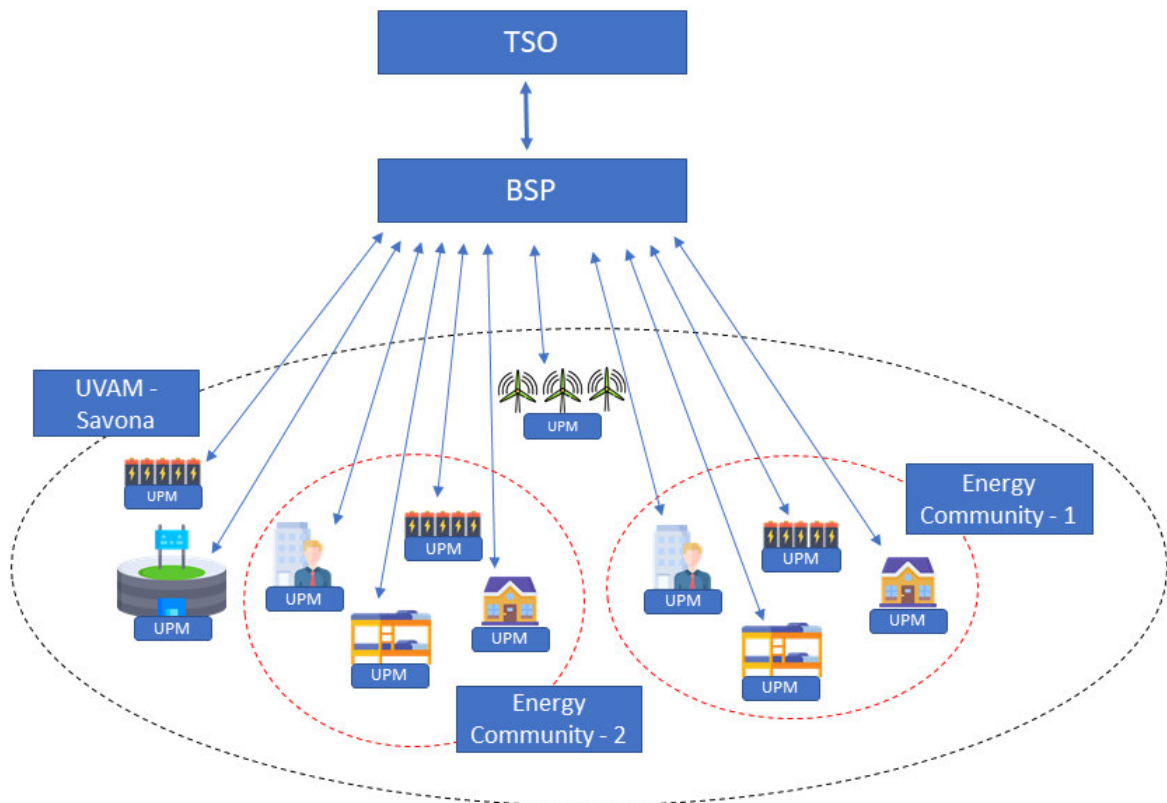


Figure 17 – UVAM - Virtually aggregated mixed units (Savona)

3.4 The energy community

Two different energy communities are considered in the Savona Pilot: the first one will include the social housing, the swimming pool and the public park, the second one includes the mini-campus, the stadium and the related services as listed in the following (the numbers are referred to the previous Figure 14):

1. Renewable Energy Community REC #1: Area # 6a,6b,6c,6d,7,8
2. Renewable Energy Community REC #2: Area # 1a,1b,2a,2b,2c,2d,3,4,5a,5b,5c

The hypothesis of designing two distinct energy communities basically derives from the very different size and nature of the involved power plants.

The REC #1 will be composed of users connected to the LV distribution grid and probably served by the same MV-LV substation so that they fully meet the requirements set by law 28/02/20 no. 8. In this case, the community members will benefit from the incentives described in the previous section.

The players involved in REC #1 are: private citizens, the local municipality and private stakeholders.

The contractual relationship between the actors could be one of the following as provided by the Italian energy authority:

- i. association (Italian: Associazione)
- ii. consortium (Italian: Consortium)
- iii. cooperative (Italian: Cooperativa)
- iv. partnership (Italian: Partenariato)

The REC #2 exceeds the limits of 200 kW set up by the above-mentioned law 28/02/20 no. 8 in terms of connected power. Even if this limit will be removed in the final version of the law, the connection to the MV distribution grid will prevent applicability of this law and reception of incentives on the shared energy under the same framework as applied to REC #1.

Nevertheless, REC #2 will still be an energy community, simply one set up outside the framework of the above-mentioned law, aiming at looking for common opportunities in the electricity market.

The REC #2 will be formed by two public bodies: the University of Genova and the Municipality of Savona.

The specific type of grid connection allows the application of the so called SSPC systems (Italian: Sistemi semplici di produzione e consumo) for each of the two main microgrids of the district. In this framework the users will benefit from a discount on general system charge.

As far as the energy production from the PV plants of the two microgrids is concerned, it is currently possible to benefit from incentives by participating in an auction (Law D.M. 4/07/2019). The incentive is applied to the net energy injected into the grid. The basic tariffs are 9 c€/kWh for plants under 1 MW and 7 c€/kWh for plants over 1 MW.

The most likely contractual relationships between the actors could be the following ones:

- i. consortium (Italian: Consortium)
- ii. partnership (Italian: Partnernariato)

During the present research project the aforesaid aspects will be investigated more in detail to define the best scheme that could be applied to the REC #2, in order to better exploit and share the renewable resources inside the microgrid and between the involved players. The energy sharing will be optimized by the presence of electric vehicles and energy storage systems whose optimal size will be determined in the next steps.

3.5 Implementation plan

The pilot project implementation plan is presented in the following Table 10. The terms of delivery have been updated as a consequence of the sanitary emergency from COVID 19.

Table 10 - Pilot implementation time table (Savona)

	2019		2020												2021							
	Nov	Dec	Gen	Feb	Mar	Apr	May	Jun	Jul	Ago	Sep	Oct	Nov	Dec	Gen	Feb	Mar	Apr	May	Jun	Jul	Ago
Local context analysis																						
Pilot feasibility study - Data collection on existing facilities																						
Preliminary design pilot project																						
Pilot feasibility study - Simulation Phase																						
Pilot feasibility study - Simulation results																						

Pilot 4: Thannhausen (AT)

4.1 Context and general objectives

Thannhausen is a rural region in Austria. The political leaders of the region have a strong urge to partake in the energy transition by making use of renewable energy sources. Since the aspect of regionality plays an important role in that region, the share of regional renewable energy use is a primary focus.

The municipality owns a couple of buildings at the centre of Thannhausen where PV generation plants are already installed. There is the potential to install further PV plants. The municipality does not want to make use of that potential just for covering its own electricity demand, but also for supplying the surrounding buildings (small enterprises and households). Since the Austrian legislation does not allow for direct electricity trade between different users via the public grid without an energy supplier acting as intermediary, it was decided to create a microgrid consisting of new direct lines to allow for direct supply of neighbouring consumers with electricity. It needs to be stated, that new laws for energy communities are in the making, which would allow said exchange, see chapter **Fehler! Verweisquelle konnte nicht gefunden werden..**

The goal is to provide local and cheap energy to the users of the direct line system and further contribute to the following points:

- reduce strain on the public grid by directly using the electricity within the micro-grid
- reduce the generation peaks caused by PV
- provide the technical setup to allow energy supply in case of a failing of the public grid
- provide the technical setup to include a battery storage for further increase of the own consumption

4.2 Technical description

The pilot in Thannhausen consists of 8 different consumers (grid coupling points) which are connected to the public low voltage (230/380 V) grid. At this moment all of the consumers are still metered with classic Ferraris metering units as the roll-out of smart meters has not yet reached the region. All consumers are part of the same low voltage grid branch connected to a transformer to the medium voltage grid. The consumers are in proximity of one another, which makes the realisation of a direct line system possible.

The pilot currently considers two residential buildings, five small enterprises and the buildings of the municipality which share one connection point to the public grid. Currently there is only one PV generation plant installed at one of the municipal buildings with an installed capacity of 56 kW_p, which provides energy to the municipal building and feeds the surplus into the public grid. Currently, the PV is granted a feed-in tariff which will expire in 8 to 9 years. An additional generation capacity of 29 kW_p is planned as main energy source for the microgrid.

Table 11 shows the current consumption situation of the different users of the to-be-established direct line system. For reasons of data protection, the clear names are not shown.

Table 11 - Consumption data of the users of the direct line system (Thannhausen)

User	Annual Consumption [kWh]	Peak load [kW]
Household 1	5.000	8,4
Household 2	8.600	8,0
Small Enterprise	18.000	30,0
Municipality	46.000	13,5
Small Company 1	4.200	8,8
Small Company 2	3.000	2,0
Small Company 3	1.800	0,5
Small Company 4	4.200	2,0

The overall setup of the micro-grid (direct line system) is shown in Figure 18.

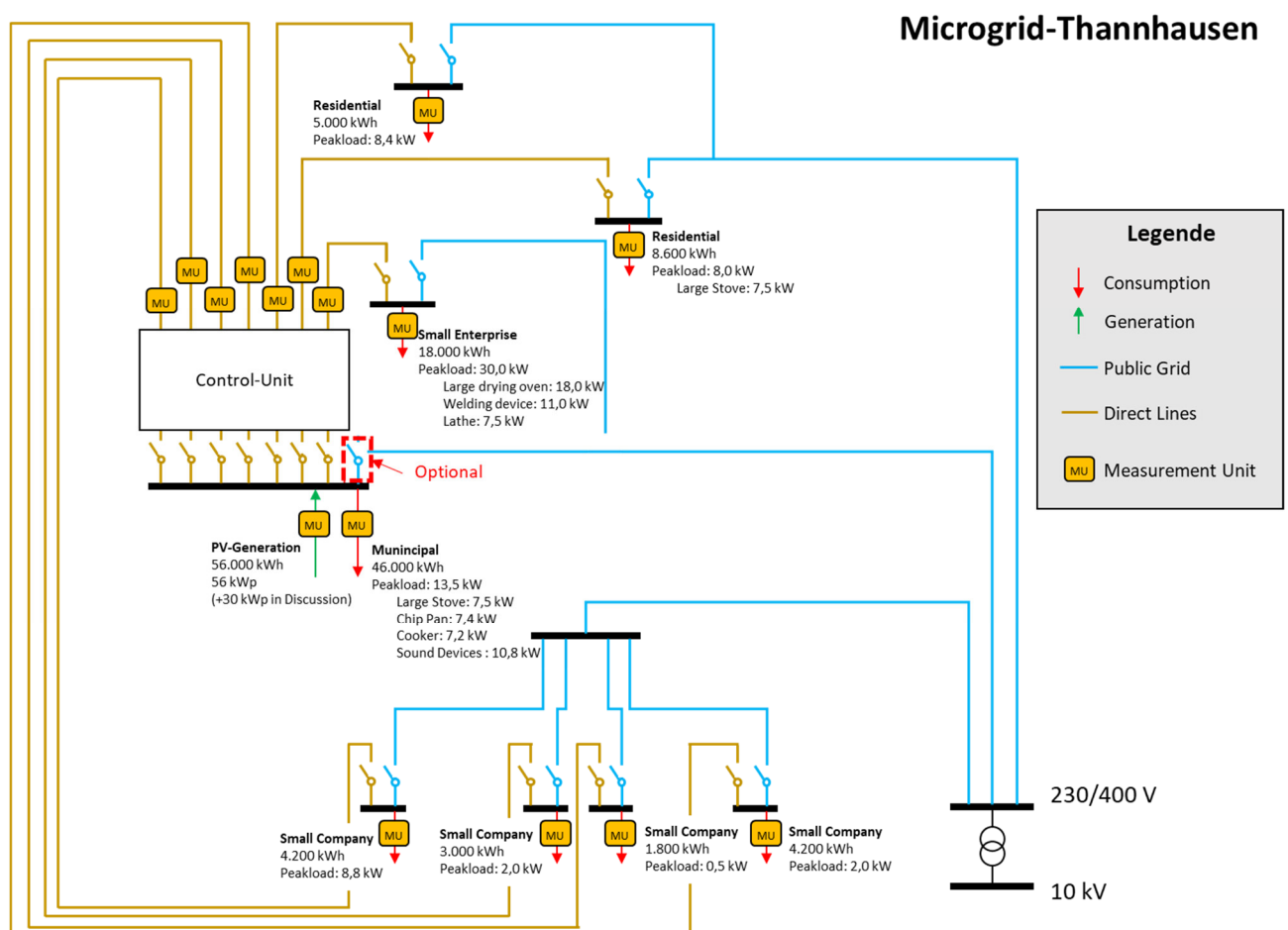


Figure 18 - Technical set-up of the pilot (Thannhausen)

The microgrid will feature the municipality's PV generator as main power source. Each of the user will be connected to the PV generator with a direct line. The direct line will be connected to the user's electrical system behind the metering system of the grid operator. The direct line can be switched on and off on both sides (for safety reasons) of the direct line. Each of the users also has a connection to the public grid which can be switched off when the entire consumption can be satisfied within the micro grid. The PV generator also has a switch which allows separation from the public grid, but this will only be used in the case that islanding is necessary. During normal operation the PV generator is connected to the grid.

Each of the users will be equipped with a measurement unit to measure the total power consumption, in addition a measurement unit will be installed on each direct line and for the PV generation and the consumption of the municipality. The measurement units at the user's sites will be installed behind the official metering units of the grid operator. These measurement units only have a purpose for the control unit, while the measurement units on the direct line also serve a metering purpose for billing and thus need to be gauged.

The control unit (an energy management system) will receive its data via Ethernet cables which are placed together with the cables for the direct lines. Ethernet cables will also be used to control the switches of the direct lines which will be implemented as air gap switch.

For the control regime the following rules apply:

- First off, the consumption of the municipal buildings will be covered, only excess energy will be provided to the direct line system.
- The control unit will then check the power consumption values of the users and will sort them according to an internal ranking system such that most of the PV generation can be used directly.
- Only users whose demand can be fully satisfied by the PV generation will be connected to the direct line system and separated from the public grid.
- The internal ranking system will ensure, that over the course of a certain period, distribution of PV generation will happen on a fair and transparent basis.
- Any remaining excess PV generation will be fed into the public grid at the coupling point of the municipal building.

In case of a disruption of the public grid, all users will be disconnected from the public grid and permanently connected to the direct line. To compensate load and generation fluctuations, a diesel generator will be used, which later on will very likely be replaced by a battery system.

4.3 Legislative framework

Operating a direct line or a direct line system is made possible by the Elektrizitäts- Wirtschafts- und Organisationsgesetz (ElWOG), Austria's federal energy law. The concept of direct line is defined in the basic provision of Section 7 (1) no.8 ElWOG as follows:

"Direct line: either a line connecting a single production site to a single customer, or a line connecting an electricity producer and utility company for the purpose of direct supply to their own permanent establishment, subsidiaries and approved customers; lines within residential complexes are not considered direct lines."

For that reason, the system must consist of multiple lines and each consumer will be connected only to one direct line and each direct line will thus only be connected to the PV generator (production site) and one user (single customer). The direct line system is operated outside the domain of the grid operator.

While the ElWOG provides only very limited rules, guidelines or general information on how to operate direct lines, the following basic principles need to be taken into account:

- **Separation between direct line and public network**

A direct line within the meaning of Section 7, Paragraph 1, Item 8 of the Federal ElWOG exists only if there is no direct connection between the line in question and the public network. There must

therefore be no direct exchange of electricity between the direct line and the public grid, i.e. no public electricity flows in the direct line.

Under no circumstances may the generating plant be supplied with electrical energy from the distribution network via the direct line. This also applies when the generating plant is at a standstill. *This condition is satisfied by the rule, that the PV generator is always connected to the public grid, while the user will be separated from the public grid in case of a transport of energy by the PV-plant. Furthermore, the users will only receive energy via the direct line if the PV generates enough electricity to still have a minor infeed into the public grid at its own coupling point.*

- **No PV surplus is fed into the public grid via the direct line**

Furthermore, no electricity may be fed into the distribution network via the direct line (e.g. via the customer's system). Here, too, this would otherwise lead to the direct line becoming part of the public distribution network.

If more electricity is generated than is consumed by the customer, the generating plant can also be connected directly to the distribution network so that the "excess" energy can be fed into the network. This is not detrimental for the assessment as a direct line (VwGH 04.03.2008, 2007/05/0243). But even in this case the consumers may not be supplied with electricity from the distribution network via the direct line.

It should be mentioned that the excess feed-in at the producer or consumer is (legally) insignificant for the design of the direct line.

In case of the direct line system in the Thannhausen MicroGrid, this condition is also met by the general approach for the control strategy. By disconnecting the users once they are connected to the direct line, there is no connection to the public grid anymore. Thus, no transport of PV generation will happen. It needs to be mentioned though, that there is a short period (milliseconds) during the switching process where the user is connected to both the public grid and the direct line. This is in line with the law as the Austrian Market models recognises a period of 15 minutes as the smallest time step.

- **The direct line must be operated by the producer**

According to the law, a direct line always exists when an electricity company or a producer supplies one or more customers via an electrical line system that is not directly connected to the public grid. Since the right to set up and operate the direct line belongs exclusively to the producer, the direct line must also be operated by the producer.

Since the system is operated by the Municipality Thannhausen who is also the operator of the PV-generation, this poses no problem.

- **Star network is not a contradiction to applicable electricity law**

From the definition of the term of the direct line, which speaks of the supply of a single production site with a single customer, it can be deduced that several customers may not be supplied via the line. This means that each individual consumer has to be supplied with a separate direct line. Such a star network does not contradict the requirements of the electricity law.

In addition, there is of course the possibility of supplying customers via the public network, for which the above-mentioned system service fees and other charges must be paid.

4.4 The energy community

At the moment (09.2020) there is no legislation for energy communities in Austria, neither was there a draft for the corresponding law published just yet. According to the Austrian Minister Gewessler (Ministry of Climate Action) the laws in which citizen and renewable energy communities will be defined, will be in force by the first of January 2021. Since there is already a very strong delay on the draft, the parliamentary process will most likely take longer than that.

Nevertheless, the Ministry of Climate Action has already published information on how the laws concerning energy communities will look like. The information provided here reflects on the currently available information and is not necessarily the final definition.

It needs to be stated, that the Thannhausen pilot will not be set up as energy community as defined in the information provided by the Ministry of Climate Action. The reason is that the municipality in Thannhausen would also like to assess the topic of supplying the users in case of a black out. The grid operator will not be able to isolate the “Thannhausen-Island” in case of a black out, thus alternative concepts such as the direct line system are necessary.

4.4.1 Players involved, their roles and contractual relationships

As defined by the EC’s renewable energy directive and the electricity market directive, membership in energy communities is limited to:

- private consumers
- small and medium enterprises
- public bodies (such as municipalities)

In either case a formal membership in the energy community is required. The energy community itself needs to take the form of a legal body (“Rechtspersönlichkeit” in German). Currently the following forms of organisation are eligible for energy communities:

- association (German: Verein)
- cooperative (German: Genossenschaft)
- business partnership (German: Personengesellschaften)
- Corporation (German: Kapitalgesellschaften)

Whichever form of organisation is chosen, the energy community must operate as non-profit organisation. The financial benefit must stay with the members of the community.

Within the community, members can exchange energy. In case of a renewable energy community it has to originate from a renewable energy sources, in case of the citizen community the exchange is limited to electricity. Citizen energy communities can contain members from all over Austria, there is no proximity requirement for them, while within renewable energy communities the members have to be in close proximity to one another.

In Austria the degree of proximity will be defined by the grid levels the members are connected to. Austria’s grid is composed of 7 grid levels. The levels with a even number correspond to transformers, the levels with uneven number to grid lines. Small customers are generally connected to the low voltage level (layer 7). There will be two types of proximity possibilities an energy community can choose from:

- Regional proximity: This includes levels 5 to 7 and also the “Sammelschiene” at level 4.
- Local proximity: This includes levels 6 and 7.

When the energy community is founded, there needs to be taken a decision on the proximity type. The proximity type also influences the cost savings the members of the renewable energy community can generate. For each kWh exchanged within the energy community, the receiving member will be partially exempted from paying grid fees and from certain taxes and payments. The reduction of grid fees will be 60 % for the local proximity and approximately 30 % for energy communities of the type regional proximity.

For metering purposes smart meters need to be installed at every consumer. The grid operator will measure the consumption of each member with a resolution of 15 minutes. The total surplus fed into the energy community will be subsumed and divided amongst the members according to a distribution key provided to the grid operator. Each member will thus receive two bills, one from his regular energy supplier (which according to the EU law can be changed at will by the consumer) one from the energy community.

4.4.2 Type and characteristics of community developed

As mentioned, Thannhausen will not be set up as an energy community in the sense of the published information. But if it was set up as an energy community, it would be set up as renewable energy community.

4.4.3 Expected socio-economic outcomes

None as the pilot in Thannhausen will not be set up as an energy community project.

4.5 Implementation plan

Due to the Covid 19 situation the original plan for the deployment of the pilot has been postponed. At this point the following plan for implementation exists.

Table 12 - Implementation plan for the pilot (Thannhausen)

Action	Deadline
Apply for funding for the new PV	08.2020 (done)
Digging work for the direct lines and putting the cables in place	10.2020
Installation of the metering and measuring equipment and the energy management unit	11.2020
Installation of the new PV plant	12.2020
Initialisation of the direct line system operation	01.2021

Pilot 5: W.E.I.Z. Campus (AT)

5.1 Context and general objectives

The objectives of the WEIZ pilot are the conception, the development and the implementation of a microgrid connecting the consumer WEIZ I and the prosumer WEIZ II, that is a direct-line system for the energy exchange between buildings. The aim of the system is the maximization of the autarky of both buildings, facilitated by their supplementary load profiles.

At first, the focus of the project is on the clarification of the legal and economic aspects, on finding appropriate ways of problem solving by the development and adaption of single components as well as on the integration of them in the overall system. A second focus is on the intelligent controlling and monitoring systems and moreover on the building-integrated sustainable energy supply. Thus, the foci are on the following areas:

- electricity generation with building-integrated photovoltaic plants (a high level of utilization of the generated electricity in the respective building complex is aspired)
- energy storage (usage of battery storage systems)
- development and use of an intelligent energy management and monitoring system
- development of interfaces for the connection with the electricity grid

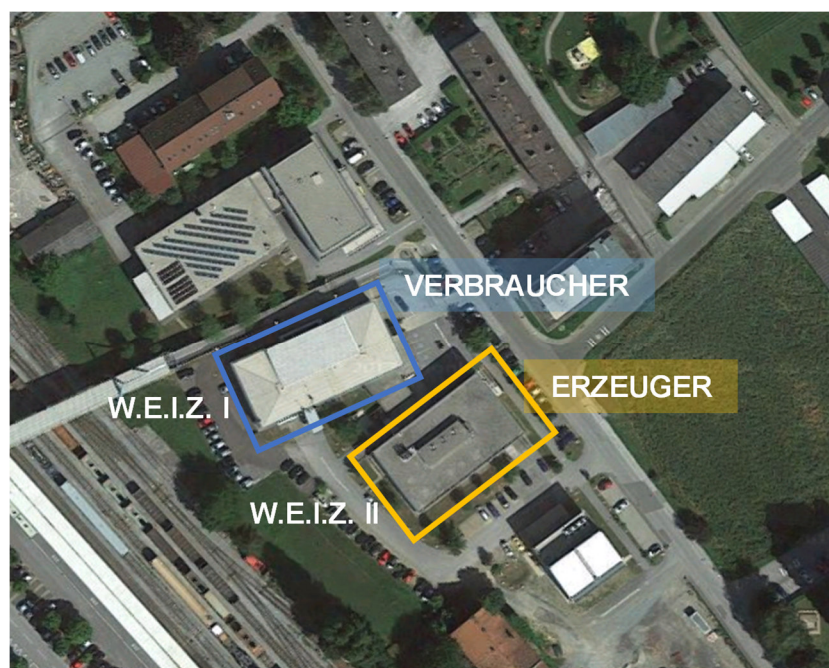


Figure 19 - WEIZ I producer and WEIZ II prosumer (W.E.I.Z. Campus)

W.E.I.Z. I - 1st passive office building in Central Europe: The W.E.I.Z. I is a compact, 3-storey office building (1,350 m²), designed in the form of a wooden frame structure, filled in with glued board stacked ceilings and prefabricated wall elements. The building envelope is optimized (U-values: (1) roof: 0.1 W / m²K, (2) walls 0.12 W / m²K, (3) windows 0.7 W / m²K). The building is heated by means of air heating. This system is used to cool buildings in summer. These basic components enable the 1st passive office building in Austria with an energy consumption of 15 kWh / m² / year.

In the W.E.I.Z. I, around 80 people work as employees in research companies (Joanneum Research Forschungs- GmbH, Human Research GmbH), business-related service providers (TB Energietechnik, EDV) and management and consulting companies. Office and laboratory facilities are installed here that require a total of approx. 200,000 kWh / a of electricity. A large part of the electrical energy for the building is

required for ventilation (approx. 90,000 kWh / a). Because of the central ventilation system, which is in operation all year round, the energy costs are 8 € / m²a.

The W.E.I.Z. I has a covered atrium (glass roof: approx. 240 m²) that is not suitable for PV equipment. The remaining roof area is equipped as a membrane roof with a lightweight wooden substructure. The load-bearing capacity is tightly calculated and, in addition to the possible snow load, offers only a few additional load reserves for a possible PV system. The electrical installations in the W.E.I.Z. I are very selective. There is a good technical separation of "general electricity" and "office / customer electricity". Therefore, for research purposes, the general power area can be supplied by direct line and any power fluctuations that may occur during the test phase cannot have a negative impact on sensitive laboratory equipment at tenants in the W.E.I.Z. I impact. The billing for the electricity supplied from WEIZ II to WEIZ I can be made clearly visible in the internal operating cost billing and billed financially clearly.

W.E.I.Z. II - Cooling and heating with the sun ("Kühle Kiste"): The building with approx. 2,200 m² is mainly dedicated to R&D and start-up activities and also offers high quality laboratory space (including clean room). The W.E.I.Z. II is structurally a "cool box". This very innovative energy concept of the 4-storey office building enables the building to be heated and cooled using geothermal probes in combination with a heat pump and district heating. The compact structure with good thermal insulation also has thermally active storage masses with concrete core activation. These and other measures lead to an energy figure of 29 kWh / m²a (lowest energy house thermal protection class A).

The W.E.I.Z. II is heated by means of a heat pump and depth probes via ceiling heating (concrete core activation). In the summer, the building is cooled without a cooling machine (the heat pump can also be operated as a cooling machine) by flushing the geothermal probe (circulation pumps pump the cooling water from the geothermal probes into the ceiling heating / cooling). This method is very energy-efficient, so that only around 40,000 kWh / a of electricity are required for year-round room conditioning (heating and cooling). The specific energy costs in the W.E.I.Z. II approx. € 2 / m²a.

The compact and efficient use of space only allows a very smart, central atrium. As a result, however, the roof area is relatively large, which in turn is favourable for the installation of a larger PV system (max. Expansion capacity: 40 kWp). A 20 kWp system was installed on the roof of the W.E.I.Z. II

5.2 Technical description

Using direct power cabling, the W.E.I.Z. I with the W.E.I.Z. II connected, with both buildings having an independent power connection to the public power grid. The detailed concept of pilot plant 1 is shown schematically in Figure 20.

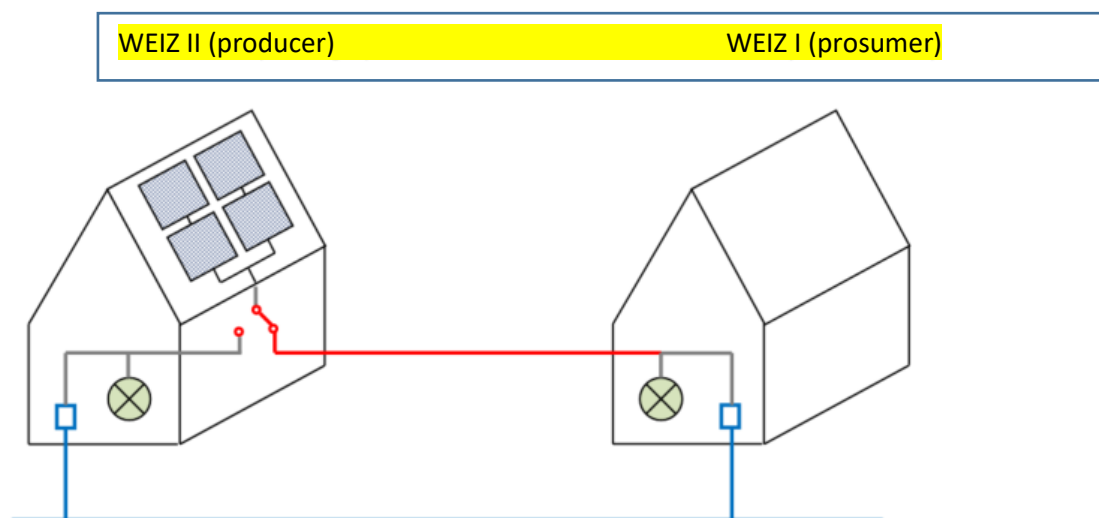


Figure 20 - Schematic visualisation of the direct line between WEIZ I and WEIZ II (W.E.I.Z. Campus)

On the basis of this basic variant, it is examined to what extent a storage facility for the intermediate storage of excess electricity makes sense, or how it must be dimensioned in order to enable economical operation. In addition, these considerations form the basis for the development of the energy management system.

5.2.1 Requirements of the energy management system

The project-related energy system basically consists of decentralized PV generation units, consumers, storage, a connecting network and ICT components. The entire energy system is to be monitored and controlled centrally. The energy consumption, supply and management system records not only the current energy requirements of the individual consumers / buildings, but also the current generation of electricity by the photovoltaic system(s) and the state of charge of the storage unit.

In principle, the current demand should be compared with the current PV generation. A decision is then made on the basis of a number of parameters as to what to do with the electricity supplied by the decentralized generating unit or how the consumers are to be supplied. A decision is made as to whether the PV electricity is to be used directly in the building, stored, made available to another building, fed into the public grid or whether electricity has to be drawn from the storage facility or from the grid.

The development and testing of the overall system presented was carried out for two different pilot plants, which is why the relevant results and milestones are presented in the following chapters using the two pilot projects.

The storage system is there to compensate for the fluctuations in the PV and to make a contribution to increasing self-consumption

In the energy center of the W.E.I.Z. II the inverter and the supplementary 15 kWh power storage with battery inverter were installed. Both inverters are self-commuted and can be operated in "island systems" independently of the public power grid. For WEIZ connected, for demonstration purposes the PV generator installed at W.E.I.Z. II provides energy for the circulation pumps for the depth probes and ceiling heating as well as for public lighting and lift operation within the building. This limited power consumption enables the excess power of the installed PV system to be sent to the building W.E.I.Z I using the WEIZ connected technology. A general overview of the installed hardware components in the WEIZ I is given in Figure 21.

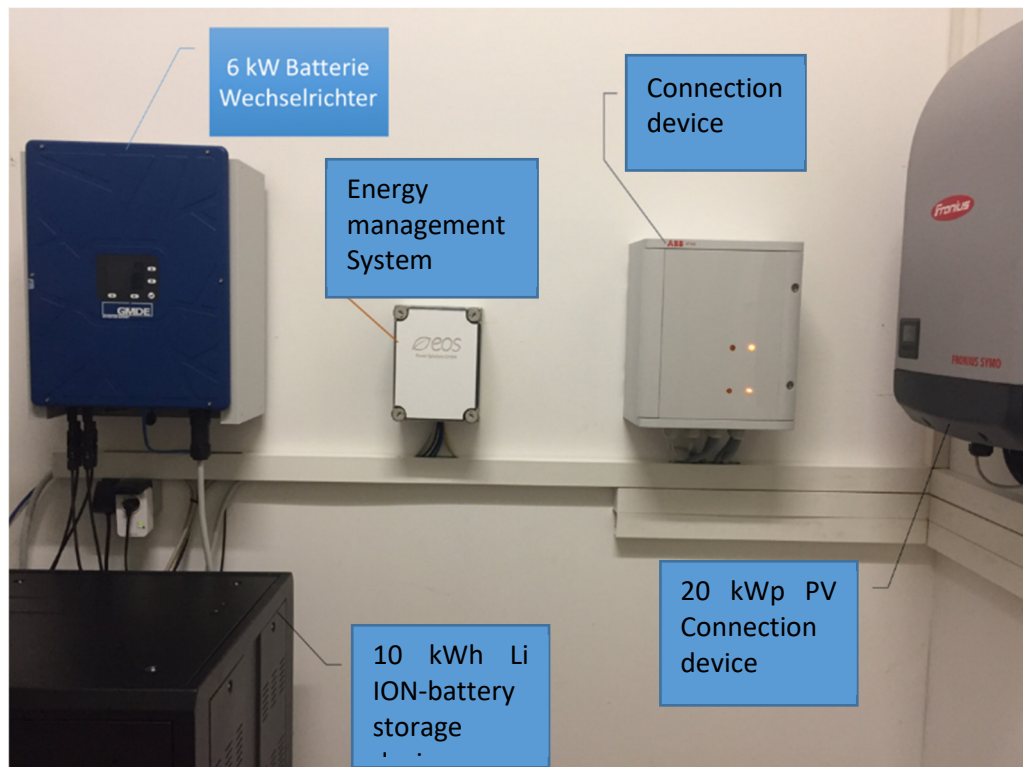


Figure 21: installed hardware components within the WEIZ II building (W.E.I.Z. Campus)

5.2.1 The electrical plan

Microgrid-WEIZ

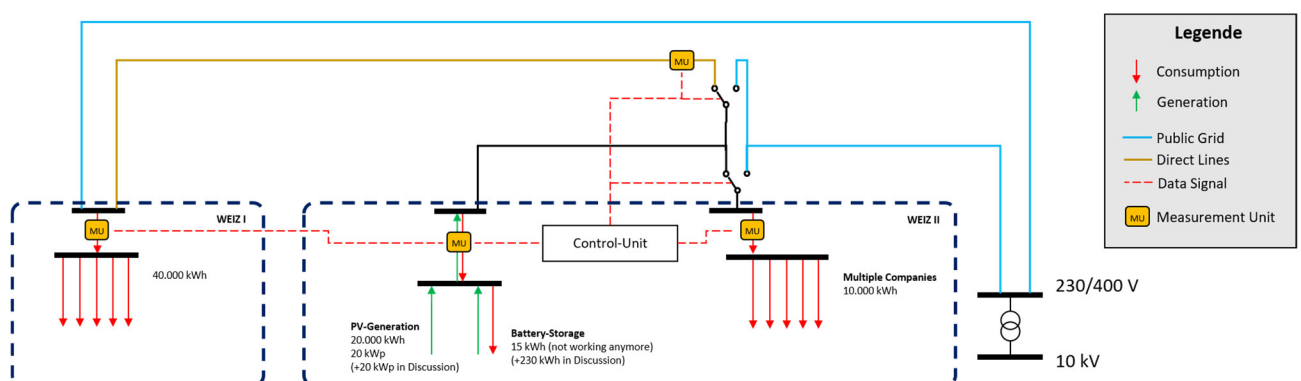


Figure 22 - Technical schemec for the microgrid WEIZ (W.E.I.Z. Campus)

Figure 22 shows the technical scheme for the microgrid in Weiz. Both buildings are connected to the public grid. While WEIZ II can be separated from the grid, WEIZ I has a permanent connection. The direct line can be switched on and off directly at WEIZ II. Also the supply system can be used to either support one of the buildings or both, by connecting it either to the direct line or WEIZ II or both. All consumption and

generation values are measured, thus providing the control unit with the means to switch the switches according to the current load and generation situation.

5.2.2 Connection device

The development of the so-called “connection device” posed a major challenge. The task of the connection device is to activate the connection line whenever excess photovoltaic power is available and to forward the excess power to the connected building.

Figure 23 shows the embedding of the connection device in the existing building installation

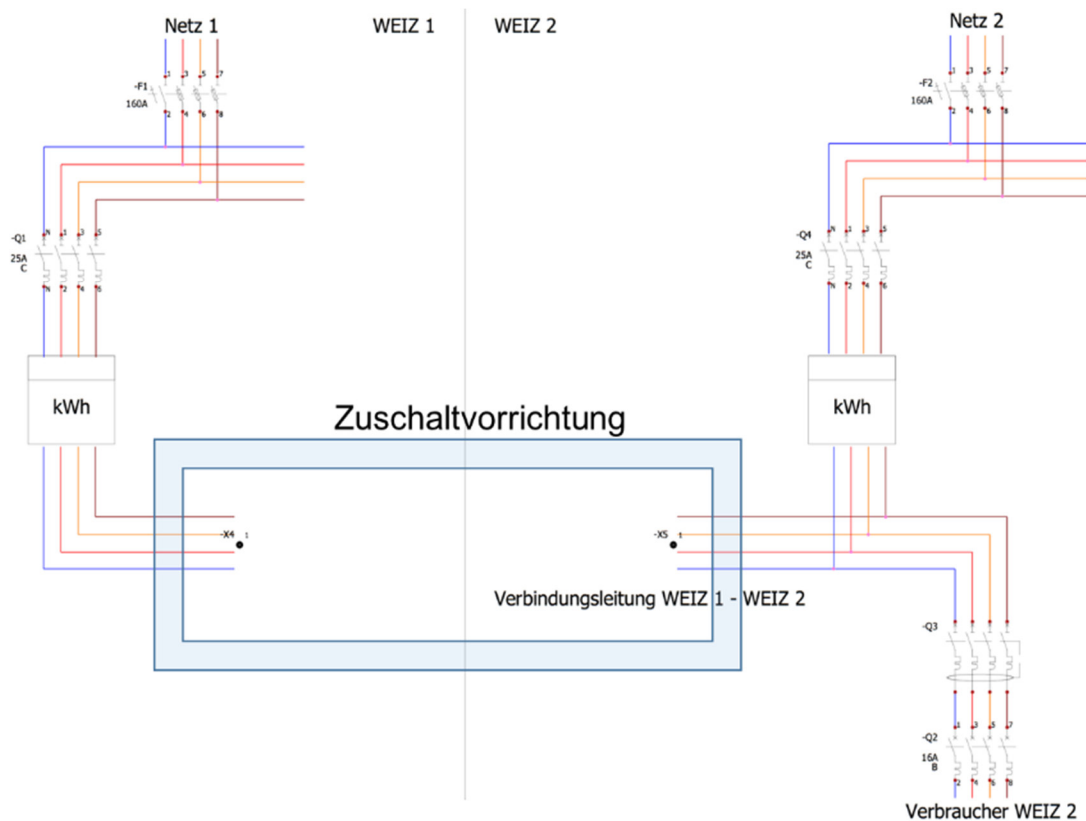


Figure 23 - Connection device for handling the switching of the direct line between WEIZ I and WEIZ II (W.E.I.Z. Campus)

The technical requirements led to the technical implementation concept shown below. The connection device essentially consists of two switching units, referred to in Figure 24 as “Schalter 1” and “Schalter 2”.

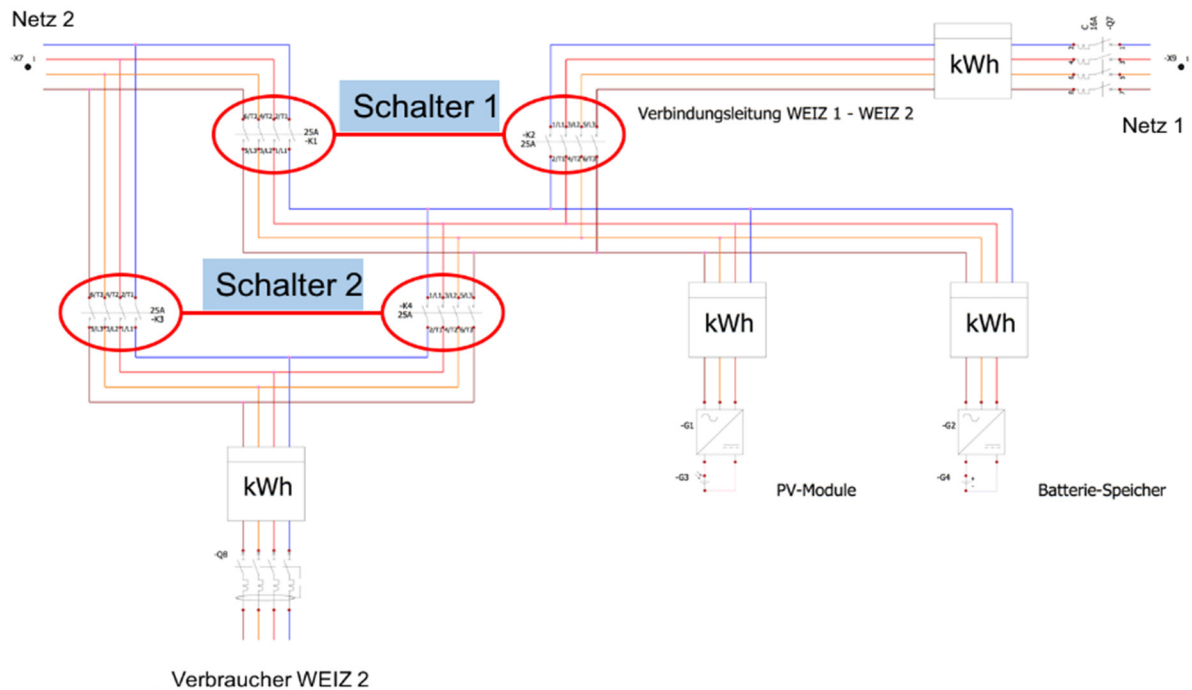


Figure 24 - Circuit diagram of the connection device (W.E.I.Z. Campus)

These two switching units are each implemented with two contactors for switching the power paths. The contactors are interlocked with one another via auxiliary contacts and a corresponding switching logic, so that only one contactor can be closed at any one time and there can never be a direct connection between network 1 and network 2 via the connection line. This is necessary to be able to comply with the technical requirements for operating the direct line at all times. Figure 25 shows the coupling of the contactors via their auxiliary contacts so that this condition is met accordingly.

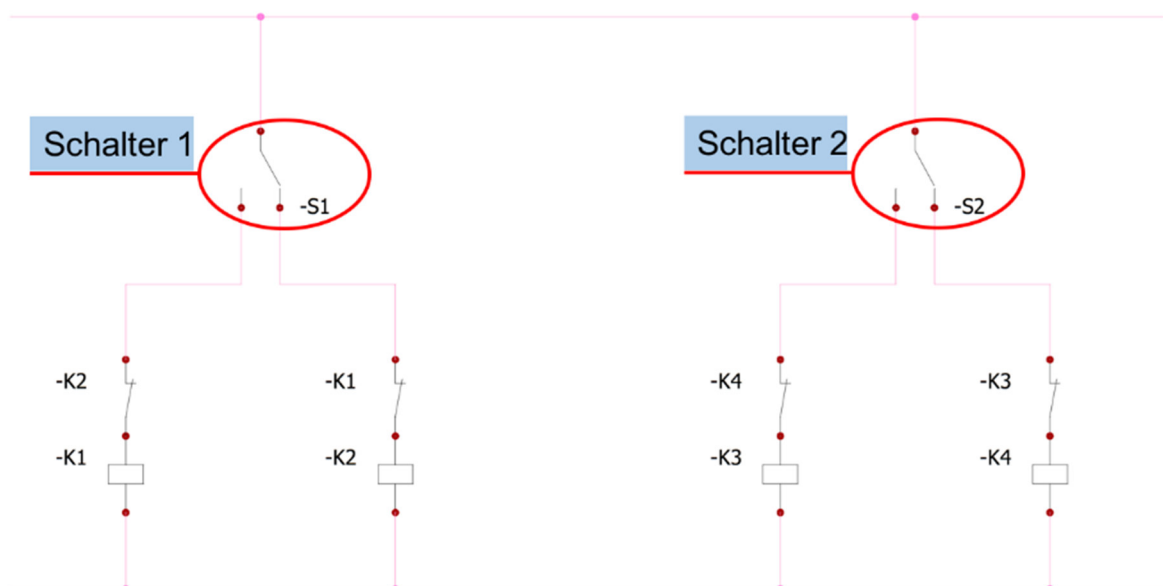


Figure 25 - Contact control with mutual locking through auxiliary contacts (W.E.I.Z. Campus)

The question now arises, why two switching units are needed for this relatively simple switchover? The answer is based on the fact that the brief interruption of the current flow during the switching process of the contactors automatically disconnects the inverters from the grid, both from the PV system and from the battery storage system. This behaviour is also correct, since all grid-connected inverters must immediately disconnect from the grid in the event of a grid failure to avoid islanding.

However, this separation also means that the inverters only connect to the grid and continue to feed in after a certain period of time after they have again identified a stable grid.

5.3 Legislative framework

The legislative framework is described within the chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**

In case of the direct line system in the WEIZ pilot system, a direct line within the meaning of Section 7, Paragraph 1, Item 8 of the Federal ElWOG exists only if there is no direct connection between the line in question and the public network. There must therefore be no direct exchange of electricity between the direct line and the public grid, i.e. no public electricity flows in the direct line (cf. also Hauer / Oberndorfer, loc. cit., margin no. 5 on § 42 ElWOG 2007).

Under no circumstances may the generating plant be supplied with electrical energy from the distribution network via the direct line. This also applies when the generating plant is at a standstill. In this case, the customer either requires a separate connection to the distribution network (to do this immediately) or another power source (such as an emergency power generator), and the generating plant must not be supplied with power via the direct line (e.g. in the event of an inspection).

If both buildings have a connection to the public network (as usual), the electricity fed into the public network or the direct line by the generator must be measured strictly separately using two different meters. In order for such a dual supply system to function, the necessary coordination of the two electricity flows (the electricity flow via the public grid and the direct line) must always take place in the electricity supplier's or the customer's own facility, under their control.

5.4 The energy community

This issue is described with the chapter **Fehler! Verweisquelle konnte nicht gefunden werden..**

5.5 Implementation plan

Table 13: Implementation plan (W.E.I.Z. Campus)

Action	Deadline
Implementation 200 kWh batterystorage and the 30 kWh Vanilinstorage	08.2020 (done)
Digging work for the pipes from the storage to the building and putting the cables in place.	09 / 10 2020
Installation of the metering and measuring equipment and the energy management unit	12.2020
Running of the whole system and visualisation	01 – 03.2021

Pilot 6: Selnica (SL)

6.1 Context and general objectives

In 2011, a Local Energy Concept (LEK) for the Municipality of Selnica ob Dravi was prepared. It was based on an analysis of the consumption and costs of energy of all consumers in the municipality, and of factors influencing the efficient use of energy in the municipality and the associated living comfort of citizens. The goals of the Local Energy Concept were formulated in line with the national energy goals and a corresponding action plan with local measures to achieve them was defined.

In the period 2011 - 2019, the factors influencing the implementation of the LEK action plan changed significantly, such as the support scheme for photovoltaics and available financial means for public investment. Major investments in the municipality in the sewerage network, several new constructions and others affected the available amount of funds for investment in energy projects. Nevertheless, the planned activities were carried out as far as possible.

The aim of the pilot project of the Municipality of Selnica ob Dravi within the ALPGRIDS project is to establish a pilot microgrid that would serve for modeling and finding solutions for:

- possible self-sufficiency of public buildings and related reduction of energy costs
- possible island operation of the microgrid which would provide energy even in the event of a failure of the public network caused by natural and other disasters
- legal formal establishment of an energy community in which, in addition to the municipality, interested citizens would participate and finance the installation of photovoltaic power plants at the fire station

6.2 Technical description

The Selnica ob Dravi pilot project is briefly called the Selnica Pilot. It involves the following public buildings:

- Selnica ob Dravi Primary School with a gym
- Selnica ob Dravi Kindergarten
- Culture Centre Arnold Tovornik
- Selnica ob Dravi municipal building
- Selnica ob Dravi Fire station (PGD)

Further, a photovoltaic power plant and a cogeneration plant (CHP) for the production of electricity and heat are part of the pilot project. Both installed at the primary school. The CHP and is fueled with liquefied petroleum gas. The other buildings are only energy users. The culture centre and the PGD are heated with heat pumps which represent major switchable electricity consumers.

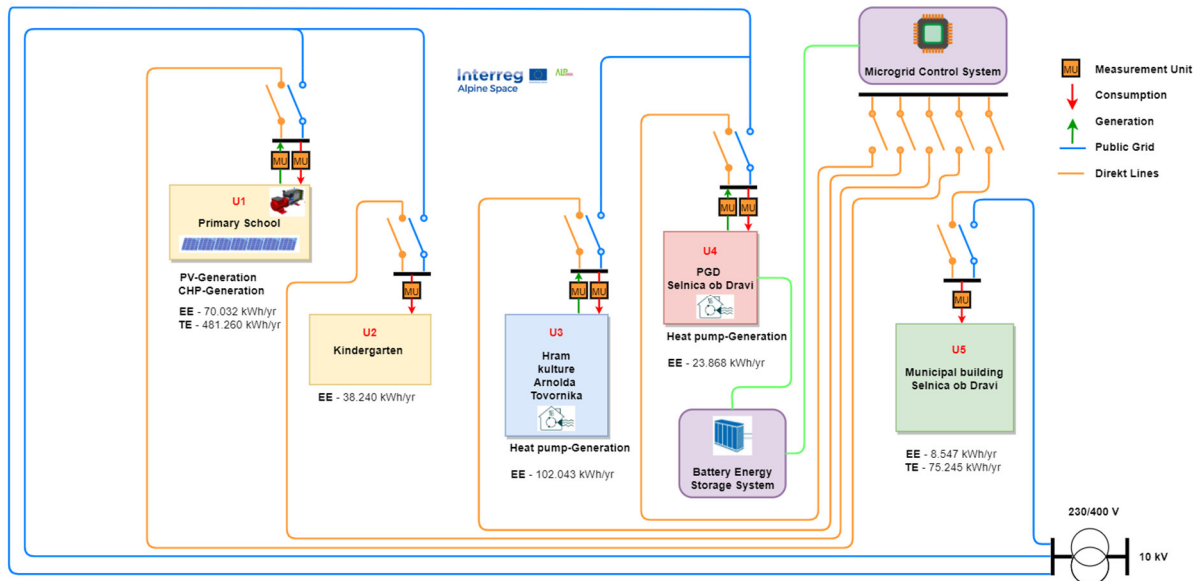


Figure 26 - Scheme of all producers and consumers in the microgrid network (Selnica)



Figure 27 - PV installation on the south-oriented part of the roof of the school building roof (Selnica)

The annual electricity consumption of the buildings in 2019 is shown in Table 14 and the heat consumption in Table 15.

Table 14: Electricity consumption for 2019 (Selnica)

	2019
Cultural Centre of Arnold Tovornik	102.043 kWh
Selnica ob Dravi Primary School	70.032 kWh
Kindergarten Selnica ob Dravi	38.240 kWh
Selnica ob Dravi municipal building	8.547 kWh
Selnica ob Dravi Fire station	23.868 kWh
Skupaj	242.730 kWh

Table 15: Heat consumption for 2019 (Selnica)

	2019
Cultural Centre of Arnold Tovornik	-
Selnica ob Dravi Primary School	481.260 kWh
Kindergarten Selnica ob Dravi	-
Selnica ob Dravi municipal building	75.245 kWh
Selnica ob Dravi Fire station	-
Skupaj	556.505 kWh

6.2.1 Establishment of monitoring (energy control and management system)

In the first phase of modeling the microgrid system, we found a solution for the monitoring of the consumption and production of electricity at all facilities included in the microgrid. The solution for the establishment of an energy information system is in the installation of meters or controllers to each measuring point or electric meter. The implementation for the central control system will take place in phases, namely in the first phase only consumers (all buildings) and production sources (solar power plant) will be connected to the control system. The monitoring will provide insight into real-time electricity data and thus the possibility of reducing energy consumption and costs, the possibility of reducing current loads and peak power. The communication between the controller and the main electricity meter allows us to monitor the following parameters:

- total electricity consumption
- current power consumption, voltage and current of each phase

For all buildings, automatic energy accounting will be established for targeted monitoring of energy consumption in the online application of the control system. With the automatic import of energy bills (electricity, heat, water, etc.), it will be possible to identify major deviations from the average values of energy use and determine the causes for them. It will provide insight into the condition of buildings and heating systems, thus making it easier to determine priority measures to reduce energy consumption and thus reduce costs.

The implementation of the planned activities until the installation of meters and the start of monitoring has slowed down slightly due to the current situation related to COVID-19. There were also legal obstacles in the implementation of probe connections to electricity meters. Namely, the local electricity distribution company had to allow the connection of probes to household meters, which do not allow 15 minutes of

measurements. It was also necessary to install the controllers in separate electrical cabinets with external power supply. Table 16 details the connections of the probes and controllers.

Table 16 – List of build-in controllers in buildings (Selnica)

	Number of electric power meters	Connection method (by probe or directly to Amihub controller)
OŠ SELNICA OB DRAVI	1X school	Connecting the ZMD meter to the Amihub controller
	1X kitchen	Connecting the ZMD meter to the Amihub controller
	1X total usage counter	Connecting the ZMD meter to the Amihub controller
	1X cogeneration	/
	1X PV plant	Connection to Controller (2 inverters)
VRTEC	1x kindergarten	Probe connection to the meter and then to the Amihub controller
GASILSKI DOM	1X household	Probe connection to the meter and then to the Amihub controller
	1X fire station	Probe connection to the meter and then to the Amihub controller
OBČINSKA STAVBA	2x municipality	Probe connection to the meter and then to the Amihub controller
SONČNA ELEKTRARNA	1X PV plant	Connecting the ZMD meter to the Amihub controller
HRAM KULTURE	1x household	/

Connections of individual controllers occurred at different time periods. Of all the buildings, the solar power plant was connected first, on Friday 5 June 2020. A total of 13,123 kWh of electricity was produced by 8 September 2020.

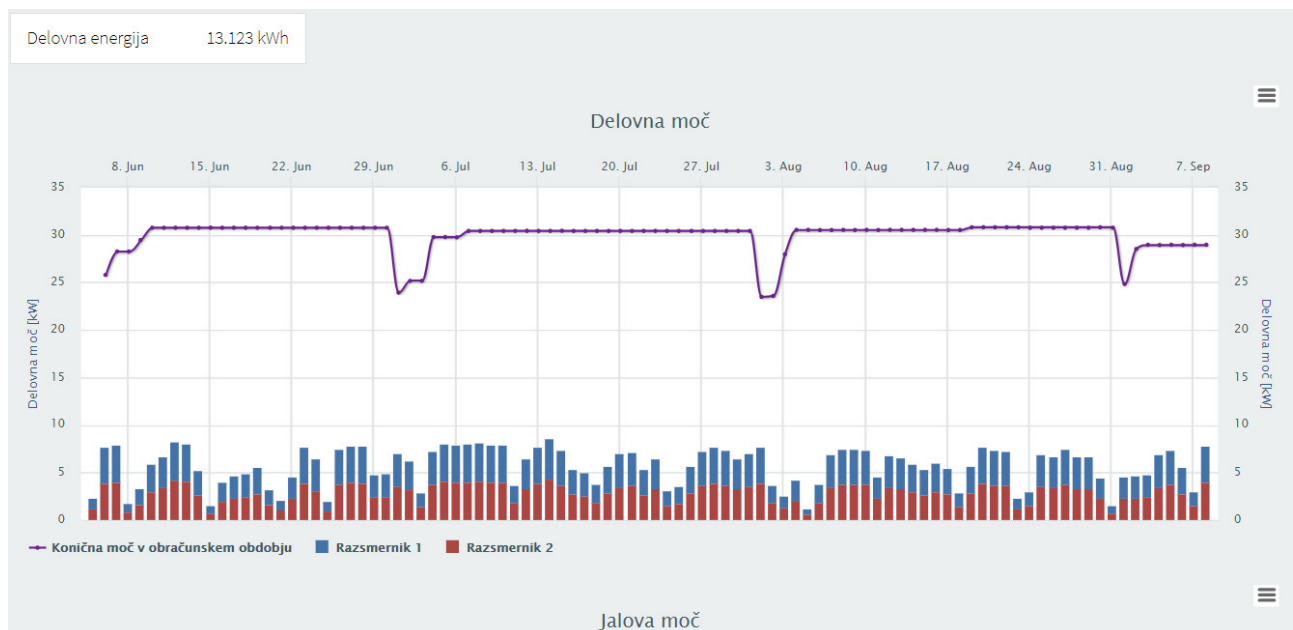


Figure 28 - Solar power plant operating power graph in kW (Selnica)

The connections of the controllers at the Selnica ob Dravi primary school, kindergarten and the municipal building were carried out on 10 August 2020. Due to the existing control systems in the first phase of energy monitoring, the connections of the controllers to the electricity meters at the Cultural Centre were not carried out. The connection of the meters at the fire station was carried out on 24.8.2020.

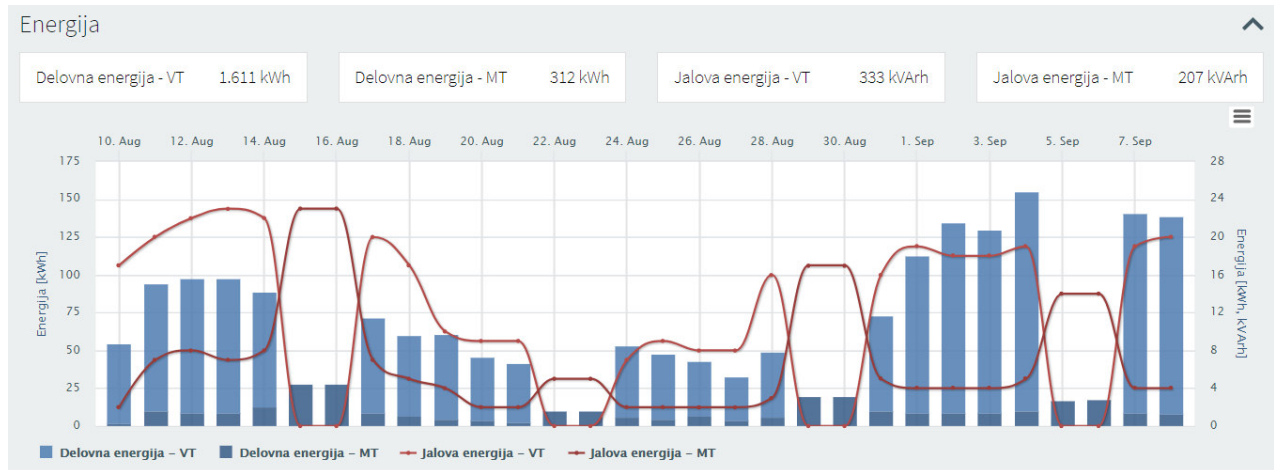


Figure 29 - Actual movement of true and reactive energy with the beginning of measurements at the Selnica ob Dravi primary school

6.2.2 Operation description of the built-in controller and sensors

The probe for reading the light signal of the electricity consumption meter consists of a phototransistor, with a relative spectral sensitivity of 0.6λ at a wavelength of 650 nm. To ensure robustness, an NPN bipolar transistor with a maximum collector current of up to 100 mA and a maximum collector-emitter voltage of up to 65 V has been added to the phototransistor in a Darlington connection. The probe itself does not interfere with the operation of the electricity consumption meter and also offers galvanic separation between the meter and the controller, which captures data from the probe.

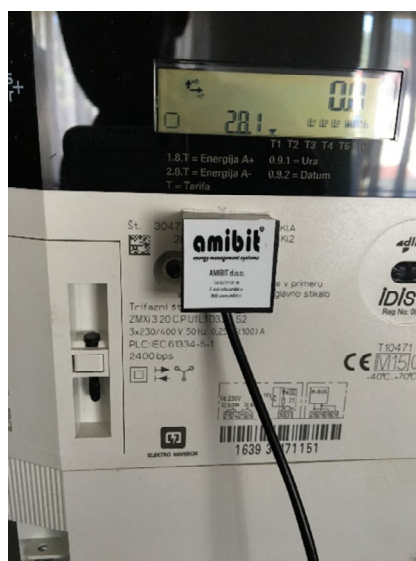


Figure 30 - Phototransistor probe connected to the electric meter (Selnica)

The signal light detected by the probe can communicate any information set by parameterizing the electricity consumption meter. Of course, the options differ from the manufacturer or meter type. The most commonly used light pulse is as a simulation of disk rotation in analog meters, where the pulse means 1/1000 of the consumed 1 kWh or 1/10, depending on how the meter is set. Of course, the meter setting data must be entered into the controller so that it can correctly display the power consumption.

The controller has eighteen 32-bit internal meters for meter reading. Each time the signal light is turned on, the phototransistor conducts current. The current flowing through the probe to the optically separate digital input makes a change in the voltage at the controller itself. On the low-level program part of the controller, a program runs that detects voltage changes at the inputs. Each time a voltage change is detected from low to high, the value of the internal 32-bit counter increases by one.

In the standard configuration of the controller, errors in reading the light pulse of the signal light can occur if the signal width is too short - below 5 ms, or the signal has too high frequency - above 100 Hz. In this case, the controller will count fewer pulses than reported by the counter. If higher frequencies are required, the low-level controller program is adjusted. Reading errors can also occur in the event of poor contact of the probe with the meter - light intrusion, or in the event of a power failure of the controller or probe.

In the standard case, the higher-level program on the controller reads the values of the internal 32-bit counters every 15 minutes and forwards them to the server. If necessary, this reading frequency or sending can be changed at the request of the user.

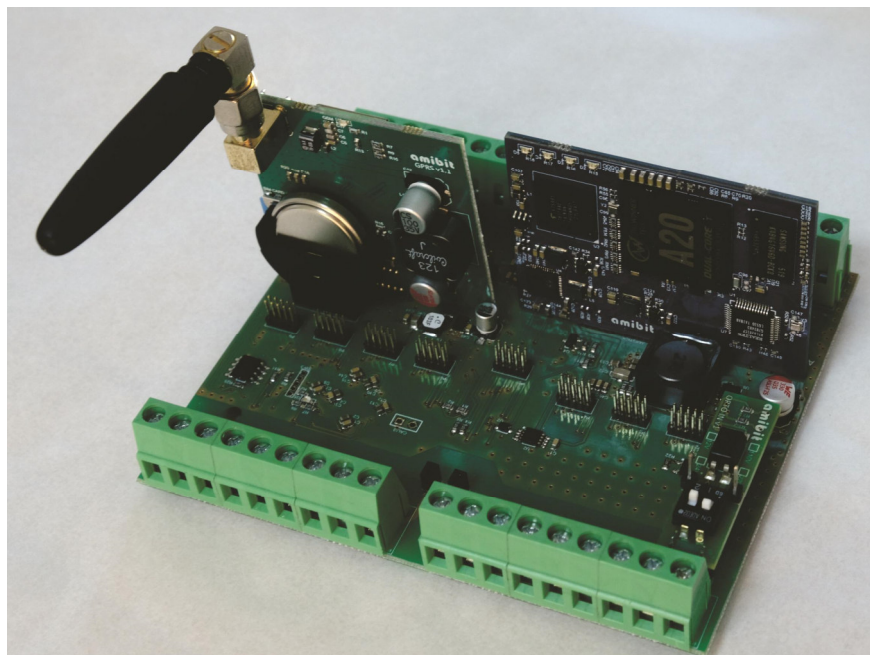


Figure 31 - The picture shows the Amihub controller with a built-in optically separated digital input (bottom right), GSM modem (Selnica)

6.2.3 Controller characteristics

The housing of the Amihub device can be attached to a DIN rail according to the IEC / EN 60715 TH35 standard

- Height without GSM / LTE module: 58.0 mm
- Height with GSM / LTE module without antenna: 64.9 mm

- Width: 106 mm (6x module width 18 mm)
- Manifold opening size: 45 mm
- Degree of protection: <IP20

Table 17 – Technical details of controller (Selnica)

Power supply	
Supply voltage	12 V DC
Average consumption at 12 V DC	300 mA
Max. consumption (USB + GSM)	1800 mA
Current protection	2 A at 24 V
Surge protection	27 V

Connections	
Power supply	2-pin terminal block
Network	RJ45 10/100 Mbps (half/ full duplex)
USB	2x USB tip A
RS232	3-pin terminal block
RS485	2-pin terminal block
M-BUS	2-pin terminal block
GSM	SMA antenna connector

Other	
Operating temperature range	From 0°C to +60°C
Storage temperature range	From -10°C to +70°C
Relative humidity during operation	< 95% (no condensation)
Housing protection	< IP20

Figure 32 shows the PV electricity generation and the consumption of all buildings included in the microgrid except the culture centre for a period of one month. There is a high level of simultaneity between generation and demand showing a high potential for local self-supply within the microgrid.

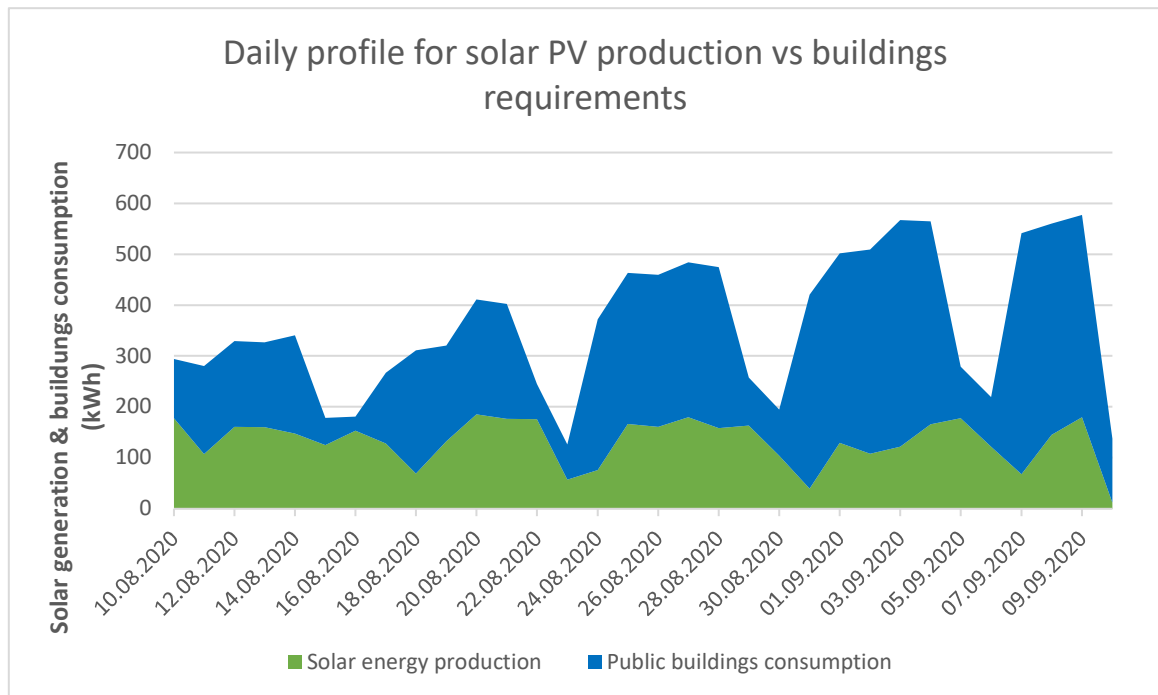


Figure 32 - The graph shows the ratio between electricity produced and consumed in all buildings together except the Cultural Centre (Selnica)

Figure 33 shows in higher resolution the two days average daily load of the primary school with annual electricity consumption of 70.032 kWh and PV-production/possible self-consumption per day (green zone).

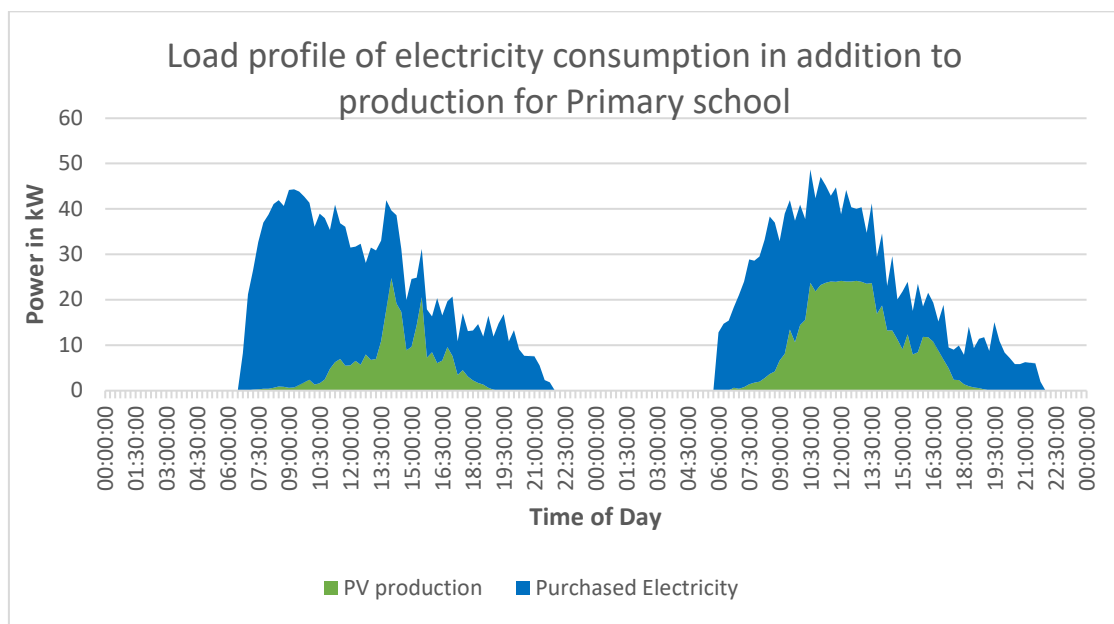


Figure 33 - The average daily load mode of a Primary school (Selnica)

Planned measures in the second phase of the pilot project:

- installation of electricity meters on the existing cogeneration plant in the primary school

- plan preparation for the installation of a solar power plant on the fire station including the battery system

6.3 Legislative framework

Energy communities are not common in Slovenia. The law on energy communities in Slovenia has recently been complemented a new by-law on the self-supply of electricity from renewable energy sources that entered into force on the 1st May 2019. The by-law is an enforcement of the first paragraph of Article 314 and Article 315 of the Energy Act and introduces the concept of 'Renewable Energy Source Community' (RESC). The main actors involved in the design of the framework were regulators, cooperatives and consumer organizations. The by-law promotes both the activity of individual as well as collective self-consumption.

6.3.1 Legal concept – Renewable energy source community

A RESC is defined as jointly acting final consumers behind the same low-voltage (LV) transformer station who are engaged in collective self-consumption. A legal entity is not required, but is allowed to be established.

Any type of entity is allowed to participate in a RESC. However, a third-party power plant owner is not allowed to have effective control over the RESC.

In order to benefit from the virtual net-metering scheme, participants in a RESC need to consume electricity through two or more metering points that are connected to a low-voltage network of the same transformer station as the production unit.

6.3.2 Activities, rights and responsibilities

The by-law views a RESC as a form collective self-consumption, which is formed by customers in buildings (houses) and/or dwellings that consume self-produced electricity via two or more measuring points that are connected to the network of the same LV transformer station as the production unit used for self-consumption purposes.

All participants are obliged to share the produced electricity amongst them, and match it to their consumption profiles. The electricity shares allocated to the different consumers' portfolio's in a RESC should match the anticipated production. If, at the end of the accounting period, the amount of electricity delivered (in kWh) by the customer is greater than the amount of electricity received (in kWh), the customer shall hand over the surplus electricity to his or her supplier. A RESC is exempted from the supply license requirement for electricity that is collectively consumed and shared by its members or shareholders behind the same low-voltage transformer station.

In case of excess electricity, the owner of the production unit cannot acquire the status of producer and sell the generated electricity to the market. The excess electricity goes to the external supplier and is directly fed into the public grid. The supplier (depending on the agreement between supplier and consumer) then pays for this energy according to the contractual price. The payment can take the form of a discount on the account of the following year. Each participant in a RESC can choose to have its own electricity supplier.

The agreed upon shares will then have to be communicated to the DSO to calculate the consumption data that needs to be applied on the electricity bill by each supplier.

The production unit does not have to be in ownership of the community members or shareholders, needs to be connected to a sperate measuring point, located behind the same low-voltage transformer station, and cannot be (or have been) included in a support scheme for the production of electricity from renewable energy sources and in high-efficiency cogeneration. The maximum installed capacity of the production unit may not exceed 80 % of the sum of the connection capacities of the individual measuring points in the community. The balancing responsibility is transferred to the supplier.

An energy storage device is also allowed to be connected to the installation or the network to which the self-consumption unit is connected. The participants of a RESC then have to agree in advance on the exact

shares of electricity distributed among them. The sum of shares should equal 100 % of estimated electricity production. The distribution model can be modified, but is subject to prior communication to the DSO.

6.3.3 Relation to the Clean Energy Package documents (CEP)

The new by-law in Slovenia was not an intentional implementation of the CEP, although it is considered an important first step.²

The focus is on Renewable Energy Communities as a form of collective self-consumption. The associated rights, privileges and responsibilities are consequently aimed at regulating this particular type of activity. This renders the scope of the Slovenian framework considerably narrower than for REC and CEC under the CEP.

In terms of participation criteria, the concept of RESC is more broadly defined than a CEC and REC, since any entity can participate. However, the geographical limitation is stricter, as all of the participants need to be located behind the same transformer station for the purpose of collective self-consumption.

6.4 The energy community

6.4.1 Players involved, their roles and contractual relationships

When the community will be established it will involve exclusively public sector stakeholders: the municipality, a school, a kindergarten, a cultural house, and a fire station. The school will serve as a production unit and a user. If possible, the fire station will have production and small storage system also. Others will be the users. At the moment we do not know the contractual relationship yet.

6.4.2 Type and characteristics of community developed

It will be an energy community, using some RES and connected to the grid. Islanding will be studied.

6.4.3 Expected socio-economic outcomes

Through the pilot, we will study the technical and legal aspect of setting the community. The pilot will be as a show case for citizens to see and understand the microgrids. Though measuring the production and use and using the system of net-metering we will try to get as much as possible own energy production. The energy efficiency measures on the user's site will be also implemented to achieve as much as possible self-sufficiency.

6.5 Implementation plan

In compliance with the roles assigned by the Alpgrids project, the implementation of the different pilot development steps were split up between the Municipality of Selnica ob Dravi and ENERGAP, as highlighted in Table 18 listing the primary responsibilities of the two partners.

² https://www.h2020-bridge.eu/wp-content/uploads/2020/01/D3.12.d_BRIDGE_Energy-Communities-in-the-EU-2.pdf#page=97&zoom=100,68,126

Table 18 - Organization and responsibility for the pilot implementation

Task	Municipality of Selnica ob Dravi	ENERGAP
Technical inspection on pilot site		X
Processing of pre-existing data (bills, account of consumption)		X
Microgrid configuration		X
Technical Specification of the measurement system		X
Tender for the supply and installation of the measuring equipment	X	
Contract Assignment for supply and installation of the measuring system	X	
Supervision during measuring system installation	X	
Functional testing and commissioning of the measuring system	X	
Data acquired processing		X
Microgrid optimal configuration assessment		X
Technical benefit assessment		X
Socio-economic outcomes deployment	X	

Table 19 outlines the changed implementation time table due to situation resulting from COVID 19.

Different tasks will be performed in parallel, especially from August 2020, in order to recover the previous delays and to complete the pilot technical development within August 2021 as scheduled in the ALPGRIDS project program.

The deployment of the pilot results in order to enhance the socio-economics outcomes, which had already started in 2020 year, will continue during the next year.

Table 19 – Pilot implementation time table adapted to the COVID-19 situation (Selnica)

	2019		2020												2021							
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Site inspection and pre-existing data elaboration																						
Microgrid configuration and technical specification of the measuring system																						
Procurement, supply and installation of measuring system																						
Data acquisition																						
Data acquired processing and microgrid optimal configuration assessment																						
Economic and social benefits assessment																						
Socio-economic outcomes deployment																						

Pilot 7: Grafing (DE)

7.1 Context and general objectives

7.1.1 City of Grafing



Figure 34 – Aerial view and map of the City of Grafing

Grafing is a city in a semi-rural environment 30 km east of Munich. With around 13,600 inhabitants and around 6,100 grid connection points, Grafing has a total yearly consumption of electric energy of approximately 24 GWh. Out of this, 10 GWh are produced locally. This results in a self-sufficiency rate at city level of around 40%.

7.1.2 Rothmoser, a family owned distribution grid operator

Rothmoser is a family-owned local distribution grid operator (DSO), combined heat and power (CHP) plant operator, district heating grid and electricity distribution grid operator with 11 employees. Rothmoser owns and operates six public charging points for electric vehicles.

7.1.3 Challenges for electric grid in Grafing: increasing EV

The ALPGRIDS pilot will address challenges the electric grid of Grafing is facing caused by charging of electric vehicles (EV). Especially, one district of Grafing, Schönblick, is in the focus of this pilot project. Schönblick is a clearly separated area within the local grid with approximately 30 residential buildings. It can be looked at as a microgrid.

7.2 Technical Description

7.2.1 Detailed Influence of EV on the electric Grid

The increase of the number of electric vehicles (EV) charged within a grid area is a challenge for every DSO. As of 2018, there are 9,545 cars registered in Grafing, 7,836 of them are passenger cars. So far only 50 of them are EV. There are six charging points for EV in Grafing out of which one is public. Monitoring and measuring charging activities is part of the investigation in ALPGRIDS. The existing charging points with 22 kW are well integrated in the grid.

Adding up standard EV charging load curves with a simultaneity factor of 0.2 shows that starting from a number of about 500 EV in Grafing, that is from a passenger car electrification rate of only 6 % onwards, EV charging will have a significant impact on the overall load profile. As Figure 35 shows, the charging load curve has peaks at the same time of the day as the present overall load curve. Hence, shifting the charging load to other hours of the day can avoid grid enforcements due to EV expansion.

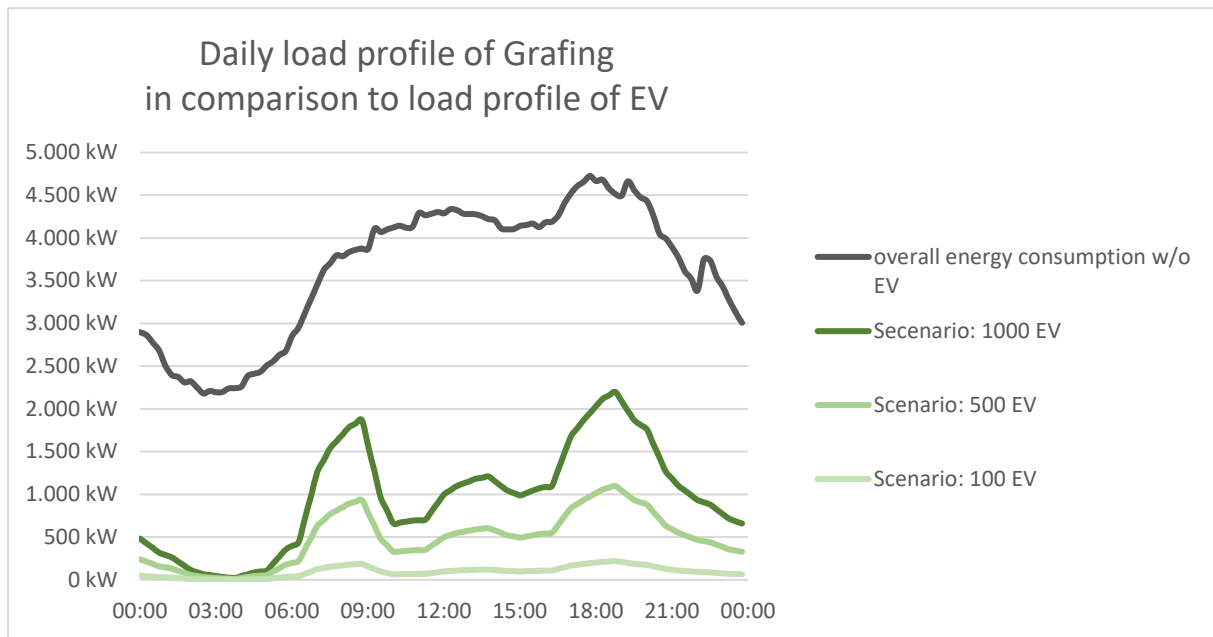


Figure 35 – Actual electric load and projected future EV load profiles (Grafing)

7.2.2 Schönblick, a district of Grafing, as a microgrid

Schönblick is a villa area with, presumably, many potential early adopters of electric mobility. A grid bottleneck is a transformer station. Sooner or later the increasing number of EV will create a load peak that exceeds the maximum power of the transformer, provided that no load management is done.



Figure 36 – Map of the Schönblick district in Grafing



Figure 37 – New development plan for Schönblick (Grafing)

The situation will be aggravated by an extension of the district for which a development plan is about to be established at the moment, expected to put further strain on the existing grid. However, it is foreseen that 40 % of the roof area of each house will be used for solar energy use, either thermal or electric. This provides scope for measures avoiding grid reinforcement by shifting electric loads thus reducing load peaks and ensuring better matching of local consumption and generation. For this purpose, an energy community could be favourable.

7.3 Legislative Framework

7.3.1 Framework for reduced net price for wallboxes with blocking times

According to §14a EnWG (Gesetz über die Elektrizitäts- und Gasversorgung – Energiewirtschaftsgesetz), grid operators have to offer reduced grid fees for users who consume energy in a way that supports grid operation. This legislation was originally designed for shifting the electric consumption of heat pumps and night storage heaters to periods of low demand, but also applies for electric mobility. To support grid operation, blocking times can be defined ensuring that heat pumps and wall boxes are blocked during high load times of the day.

As of now there is no legislation that supports the exchange of energy between prosumers to avoid grid strain, especially when both prosumers do not share the same house connection.

The EU Renewable Energy Directive Art. 22 (EE-RL) guarantees the possibility of energy sharing for all EU citizens, but as of now has not been transposed into German national law. Especially the cooperation of energy communities and DSO is not defined yet.

7.4 The energy community

7.4.1 Load management with blocking times

The most basic, but also effective way of load management is intermitting the supply of electric energy at certain times. As this is not user-friendly, blocking times should be as short as possible. Blocking times could vary with the seasons and also differ from district to district in Grafting. The optimization of blocking times for Grafting (bottleneck is the connection to the upstream grid of Bayernwerk) and Schönblick (bottleneck is the transformer station Schönblick) as a microgrid is part of the investigation.

7.4.2 Dynamic load management

Dynamic load management for distributed wall boxes in Schönblick could help avoiding peaks while providing a more user-friendly charging experience than blocking times.

7.4.3 Possible role of PV energy to avoid peaks

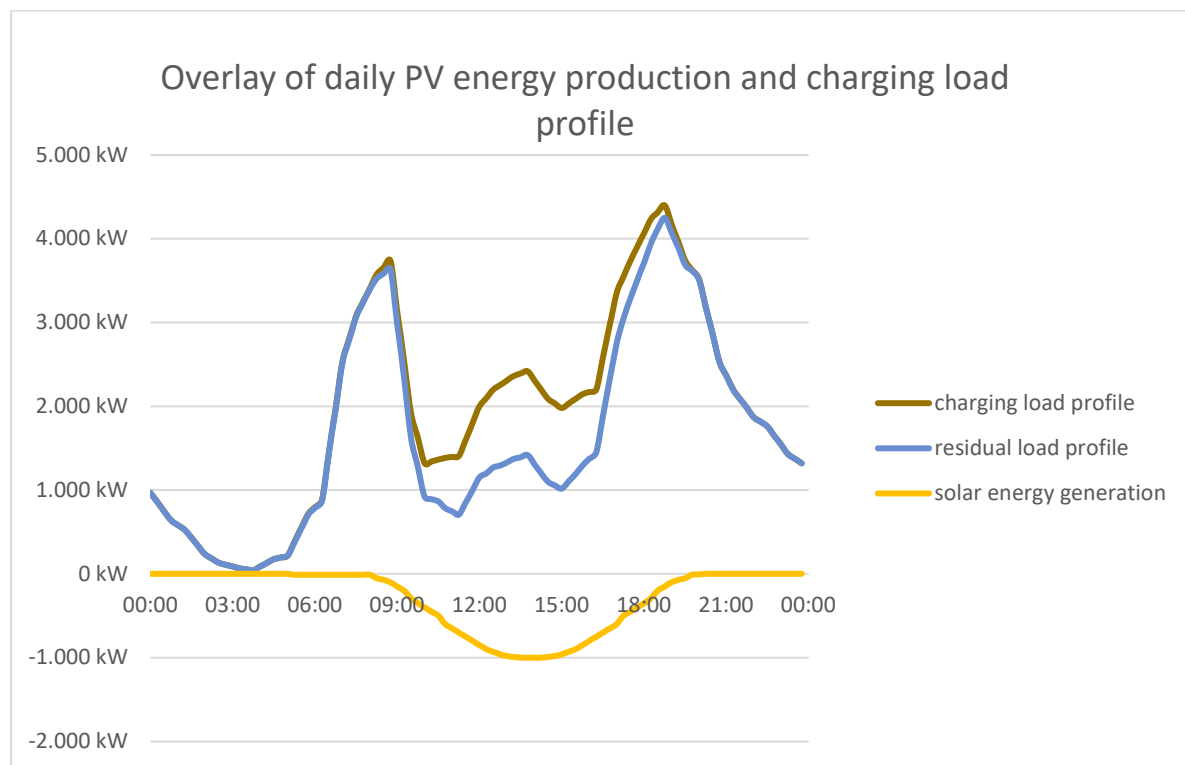


Figure 38 – Typical electric passenger car and PV generation profiles

A typical PV generation profile and a typical electric passenger car charging profile at a home wallbox show little synchronicity. The former peaks in the morning and in the evening, the latter at noon. Matching both requires further measures which will be subject of the investigation in ALPGRIDS. This includes for instance incentives for charging when solar energy is available within

the energy community. The energy community itself needs to be rewarded by the DSO if grid operation is supported, especially if load peaks are avoided.

7.5 Implementation plan

The investigation planned within ALPGRIDS includes:

- development of a tool for overlaying of EV charging load profiles provided by BDEW using simultaneity factors
- description of different EV scenarios and their influence on the grid of total grid of Grafing and “Schönblick” as a microgrid
- load profile measurements at transformer station “Schönblick”
- load profile measurement of typical consumer wallbox (ongoing)
- measurement of load curve at public charging station
- comparison of measured load curves and standard load profiles
- definition of blocking times regarding microgrid (transformer station) and total grid peak based on measurements and simulation
- finding ideas /market research for dynamic load management of distributed wallboxes
- finding ideas/market research for use and exchange of local produced PV energy to avoid load peaks

Pilot 8: Udine (IT)

8.1 Context and general objectives

The Municipality of Udine aims at increasing the use of renewable energy sources (RES), improving the environmental framework and reducing the cost of electricity supply for their inhabitants. For contributing to this aim, a peri-urban electric microgrid connected to the local electricity distribution grid with a collective self-consumption scheme is planned to be set up within the Alpgrids project. The recently established national law on renewable energy communities provides the necessary legal framework.

At first, primary energy from fossil sources is planned to be saved through the partial replacement of gas boilers by combined heat and power (CHP) plants, thereby also lowering carbon dioxide and air pollutants emissions. As a result, a higher fraction of the electricity will be generated locally, relieving the upstream distribution grid most of the time and reducing grid losses by 1.3 MWh/a. The self-sufficiency of the energy end users involved in terms of electricity supply will increase from 10 % to 30 %. Their electricity bill will be reduced by 30 %.

New installations making use of RES will also be considered later on the basis of a time-extended pilot's thermal and electrical consumption campaign.

The pilot microgrid will not allow for island operation considering its connection to an electrical system with high quality of service. In fact, the unavailability of electricity consisted of 1.47 interruptions/year with an average duration of 163 minutes/year for low-voltage electricity end users in the Province of Udine during the five-years period 2014-2018.

8.2 Technical description

The pilot is composed of, and the technical installations will be located in, 4 different types of urban buildings within close proximity of one another as shown in Figure 39:

1. primary School "Lea D'Orlandi" located in via Della Roggia 52
2. kindergarten "Dire, Fare, Giocare" located in via della Roggia 48
3. Friulian Museum of Natural History located in via Cecilia Gradenigo Sabbadini 22/32
4. social housing blocs located in via Cecilia Gradenigo Sabbadini to the house number 52, 54, 56 and 58, for a total of 36 flats

The primary school and the museum are prosumers equipped with PV plants, 6 kWp and 30 kWp respectively, while the kindergarten and the 36 apartments are pure consumers. All the electricity generated by the two photovoltaic (PV) plants is fed into the grid. Table 20 shows the electricity consumption and generation of the buildings in 2018.

Table 20 - Electricity consumption and PV generation (Udine)

building	electricity consumption		existing PV plants	
	installed power [kW]	consumption [MWh/a]	peak power [kWp]	generation [MWh/a]
primary school	30	39.5	6	6.8
kindergarten	35	33.4	-	-
museum	90	129.5	20	22.6
apartment blocks	102	53.0	-	-
total	257	255.4	26	29.4

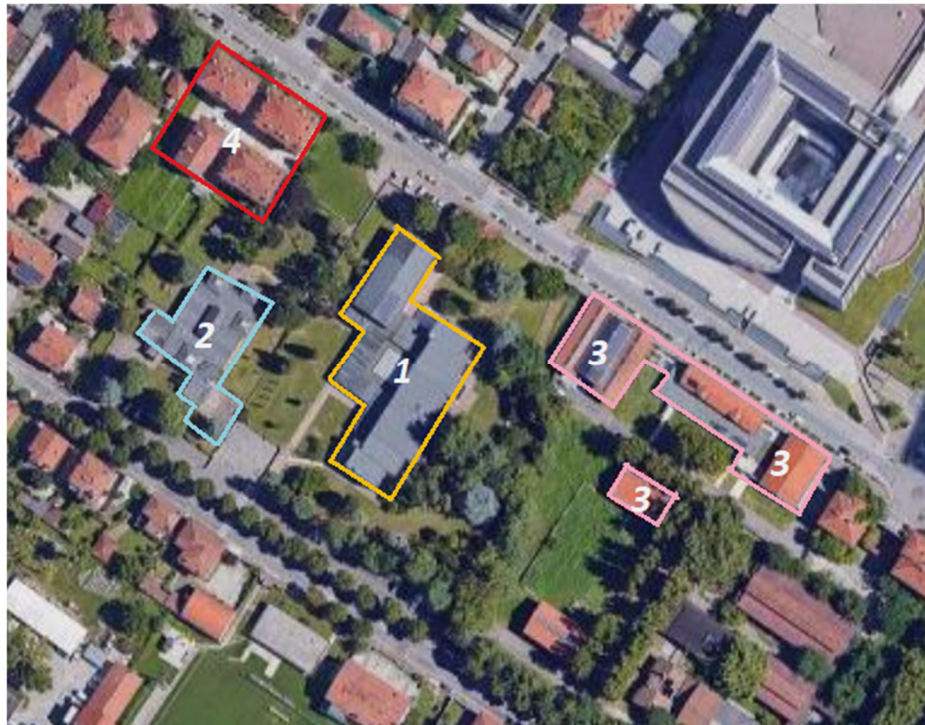


Figure 39 – Aerial photo of buildings involved in the pilot (Udine)

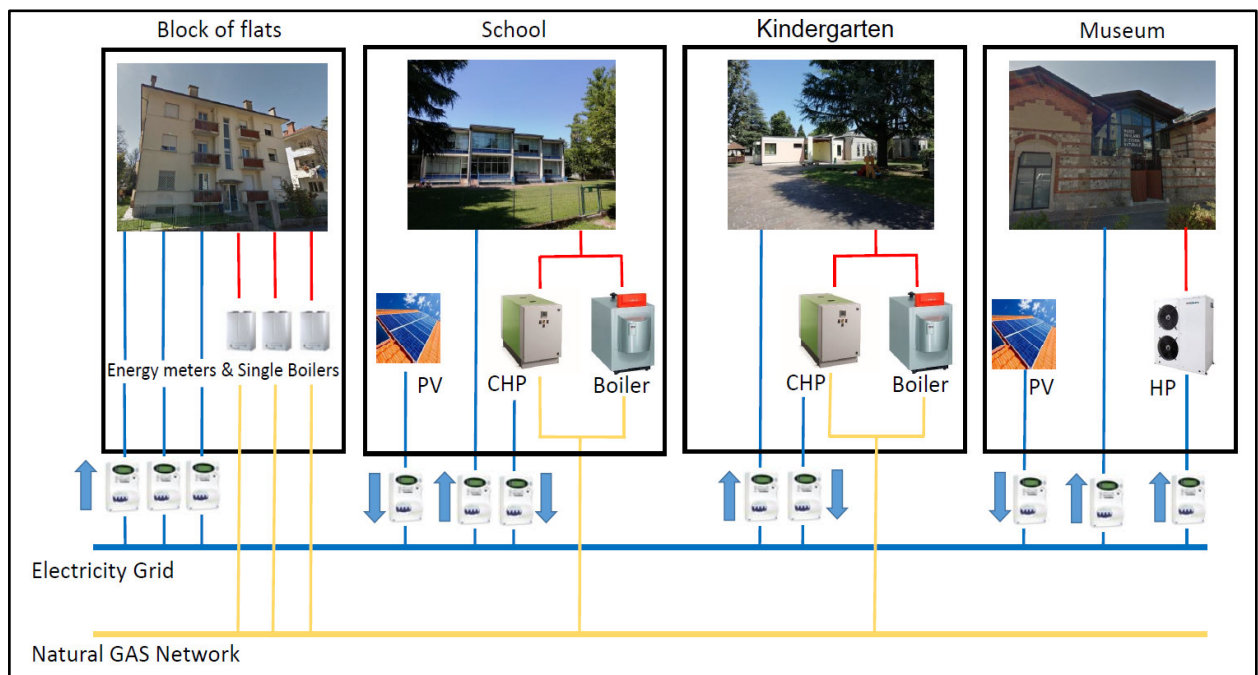


Figure 40 – Energy flow scheme of the pilot (Udine)

The entire pilot project scheme, consisting of the 4 types of buildings and the existing electricity and natural gas grids is shown in Figure 40.

As part of the pilot project, the installation of two new CHP is planned, one, respectively, at the primary school and one at the kindergarten, to partially replace the existing boilers providing space heating and domestic hot water to the buildings, and to generate electricity which will entirely be fed into the local electricity grid. Both CHP will operate in a heat driven mode and always at their maximum power when

operating. In the event the thermal demand exceeds the maximum heat output from the CHP, the existing boilers start operating according to a master-slave logic.

A preliminary assessment has shown that with the installation of:

- a CHP with a maximum electric power of 30 kW and a corresponding thermal power of 63.1 kW at the primary school and
- a CHP with maximum electric power of 11 kW and corresponding thermal power of 25.3 kW at the kindergarten

the thermal energy and electricity listed in Table 21 can be generated along the operating time of the two infrastructures.

Table 21 - Estimated energy generation of CHP to be installed in Udine

building	heat generation [MWh/a]	electricity generation [MWh/a]
primary school	78.7	37.4
kindergarten	24.2	10.5
total	92.9	47.9

Under these assumptions, the annual local electric generation within the pilot would increase to 77.3 MWh, resulting in a self-sufficiency of 30.2 %.

The use of CHP for reducing the operation time of the existing boilers will allow a primary energy saving of 48.7 MWh/a compared to the separate generation of heat and electricity. Moreover, the increase in local electricity generation leads to a reduction of the losses of electric energy in the transmission and distribution networks of 1.3 MWh/a, bringing the total energy benefit to 50 MWh/a.

The total billing reduction for the end users profiting from the pilot scheme, estimated according to Law 8 dated 28/2/2020 and on the basis of the preliminary assessment shown above, amounts to Euro 11,000 €/a, equivalent to 28 % of the municipality's current cost for the electricity supply of the buildings involved.

No CHP is foreseen in the museum and in the apartment blocks. In the museum, heat pumps are used for ambient air conditioning and each apartment has an independent heating boiler. The investment into a CHP for each apartment blocks does not pay back.

For the optimal sizing and operation of the two CHPs able to maximize the energy self-sufficiency of the community and the expected economic benefits, a continuous monitoring of the current thermal and electrical power consumption at the primary school and kindergarten. The generation of PV plants on the primary school and on the museum will also be monitored.

The sampling rate for all measurements is 1 per minute. All meters are connected by a fieldbus based on MODBUS protocol to a data logger with appropriate capacity of sampling and storage.

The measurement system installed in the primary school is sketched in Figure 41. Similar measuring systems have been installed at kindergarten, while for the Natural History Museum and the building with 9 residential apartments only electrical measurements will be carried out.

To consider seasonal effects, especially significant for thermal demand and photovoltaic generation, the monitoring will be carried out for a total of 12 months.

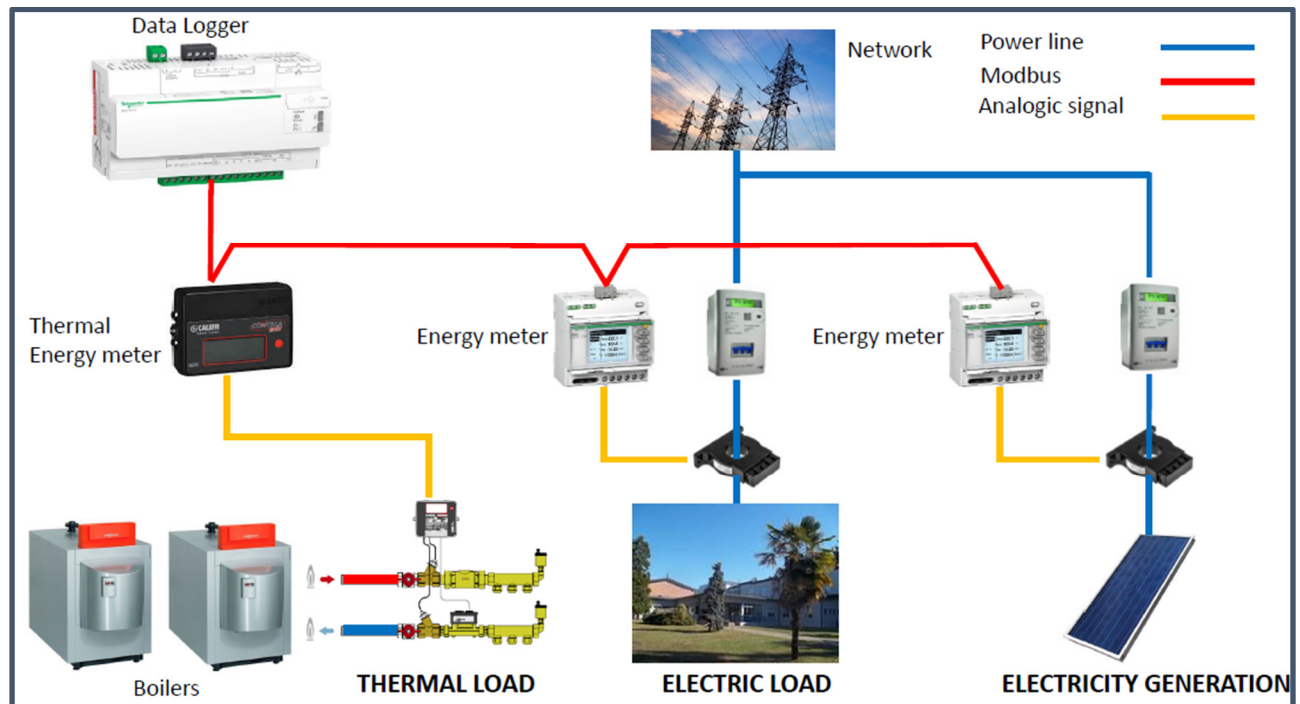


Figure 41 - Measuring system installed at primary school Lea D' Orlandi (Udine)

8.3 Legislative framework

The pilot makes use of the recently established legislative context, namely the Art. 42 bis of the Law n. 8 dated 28/2/2020, transposing the Directive on common rules for the internal market for electricity (EU) 2019/944³ (Electricity Market Directive, EMD) that allows for collective self-consumption of electricity generated from renewable sources: the consumers can joint to become a collective prosumer together.

According to this law the members of the citizens energy community (CEC) can be citizens, small and medium-sized enterprises, local authorities or municipalities under the following conditions:

- the community has no more than 200 kW of renewable sources and make use of the existing electrical distribution network (existing metering included)
- the withdrawal points of the consumers as well as the connecting points of the renewable plants are to be located on low voltage electricity distribution grids underlying the same medium voltage / low voltage substation
- all the generated electricity from renewable sources has to be fed into the existing distribution network and acquired by GSE, the national company appointed to promote the sustainable development in Italy

While each member of the community pays the same bill for the consumed electricity and committed power (all levies, charges and taxes), the community receives the following benefits for each kWh of the 'shared electricity':

- the 'zonal price' of the electricity increased by 2.6 % (around 55 €/MWh on average in 2019 year in Northern Italy); the increase of 2.6 % takes into account the avoided technical losses in transmission and distribution networks due to local generation

³ https://ec.europa.eu/energy/topics/markets-and-consumers/market-legislation/electricity-market-design_en;
text of the directive: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2019.158.01.0125.01.ENG&toc=OJ:L:2019:158:TOC

- the rate for electricity transportation and distribution (equal to 0.822 €/MWh in 2020 year)

being the 'shared electricity' the minimum between the electricity generated by the renewable electricity plants and the overall electricity withdrawn by all the members of the community.

These benefits are additional to the ones related to the existing ones mainly consisting in fiscal benefits related to the investment for the RES installation (mainly consisting in fiscal benefits).

ARERA, the Italian national Authority for energy, is currently in advanced preparation of the implementing regulations for renewable energy communities making use of new renewable sources and will subsequently also issue those relating to renewable energy communities having pre-existing RESs, in order to replace the previous 'Scambio sul posto' regulation.

8.4 The energy community

8.4.1 Type and characteristics of community developed

The renewable energy community involves 3 buildings owned by the Municipality of Udine and 36 residential consumers whose electricity bills are charged to the Municipality.

The Law n. 8 dated 28/2/2020 explicitly provides for situations like this in which the renewable energy community consists of public stakeholders.

The law requires that a private agreement has to be drawn up and made known to GSE who is responsible for the community's incentive evaluation based on the consumption of all the end users and the electricity fed into the network by each RES.

Whatever the type of private agreement, it will be prepared by the Municipality of Udine after the definition of REC final configuration.

The investments required by the REC will be on the responsibility of the Municipality that will have all the government rights.

8.4.2 Expected socio-economic outcomes

Based on the experience with the pilot project, CEC and Renewable Energy Communities (REC) will be included in the municipal Sustainable Energy Action Plan (SEAP) leading to a multiple replication of CEC and the development of REC. For financing replication projects, a revolving fund fed by savings of energy costs could be set up.

Believing that the renewable energy community can be a driving force for the local economy, the Municipality intends to commit itself in the promoting them to potential stakeholders, primarily the citizens, through adequate tools able to make available knowledge and skills:

- on cost-benefits related to renewable energy communities,
- on the legal and regulatory aspects relating to the establishment of a renewable energy communities (such as the organizational aspects of the community, the distribution of economic benefits among the members of the community and so on).

On these aspects an awareness action within the municipal administration has been started in order to determine a commitment for the Municipality to develop, jointly with other interested promoters, and then disseminate these information tools to all potential stakeholders.

8.5 Implementation plan

In compliance with the roles assigned by the Alpgrids project, the implementation of the different pilot development steps were split up between the Municipality of Udine and DeMEPA, as highlighted in Table 22 listing the primary responsibilities of the two partners.

Among the different tasks, it has to be mentioned the procurement concerning the supply and installation of the measurement systems. In full compliance with Alpine Space program rules, a tender was prepared making reference to the technical specifications issued by DeMEPA and sent to 6 potential suppliers and adopting the criterion of the minimum offered price for the contract award.

Table 22 - Organization and responsibility for the pilot implementation (Udine)

Task	Municipality of Udine	DeMEPA
Technical inspection on pilot site		X
Processing of pre-existing data (bills, account of consumption)		X
Microgrid configuration		X
Technical Specification of the measurement system		X
Tender for the supply and installation of the measuring equipment	X	
Contract Assignment for supply and installation of the measuring system	X	
Supervision during measuring system installation	X	
Functional testing and commissioning of the measuring system	X	
Data acquired processing		X
Microgrid optimal configuration assessment		X
Technical benefit assessment		X
Socio-economic outcomes deployment	X	

Table 23 outlines the original implementation time table. The activities for the definition of the pilot detailed design were started in November 2019, but have suffered from a slowdown related to the situation resulting from COVID 19.

Different tasks will be performed in parallel, especially from August 2020, in order to recover the previous delays and to complete the pilot technical development within August 2021 as scheduled in the ALPGRIDS project program.

The deployment of the pilot results in order to enhance the socio-economics outcomes, which had already started in 2020 year, will continue during the next year.

Table 23 – Original pilot implementation time table (Udine)

	2019		2020												2021							
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Site inspection and pre-existing data elaboration																						
Microgrid configuration and technical specification of the measuring system																						
Procurement, supply and installation of measuring system system																						
Data acquisition																						
Data acquired processing and microgrid optimal configuration assessment																						
Economic and social benefits assessment																						
Socio-economic outcomes deployment																						