Interreg
Alpine Space

EUROPEAN UNION

ALPGRIDS

ALPINE MICROGRID MODEL

FINAL RELEASE

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ABOUT THIS GUIDE

WHY THIS GUIDE?

This guide has been developed in the Alpine Space project ALPGRIDS, which aims to create and promote a common Microgrid model for the Alpine Space region based, amongst other things, on experience from 7 Microgrid pilots implemented within ALPGRIDS. It aims to contribute to the development of a shared understanding of Microgrids and their potential role for supporting energy transition and the implementation of local Energy Communities in the Alps.

This guide provides information about Microgrids and Energy Communities through the description of the 7 pilot projects implemented by ALPGRIDS project partners as well as the outcome of transnational exchanges. It also gives information about the policy framework supporting the creation of local Energy Communities and provides some initial hints from project partners for implementing such projects.

This release is not a one-way guide by which the ALPGRIDS consortium provides information and advice for different target groups. It is a first step towards a common and shared understanding of Microgrids. As such, it is also an invitation to go into contact and join the discussion about the proper understanding and the optimum promotion of the concept of Microgrids.

WHO IS THIS GUIDE FOR?

This guide is for

- Renewable Energy Communities (RECs), Citizen Energy Communities (CECs) and Energy Communities only complying with some of the full set of criteria for an REC or CEC and that are about to be established or aim at extending their activities and want to set up a Microgrid
- local and regional public authorities willing to support the creation or development of local Energy Communities
- energy agencies, municipal councils, engaged citizens and stakeholder networks
- energy utility stakeholders such as network operators, energy regulators and service companies
- engineering firms
- policy and decision-makers

They will benefit from a shared understanding of Microgrids by becoming aware of their potential and the opportunities Microgrids provide and will be able to join other activities of the ALPGRIDS project.

HOW CAN IT HELP YOU?

This guide may give you an initial idea about Microgrids, the variety of forms that they can take, and their potential benefits. It might help you understand the key points of the two EU directives setting the framework for Energy Communities and Microgrids, which are about to be transposed into national law. Thus, this guide may provide information on forthcoming new opportunities for local energy self-sufficiency, sustainability, resilience and the cost-effectiveness of electricity, heat/cold or gases/liquids for municipalities, communities of citizens, farmers and small enterprises.

FIND OUT MORE

You can read more about the ALPGRIDS project by visiting the project website:
https://alpine-space.org/projects/alpgrids/en/home

You can also join a dedicated LinkedIn group for sharing tools and experience Sign up now:
https://www.linkedin.com/groups/8910047/

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WHAT ARE MICROGRIDS AND WHAT ARE THEY FOR?

DEFINITION OF A MICROGRID

Microgrids can be defined in technical terms (a-d) and in terms of the organisation of energy supply (bullet points e-f):

(a) grids or interconnected combinations of grids with clearly defined local boundaries for the exchange and distribution of

- AC electricity
- DC electricity
- heat
- cold
- gas (e.g., hydrogen, methane)
- liquid (e.g., mixtures of higher hydrocarbons such as kerosene)

potentially including interconnecting devices, such as

- electric converters
- electric transformers
- heat pumps
- combined heat and power plants fuelled by grid-bound energy carriers

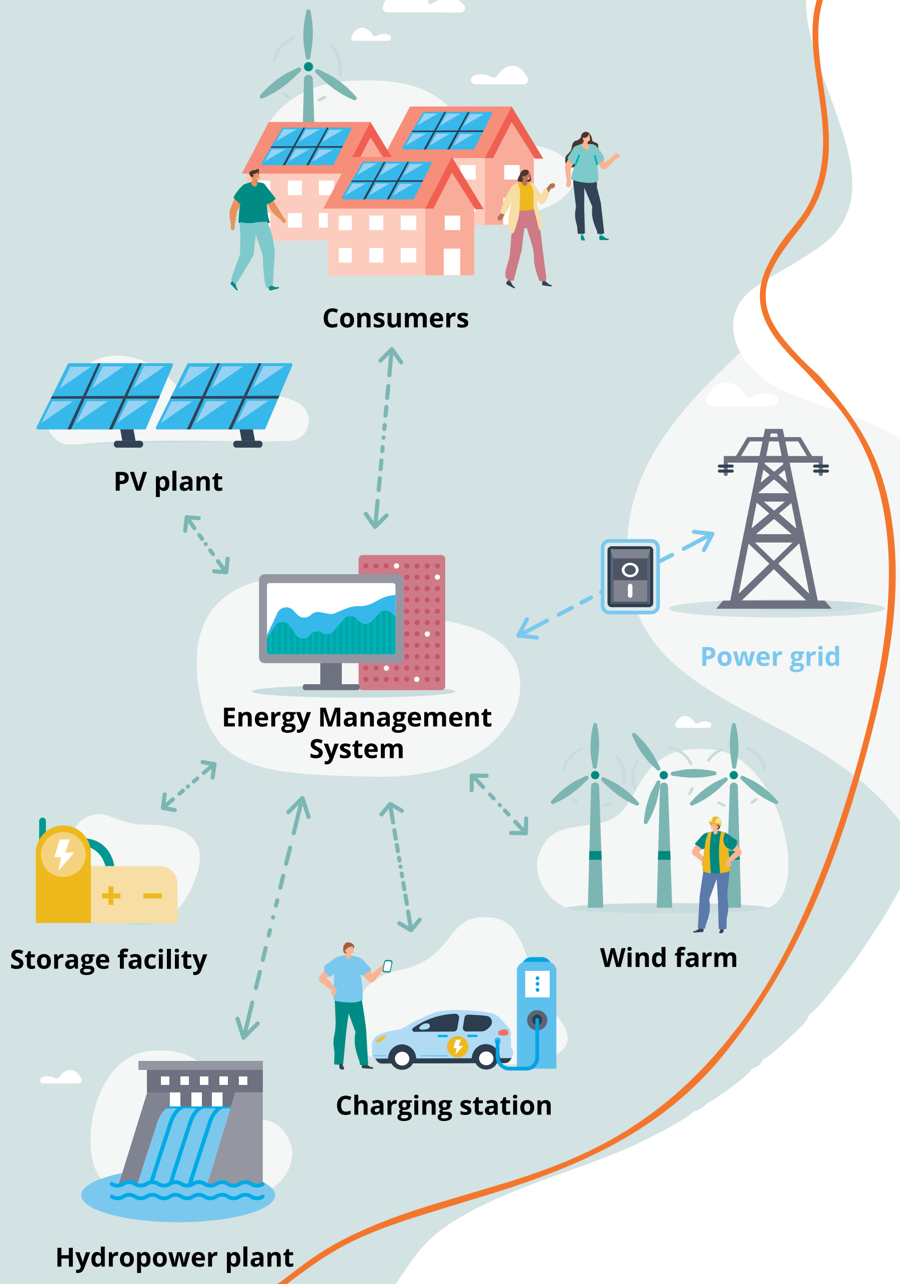
and / or devices producing gaseous or liquid energy carriers, such as

- electrolysers
- methane or ammonia synthesis plants
- Fischer-Tropsch plants

(b) which connect several devices generating, using or storing usable energy or energy carriers;

(c) in which controllable devices (generation units, flexible loads and storages) can be controlled as a single entity whereby these controllable devices might comprise all or part of all generation units, flexible loads and storages in this territory;

(d) which might be able to be operated temporarily or constantly disconnected from the respective upstream grids (islanding mode);



WHAT ARE MICROGRIDS AND WHAT ARE THEY FOR?

(e) in which the connected devices are operated by (legal) persons acting as producers, consumers, prosumers and optionally storage operators on the same territory whereby these (legal) persons might comprise all or a part of all producers, consumers, prosumers and storage operators in this territory;

(f) and which are organised by a single entity which might be (1) a local Energy Community complying partially or fully with the definition of Citizens Energy Communities (CEC) or Renewable Energy Communities (REC) given by (the relevant national transposition of) the EU directives on the internal market for electricity and on renewable energies or (2) an organisation such as a (municipal) electric utility which involves customers actively in the organisation of the Microgrid.

Gases and liquids might not only serve as energy carrier, but also as base materials for chemical industry. They might be intermediate products which have been produced with renewable energy such as ammonia which is an intermediate product for nitrogen fertiliser production.

The focus within ALPGRIDS is on Microgrids for AC electricity, but some pilots include heat, cold, or gases. For this reason, the definition of Microgrids is conceived to allow for the widest possible range of options.

THE POTENTIAL BENEFITS OF MICROGRIDS

Microgrids generally use locally available energy sources, which are mostly renewable energy sources (RES). They can improve the

- local energy self-sufficiency
- energy efficiency
- sustainability
- resilience
- cost-effectiveness

of the energy supply for

- municipalities
- communities of citizens
- farmers
- small enterprises
- others

and the awareness of energy, its origin, use, and environmental and social implications.

WHAT ARE MICROGRIDS AND WHAT ARE THEY FOR?

Microgrids can especially provide benefits in
- rural
- mountainous
- remote locations

with missing or weak connections to upstream grids, or areas particularly vulnerable to natural hazards whose frequency and severity will increase as the anthropogenic climate change evolves. Thus, Microgrids provide a protection against the consequences of climate change. If they are based on RES, they also contribute to climate change abatement and to limiting the need of protecting against the consequences of climate change.

Through their advanced control capabilities, Microgrids for the exchange and distribution of electricity can also provide for "local ancillary services" such as voltage and frequency control support, demand response and congestion management of local distribution networks. The provision of these services will make it possible to contribute to maintaining the integrity and stability of the distribution systems as well as the power quality. At the same time, the revenue from these services will improve the economic performance of the Microgrids by increasing the investment profitability and reducing the pay-back time.

MULTI-VECTOR MICROGRIDS

Microgrids for different forms of energy may be interconnected by energy converters, thus forming a Multi-Vector Microgrid (MVM). Multi-Vector Microgrids represent a form of sector coupling, i.e. the connection of different energy and material flow systems at the local scale.

The classical example of an MVM is a gas-fuelled central heat and power (CHP) plant that converts the chemical energy of gas into heat and electricity, and that feeds a local district heating grid and a local electric grid. In this case, the local gas, heat and electricity grids jointly form an MVM and the CHP is the interconnecting energy converter.

MICROGRIDS AND ENERGY COMMUNITIES

Microgrids require small-scale generation and renewable energy and smart grid technologies which are mature and readily available on the market. Though Microgrids are essentially defined by, and have in common, some technical characteristics, non-technical aspects play an important role in their implementation. A key point is the active involvement of energy consumers which allows for exploiting the flexibility of consumers and devices such as storages operated by consumers for optimising the overall Microgrid operation. Often, this goes hand in hand with the establishment of an Energy Community fully or partially in pattern with the definitions given by two recent EU directives. For this reason, Energy Communities are given great significance in this guide.

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WHAT IS AT STAKE AT EU AND ALPINE LEVEL CONCERNING ENERGY COMMUNITIES AND THE USE OF MICROGRID SOLUTIONS ?

CLIMATE CHANGE URGES FOR ENERGY TRANSITION

Two threats to mankind have the potential to destroy the elementary physical conditions needed for the existence of our civilisation on a global scale within the coming decades: (1) anthropogenic climate change and (2) biodiversity loss. The former is mainly caused by the combustion of fossil fuels for the generation of electricity, heat and motive force. The latter arises for a variety of reasons, but anthropogenic climate change is one of the driving forces. Therefore, the energy transition away from fossil fuels towards renewable energies is the biggest part of the response to these essential threats to mankind, and Microgrids are a part of this energy transition.

THE ALPINE SPACE IS PARTICULARLY VULNERABLE

By 2020, the average global annual temperatures have risen 1.25 degrees Celsius above the pre-industrial level, not much less than the maximum increase of 1.5 degrees targeted by the Paris Agreement on Climate Change of 2015. Over continents, the temperature rise is higher than over the oceans and some areas such as the Arctic are experiencing an even greater temperature surge of several degrees. The Alpine Space is an area with an above-average temperature increase. At the same time, it is particularly vulnerable to the consequences of this change. Melting permafrost at higher altitudes leads to more frequent and severe landslides, while vanishing glaciers lead to the Alpine Space losing its function of Europe’s main “water reservoir”, which regulates the water level of several major European fluvial transport routes and surrounding agricultural areas.

SURGING GENERAL AWARENESS BACKING CLIMATE POLICY DEVELOPMENT

The general awareness that energy supply has to change quickly from fossil fuel-based generation to renewables in order to possibly limit climate change to 1.5 degrees has risen significantly in recent years. In the summer of 2018, previously unknown widespread wildfires in Sweden motivated Greta Thunberg to start school strikes on Fridays, thus giving birth to the Fridays for Future movement. The global mobilisation that followed backed the development of climate mitigation policies already taking place at several levels such as the European Green Deal.

DRIVERS

WHAT IS AT STAKE AT THE EU AND ALPINE LEVEL CONCERNING ENERGY COMMUNITIES AND THE USE OF MICROGRID SOLUTIONS?

NEW EU DIRECTIVES

Within this context, two EU directives have been voted for in support of more ambitious climate change abatement policy. They provide a legal framework for Energy Communities involving new actors in sustainable energy supply schemes, notably citizens and small enterprises whose main business is not energy supply. Energy Communities are particularly important for setting up Microgrids.

A MORE RESILIENT ENERGY SUPPLY IS REQUIRED

Climate change is already harming people and damaging property and infrastructure. Among other things, it puts the energy supply at risk and necessitates a more resilient energy infrastructure. Microgrids can improve the resilience of the energy supply. Notably, semi-isolated communities, rural areas, peri-urban areas, independent generation communities and distribution grid operators specific to the Alpine Space have a high potential for benefitting from Microgrids.

MICROGRIDS FOSTER EQUAL OPPORTUNITY AND NON-DISCRIMINATION

Microgrids are a means to establish Energy Communities, which aim to provide non-discriminatory access to energy for all citizens. They can contribute to promoting energy consumer rights in the Alpine Space territories. They also offer potential for new economic activities, notably in remote and rural areas of the Alpine Space. In the case of Microgrids for electricity connected to the upstream grid, their inherent flexibility can help in balancing these, thus also providing benefits for energy consumers that are not part of the Energy Community.

BARRIERS

Microgrids represent a paradigm shift for supplying energy to local communities. They provide many benefits for a wide range of stakeholders and public interests, but there are also stakeholders who need to adapt their business and who could find themselves on the losing side if they fail. For this reason, barriers originate from two sides: (1) missing prerequisites for reaping the benefits for municipalities, communities of citizens, farmers and small enterprises whose main business is not (fossil) energy supply; (2) opposition from stakeholders of the current mainly fossil fuel-based energy economy who refuse or who fail to adapt, i.e. operators of centralised fossil and nuclear power plants, suppliers of fossil fuels, and related industry and services.

MISSING PREREQUISITES OF MICROGRIDS

Missing prerequisites include

- lack of a common understanding of Microgrid solutions and their benefits
- lack of a common understanding of Energy Communities and the new policy frameworks (at the EU and national levels)
- lack of local support for establishing communities (legal, technical, organisational) and deploying Microgrid solutions (technical, financial and territorial planning)
- legal and commercial barriers to the implementation of citizen-owned projects, as pointed out by the EC, such as disproportionate fees for internally consumed electricity, obligations to feed self-generated electricity into the energy system, and administrative burdens, such as the need for consumers who self-generate electricity and sell it to the system to comply with the full set of requirements for energy suppliers, etc.

OPPOSITION TO CHANGING TO MICROGRIDS

Opposition to change could take the following forms:

- EU member states refusing to fully transpose the EU directives into national law in order to protect established stakeholders in the energy sector
- refusal of relevant stakeholders to cooperate with Energy Communities
- disinformation campaigns aiming to discourage citizens from organising themselves into Energy Communities
- legal complaints aiming to delay permission procedures and to discourage new actors
- fear that Microgrids offer favourable conditions for energy supply for those connected to them at the expense of other users connected to the distribution grid.

Though the EU directives are very clear in their support for Energy Communities, such opposition might represent a strong barrier against Energy Community action and the establishment of Microgrids.

LEGISLATIVE FRAMEWORK AT THE EU AND NATIONAL LEVELS

EU LEVEL

Microgrids come in two flavours constituting the two parts of their definition: (1) technical solutions for the optimized operation of local grids and (2) elements of active involvement of energy consumers, such as via local Energy Communities that often strive to maximise energy self-supply. In the case of electric grids, the local grid does not need to be cut off from the upstream grid, but the preparation for islanding in emergency cases may be included, where appropriate.

If the organisation of a Microgrid takes the form of an Energy Community, two definitions given by EU directives are relevant, Art. 22 of the Directive on the Promotion of the Use of Energy from Renewable Sources (Renewable Energy Directive 2018/2001/EU[1]) (RED II), which defines renewable Energy Communities (REC), and Art. 16 of the Directive on Common Rules for the Internal Market for Electricity (EU) 2019/944[2]) (EMD), which defines Citizen Energy Communities (CEC). The main features distinguishing these types of Energy Communities are shown in the graphics below.

The two EU directives leave it to the member states to decide whether or not such Energy Communities own and operate their part of the grid. Various alpine countries have taken different approaches and defined different legal frameworks. This needs to be studied and brought to a coherent definition of terms and views for the Alpine Space.

CITIZEN ENERGY COMMUNITIES

Specific Governance, but Broad Membership
No geographical limitation
Electricity only
Technology neutral

Art. 16 of the Directive on the Internal Market for Electricity Directive on "Citizen Energy Communities"

RENEWABLE ENERGY COMMUNITIES

Limited Membership & Specific Governance
Proximity to Generation
All sources of RES
100 % RES

Art. 22 of the Directive on the promotion of the use of energy from renewable sources on "Renewable Energy Communities"

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ALPGRIDS' CONTRIBUTION

PILOTS AND THEIR STRATEGIC OBJECTIVES, THEIR PLANS AND EXPECTED OUTCOMES

PILOT AREA

The Val de Quint Valley is a rural area with approximately 760 inhabitants located in the south-eastern part of France, in the Drôme department, at the southern foothills of the Vercors Mountains. It is mainly a residential, but also touristic area with some agricultural activities and a few very small enterprises. Six villages are located 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).

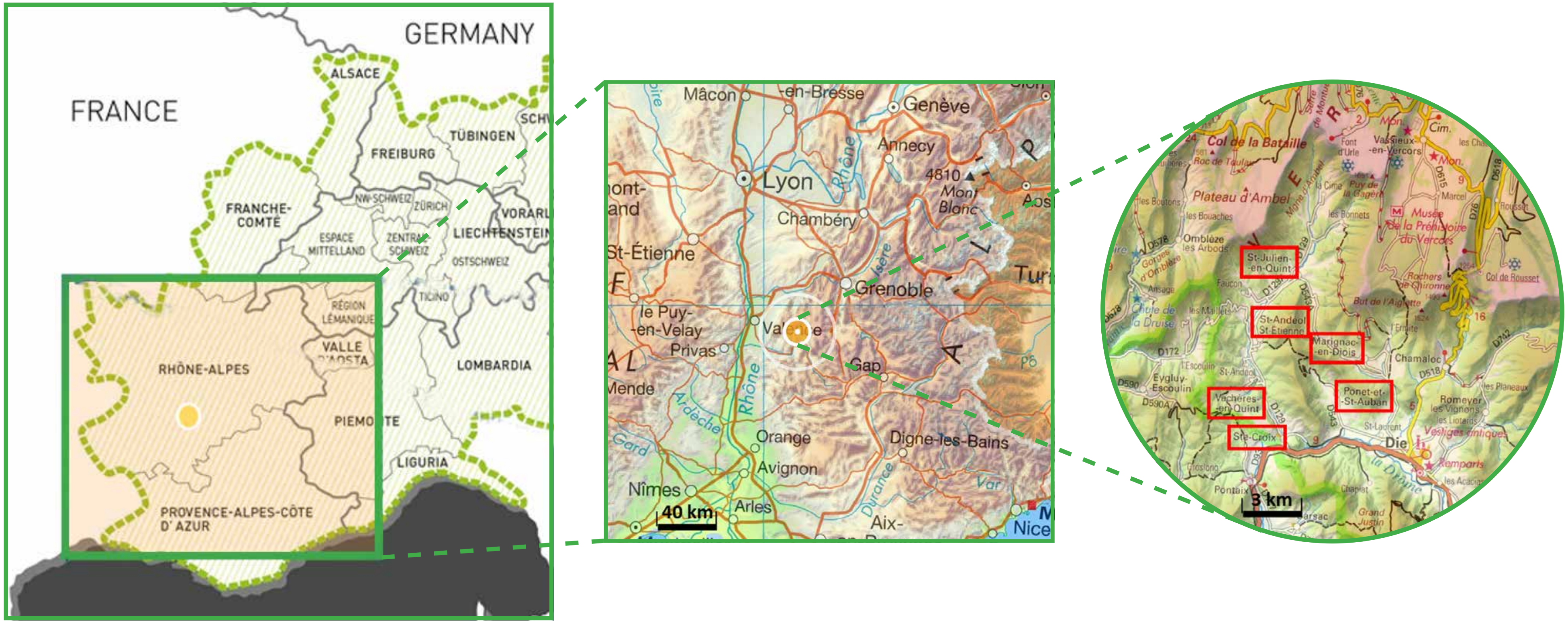

Figure 1 – Location of the Val de Quint Valley (sources : www.espacealpin.fr and www.geoportail.fr)

STRATEGIC OBJECTIVES

- develop a more resilient energy system at the end of the distribution network
- purchase renewable energy produced locally at an acceptable price
- provide support to local rural spatial development

PLANS

A Microgrid exists already at Saint-Julien-en-Quint. Within ALPGRIDS, it is planned to extend the Microgrid activities to the entire Val de Quint area. The exact configuration of the extended pilot site and the dimensioning of its elements is subject to the work within ALPGRIDS. The scheme in Figure 2 represents the elements that are considered to date while that in Figure 3 represents the target configuration on the Val de Quint area.

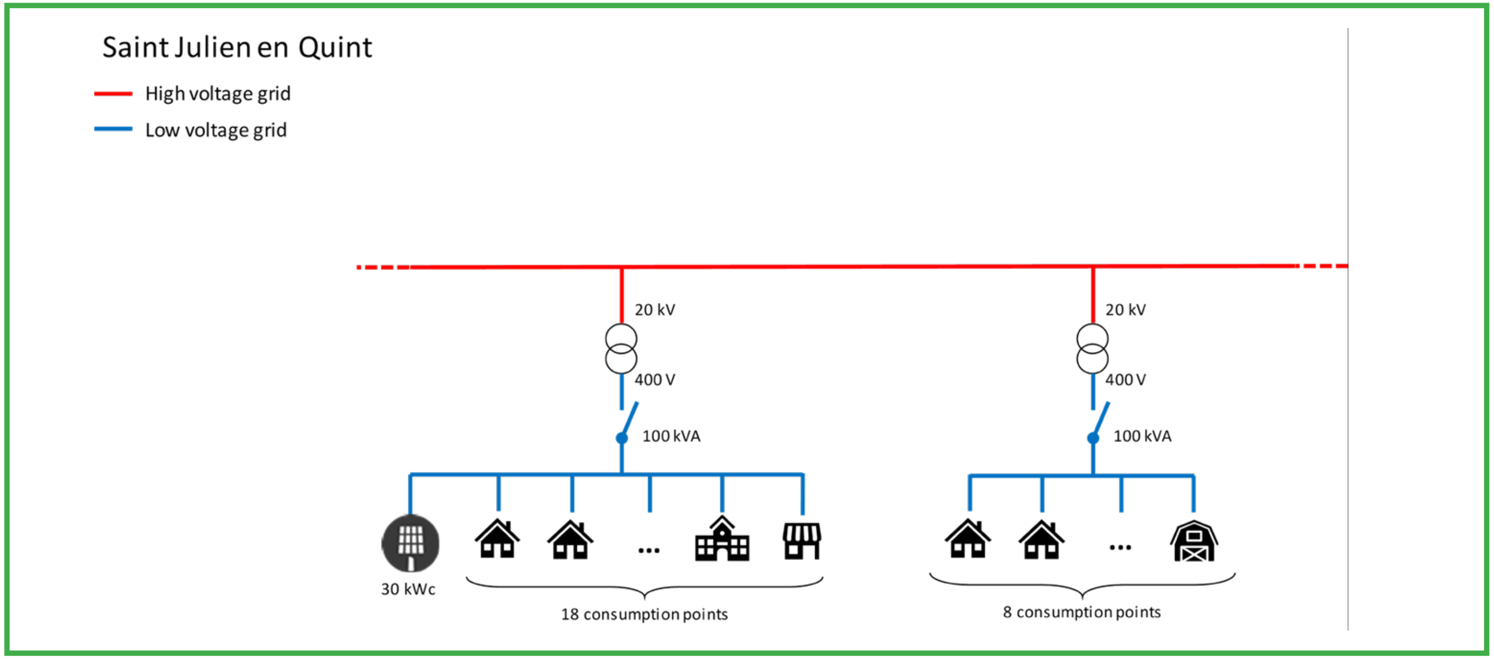

Figure 2 - Scheme of the Saint Julien-en-Quint Microgrid configuration

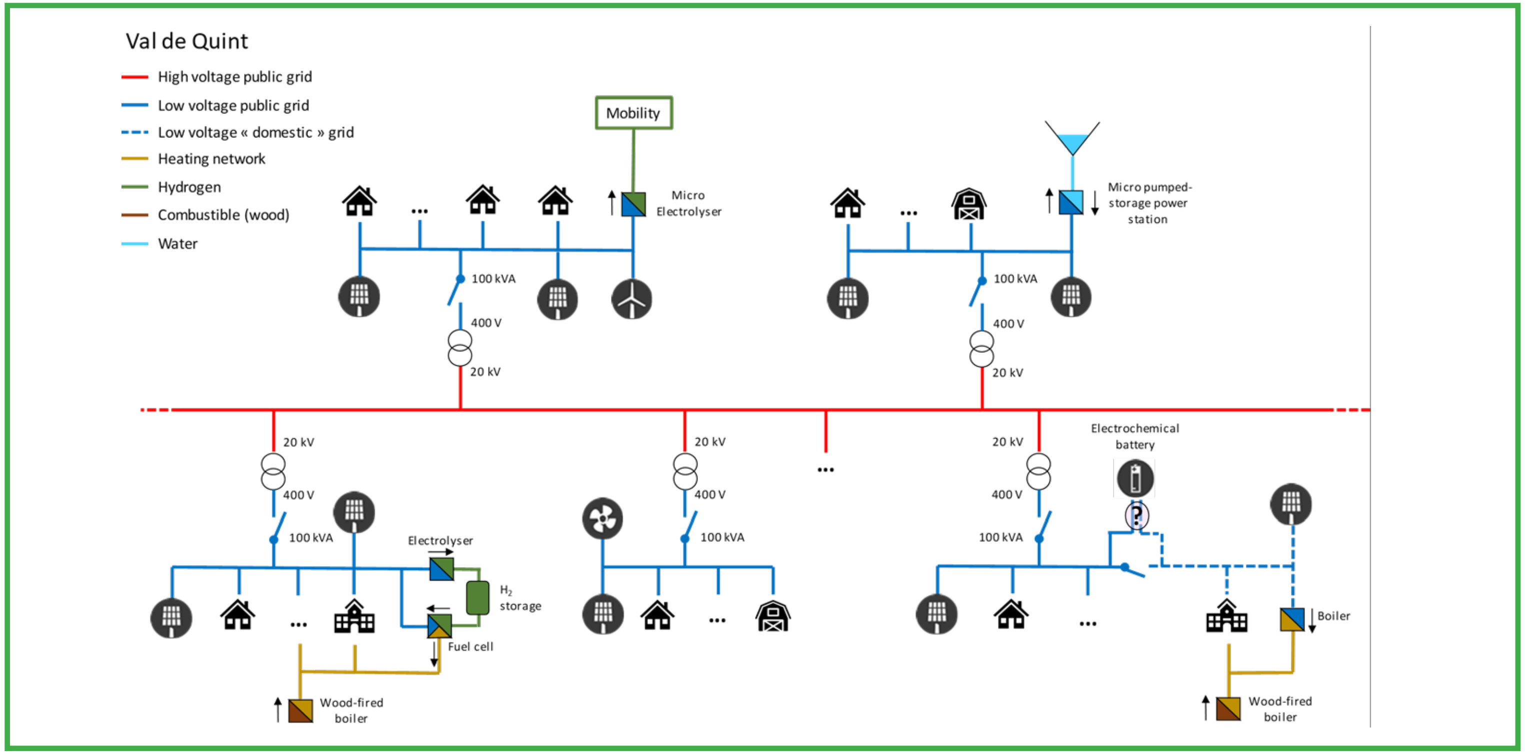

Figure 3 - Scheme of the Val de Quint Microgrid configuration

OUTCOMES

- optimization of the configuration and dimensioning of a Microgrid allowing for local shared self-consumption, thus providing benefits for local stakeholders
- evaluation of the impact of the regulatory framework in the economic value of a Microgrid
- evaluation of the additional value of the specific local Microgrid flexibilities in relation to the public grid needs

The full pilot report including results and lessons learnt can be download here.

PILOT AREA

The Drôme area is situated on the Western side of the Alps in the south-east of France in the region Rhône-Alpes. In addition to St Julien and Val de Quint, further 6 pilot sites have been chosen in this area and 9 associated municipalities are interested in Microgrids and want to profit from the pilot site experiences and set up their own project.

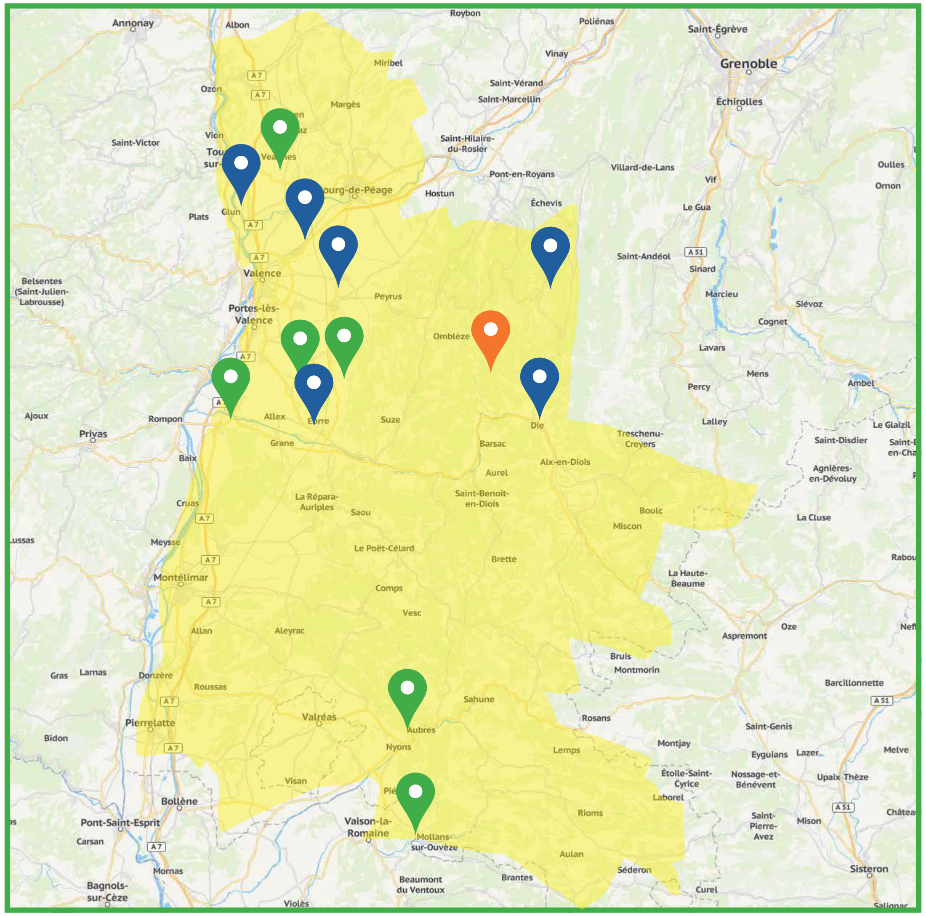

Figure 4 – Pilot sites in Drôme

Saint-Julien-enQuint (CNR)

6 pilot sites where a collective self- consumption project will be designed in ALPGRIDS

Associeted municipalities interested by the issue and might benefit from the results to develop their results to develop their own project

STRATEGIC OBJECTIVES

The aim of the 6 pilot projects within ALPGRIDS is to design local collective self-consumption schemes where

- Either a local Energy Community directly sells electricity produced by its photovoltaic (PV) plants to the respective municipality for use in public buildings.
- Or a municipality directly use the PV production of its PV plant to lower the bill from the consumption of its own buildings

PLANS

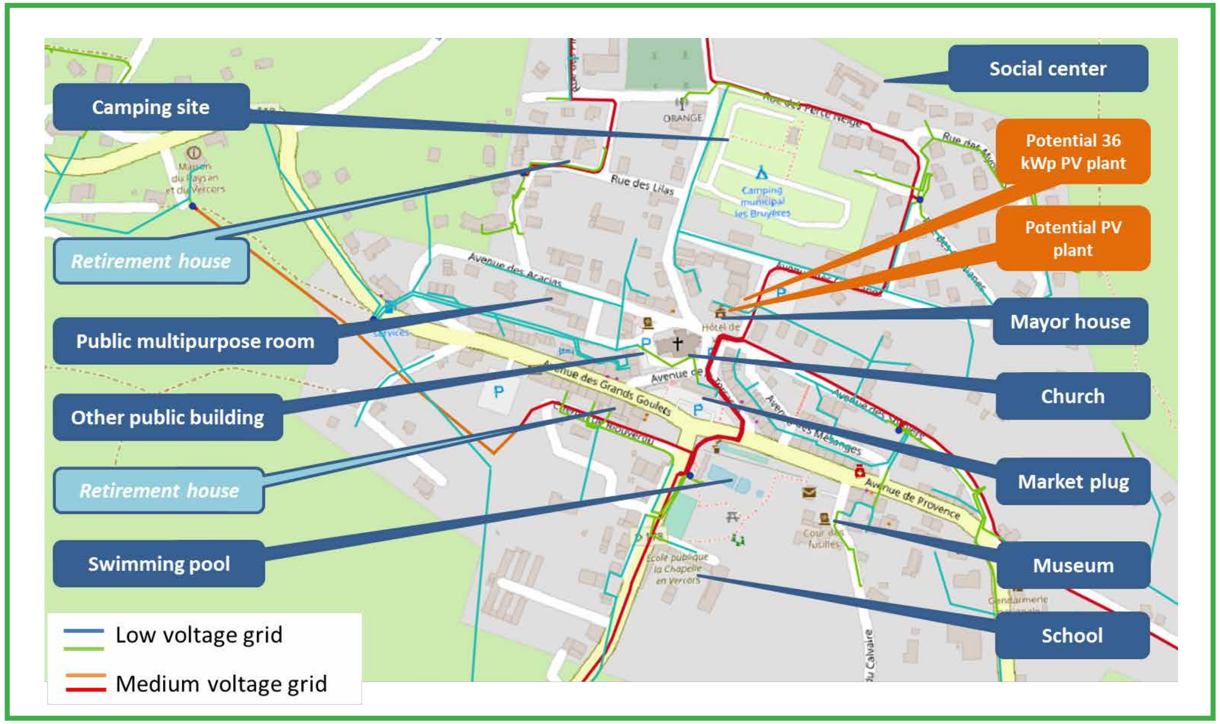

Figure 5 - Plan shows the locations of the potential PV plants and the public buildings which can be supplied by PV electricity of one of the pilot sites, La Chapelle-en-Vercors.

OUTCOMES

The most expected outcomes from the 6 pilot sites are to

- set up an easily reproducible model for municipalities and energy communities
- develop an attractive business model where the electricity bill can be better controlled by the consumers
- develop more RES projects relying on collective self-consumption scheme
- draw the attention of public bodies on this model and foster them to support more projects

The full pilot report including results and lessons learnt can be download here.

PILOT AREA

The pilot site is situated in the area of the Savona Campus of the University of Genoa. The campus is powered by a Multi-Vector Microgrid (MVM) for electricity, heat and cold developed by the University of Genoa and Siemens and in operation since 2014. Within ALPGRIDS project, a study has been developed to further improve the MVM and to extend the microgrid concept to a new district planned in the neighbouring Legino area.

STRATEGIC OBJECTIVES

The main objectives of the project are:

- testing the application of a sustainable power system such as the existing MVM 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 turbines.

The pilot project study will focus on meeting the high supply reliability requirements of research labs and the demand profiles of buildings, characterized by high heating and cooling energy needs, with the aim of reducing primary energy use and pollutant emissions.

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

PLANS

Figure 6 shows an aerial photo of site while the preliminary lay-out for the new district is shown in Figure 7. The new PV installations are planned on different buildings in the areas delimited by the yellow lines.

The availability of relevant spaces on the roofs would allow the implementation of about 2 MWp of photovoltaic power plants. The associated energy production could be used to cover both electricity consumption and thermal consumption using heat pumps. The significant increase in the coverage of global consumption from local renewable sources results in good performances from the global energy indicators point of view.

The increase of the committed power due to the shift of all the consumptions to the "electrical side" results in an increase of the committed power for several buildings: in many cases the users will need a Medium Voltage connection instead of a Low Voltage connection, thus reducing the benefits from the Energy Community incentives set by the present legislative framework in Italy.

The next steps of the research activity will be focused on modeling the two main microgrids planned in the new district from the economic point of view to evaluate their behavior within the framework of Energy Communities.

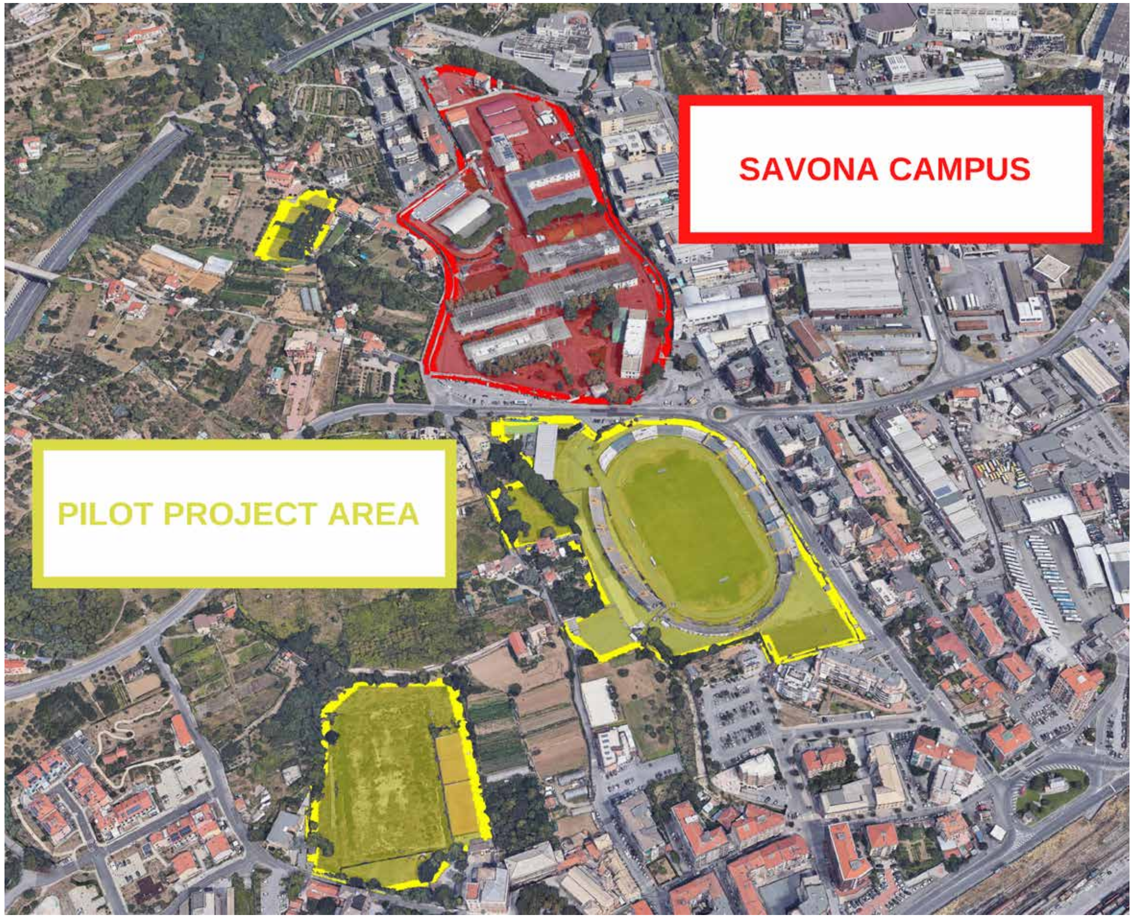

Figure 6 - Available areas and Savona Campus

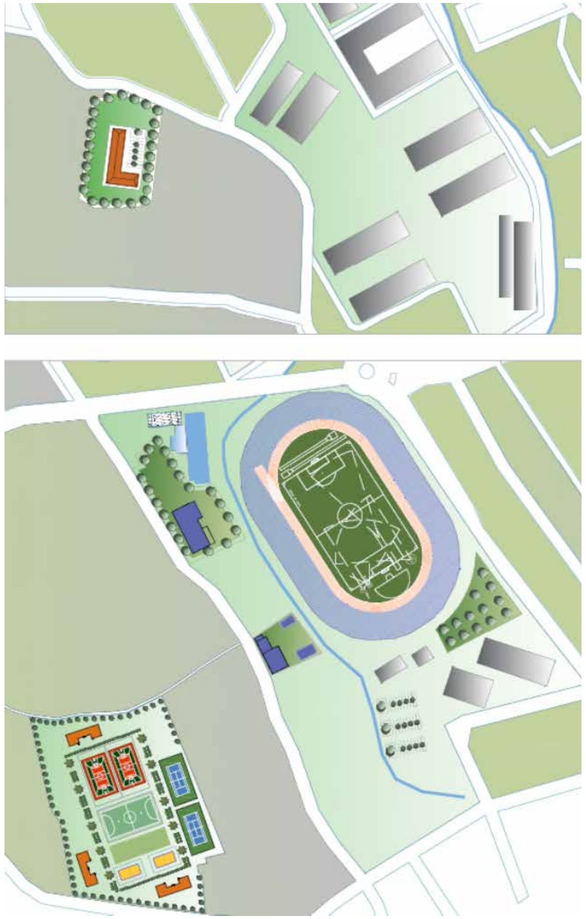

Figure 7 - New Pilot District Lay-out (Savona)

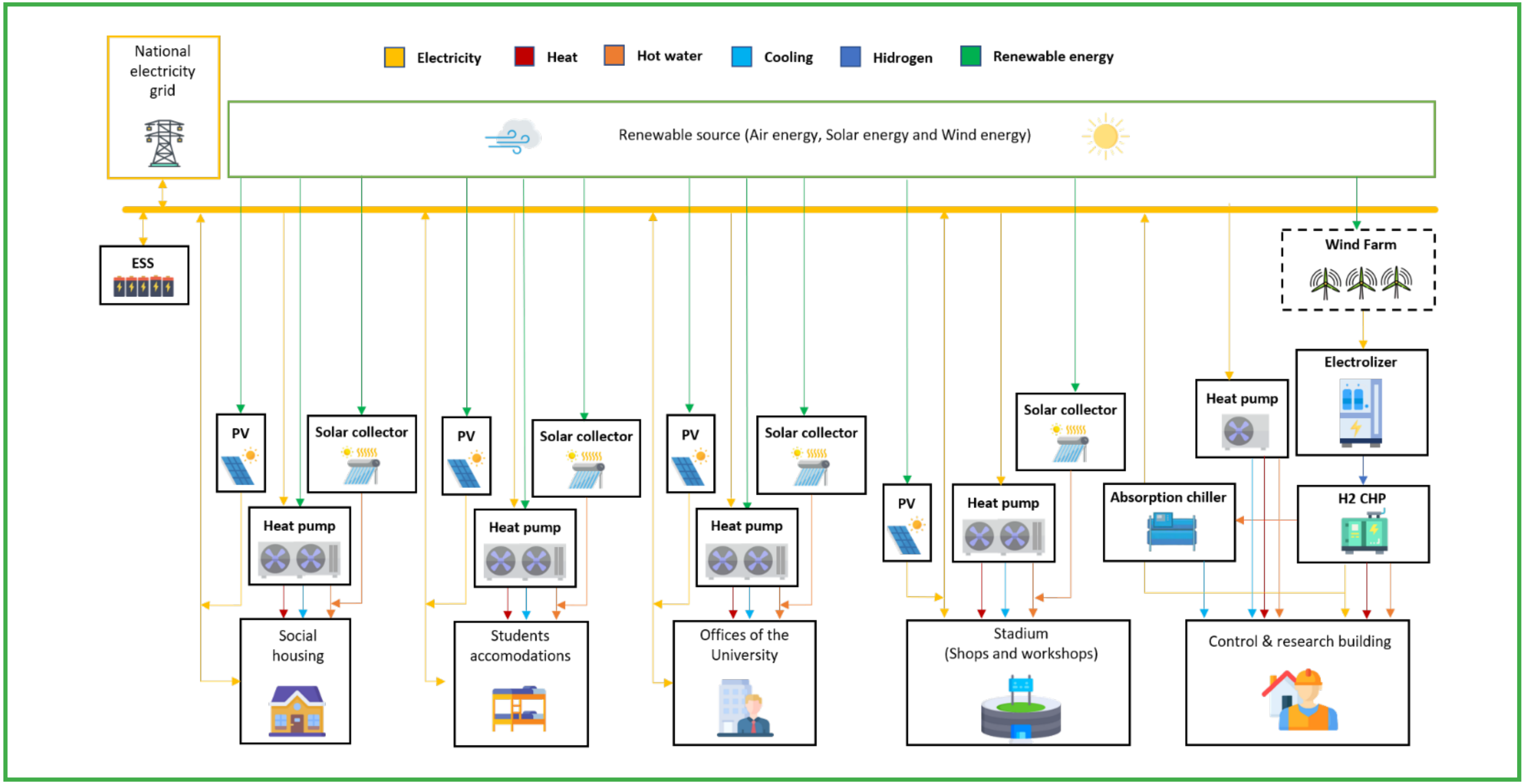

Figure 8 - Energy flow scheme (Savona)

OUTCOMES

Focusing on the inhomogeneity and the diversity of the new plants with respect to those already installed at the Savona Campus will offer interesting opportunities for comparing the behaviour of different plants installed on different buildings with the same final use and located in the same geographical and climatic area.

The use of heat pumps as the main system to meet the thermal needs of buildings allows to minimize the use of fossil sources and to effectively exploit the large amount of electrical energy production from solar source.

By focusing on maximizing self-consumption, it is necessary to carry out a careful evaluation of the sizing of storage systems coupled with photovoltaic power plants, given that the load of heat pumps is partly shifted with respect to the renewable production (management of the winter season).

The University's new microgrid will be an interesting challenge for the integrated evaluation of innovative technologies serving a carbon-neutral mini-district. It will be interesting to evaluate the improvement in technical and economic performance due to the presence of controllable generation systems (H_2 CHP) compared to the non-controllable one (PV, Wind Turbines).

From the comparison of the main KPIs with respect to the Savona Campus, it results a significant increase in self-production from renewable sources on both the electrical and thermal sides. Preliminary analyses show that the annual production of electricity exceeds that consumed; it follows that, by appropriately sizing the storage systems, the new district could be also qualified as a "Positive Energy District".

From the point of view of the energy community, the increase of the committed power causes the shift of some users from low voltage to medium voltage networks, creating a disadvantageous situation for them if compared to users connected to the low voltage network. It is expected that the legislative framework will be modified, and the existing threshold moved up to allow a full exploitation of the opportunities offered by Energy Communities.

The full pilot report including results and lessons learnt can be download here.

THANNHAUSEN (AT)

PILOT AREA

Thannhausen is a rural region in Styria / Austria and is home to 2.429 people. The Microgrid, which is currently (02/2021) being built, will be located in proximity of the municipal office where a PV generator will be installed.

STRATEGIC OBJECTIVES

The municipality operates and owns a couple of buildings at the centre of Thannhausen where a PV generation plant with 50 kWp is already installed. These buildings share a point of common coupling with the public grid. There is potential for further PV-plants on the rooftops of the adjacent buildings. 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) via a Microgrid consisting of new direct lines to allow for direct supply of neighbouring consumers with electricity. The goal is to provide local and cheap energy to the users of the direct line system and further contribute to

- reducing strain on the public grid by directly using the electricity within the Microgrid
- reducing the generation peaks caused by PV
- providing the technical set-up to allow energy supply in case of a failing of the public grid
- providing the technical set-up to include a battery storage for further increase of the own consumption and possibly islanding operation during a blackout

PLANS

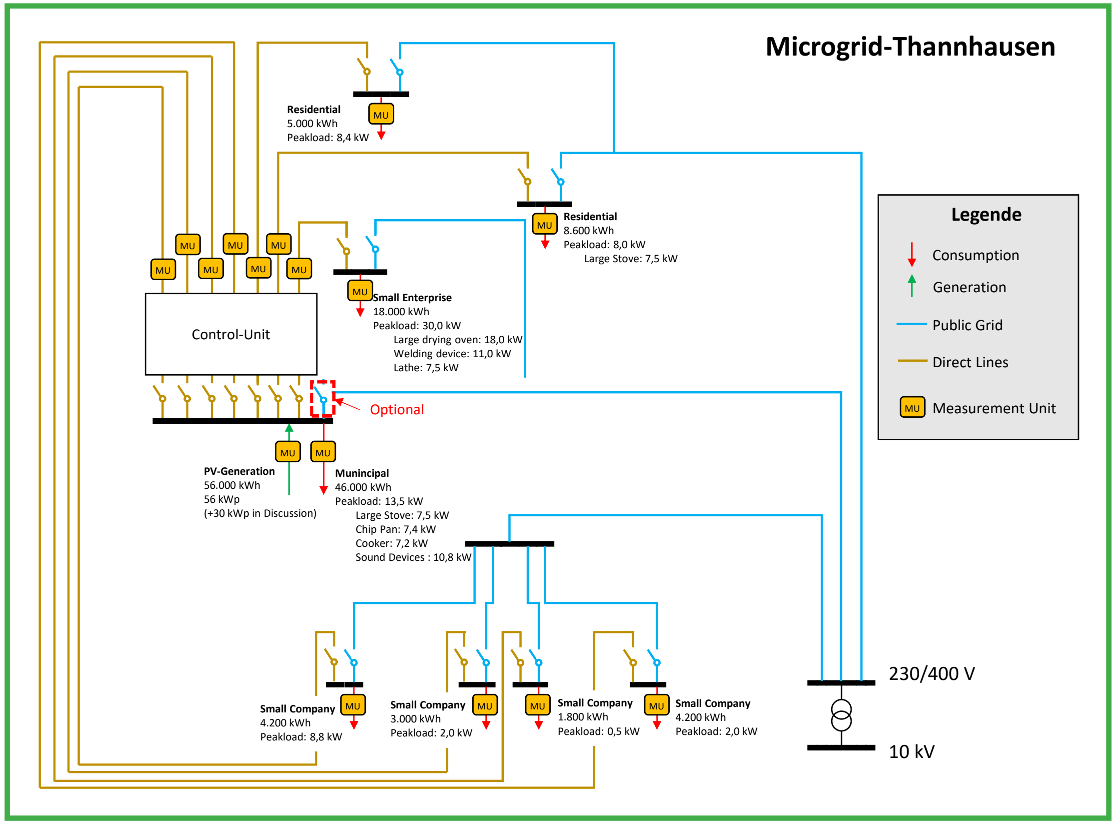

Figure 9 - Technical set-up of the pilot (Thannhausen)

OUTCOMES

- Provision of cheap and renewable electricity from local PV plants located on building owned by the Municipality to nearby consumers.
- If a battery storage system is installed, there will be an increase of security of supply for the users connected to the direct line system.

The full pilot report including results and lessons learnt can be download here.

PILOT AREA

The W.E.I.Z Campus is an area in the City of Weiz in Styria / Austria with office buildings accommodating research institutes and start-up companies.

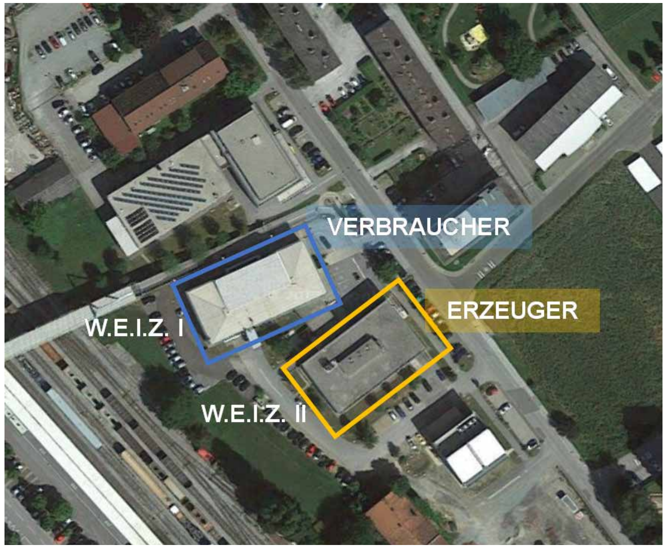

Figure 10 - WEIZ I producer and WEIZ II prosumer (W.E.I.Z. Campus)

STRATEGIC OBJECTIVES

Within ALPGRIDS, the focus 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

PLANS

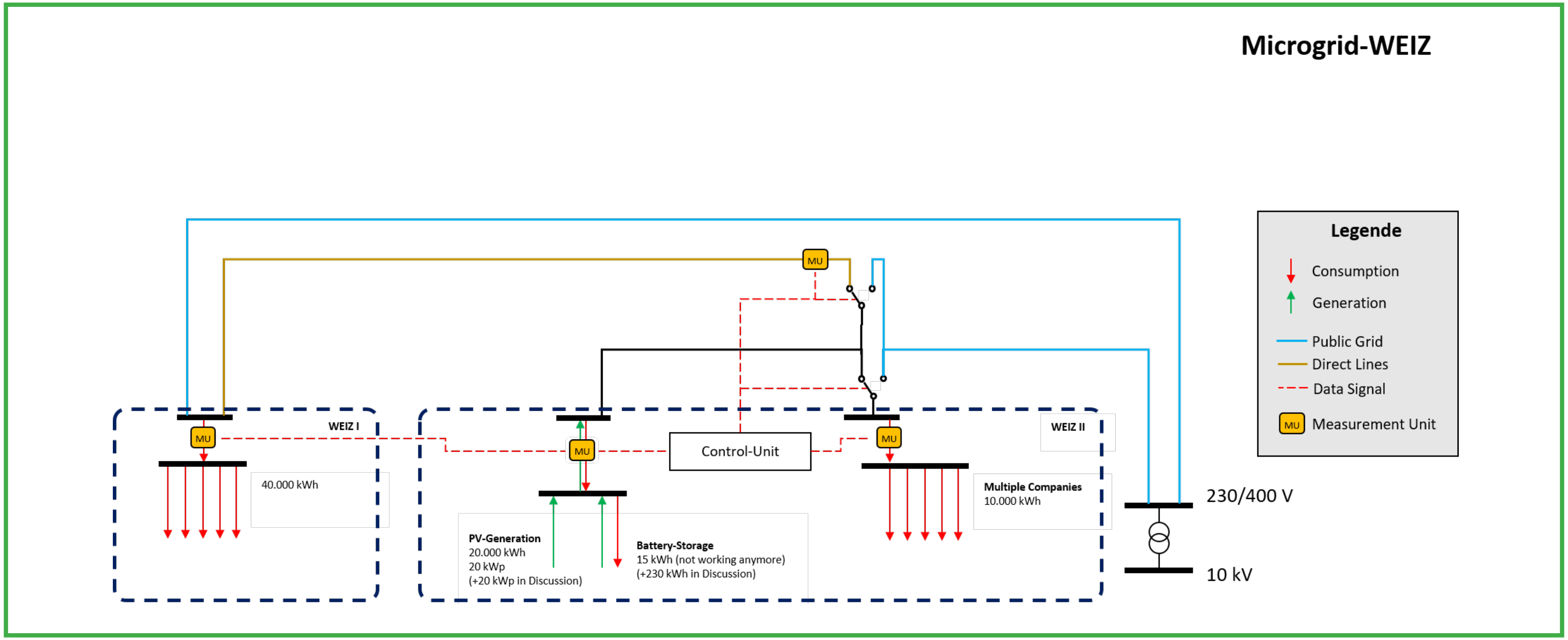

Figure 11 - Technical schemec for the microgrid WEIZ (W.E.I.Z. Campus)

OUTCOMES

- Increasing the direct use of own PV production by installation of a battery storage system.

The full pilot report including results and lessons learnt can be download here.

PILOT AREA

The Municipality of Selnica ob Dravi in Slovenia.

STRATEGIC OBJECTIVES

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

PLANS

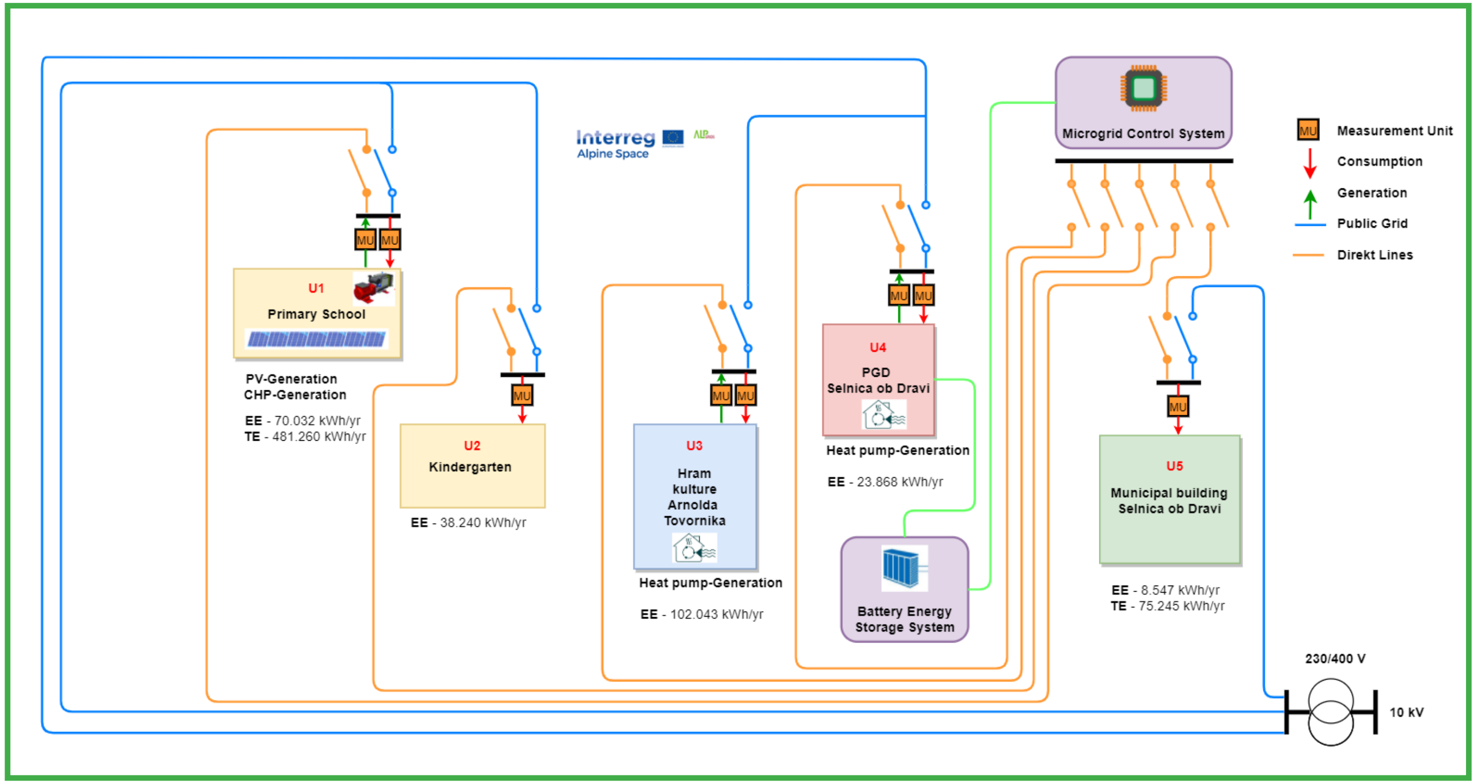

Figure 12 - Scheme of all producers and consumers in the microgrid network (Selnica)

OUTCOMES

- The primary outcome is expected to be a standard operational model where RES electricity production and user profiles will be correlated to achieve self-sufficiency and cheaper electricity supply for public users.
- Developing a model of possible off-grid operation of emergency equipment and systems at fire station during power outages.

The full pilot report including results and lessons learnt can be download here.

PILOT AREA

The pilot area is retirement home for 43 residents which will be built in the center of Grafing, a city in a semi-rural environment 30 km east of Munich, equipped with a photovoltaic power plant and electric vehicle charging in a (partial public) underground car park.

STRATEGIC OBJECTIVES

- Addressing the challenges the electric grid of Grafing is facing caused by charging of electric vehicles (EV), trying to increase self-consumption of renewable energy and enabling local energy sharing.

PLANS

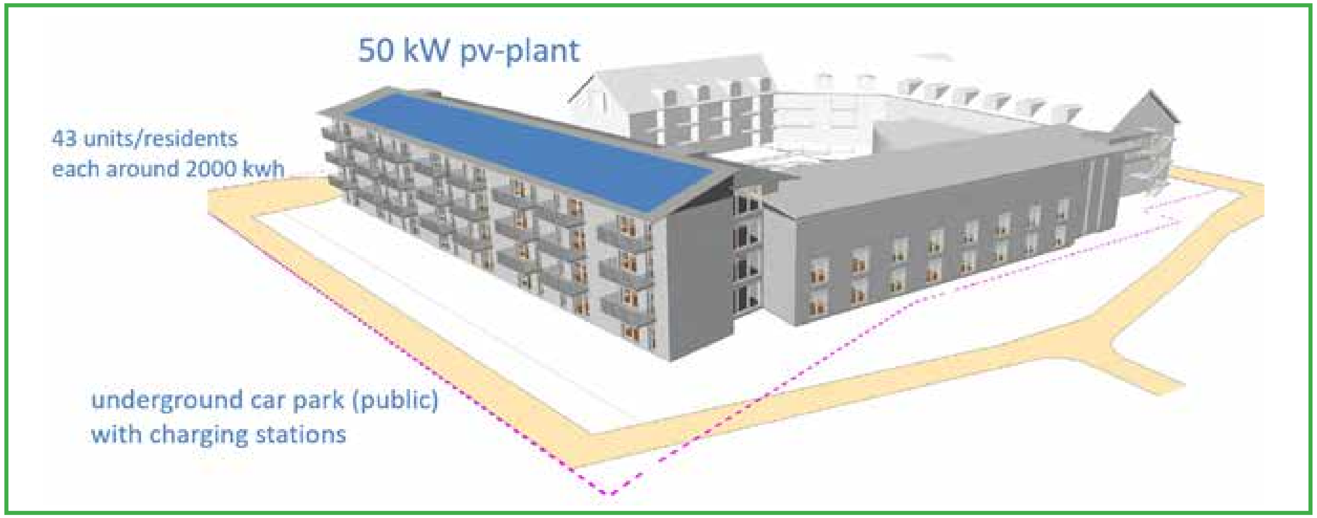

Figure 13 - New retirement home with PV plant and EV charging station in Grafing

OUTCOMES

- Avoided grid reinforcement even if the number of electric vehicles increases considerably.
- Increased self-sufficiency and use of local renewable energy resources.

The full pilot report including results and lessons learnt can be download here.

PILOT AREA

The pilot area is a grouping of public buildings and social housing in the City of Udine / Italy.

1 Primary School
2 Kindergarten
3 Museum of Natural History
4 Four social housing blocks

Figure 14 - Aerial photo of buildings involved in the pilot (Udine)

STRATEGIC OBJECTIVES

The pilot project aimed at implementing the two possible schemes of collective self-consumption defined by Italian law since 2020:

- 'self-consumers of renewable energy acting collectively', represented by the end users located in the four social house buildings
- a 'renewable energy community', represented by the primary school, the kindergarten and the museum

The general objective was to verify the technical and economic feasibility of the two collective self-consumption schemes, namely people and private and public entities intending to make use of renewable energy with the related environmental and social benefits for themselves and the local area to invest with acceptable returns of the investment made.

In particular the expected achievable advantages consist in:

- saving of primary energy from fossil sources through the partial replacement of gas boilers by a combined heat and power (CHP) plant for the renewable energy community
- local generation of not less than 25% of the total electrical consumption for both self- consumption schemes, thus avoiding losses in the transmission and distribution network
- reduction of the energy bill

PLANS

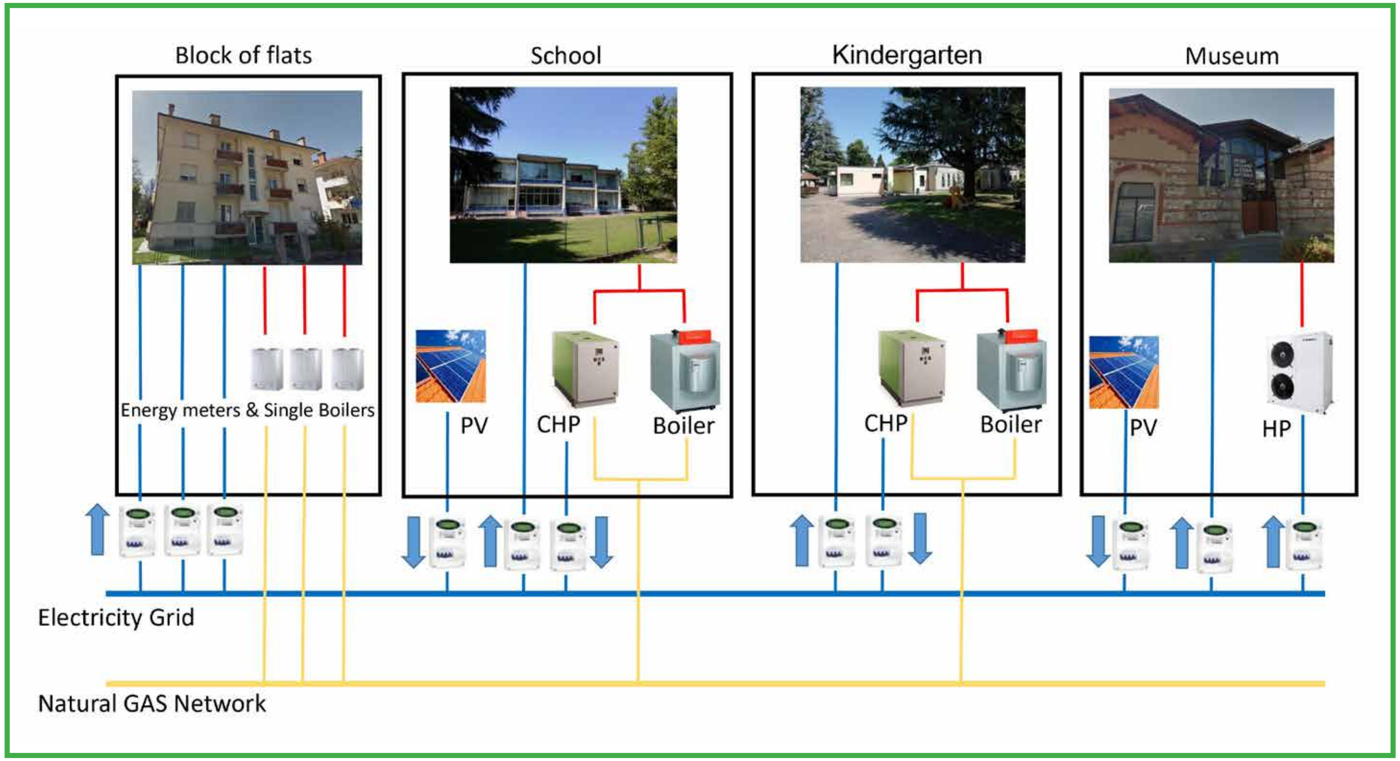

Figure 15 - Energy flow scheme of the pilot (Udine)

OUTCOMES

- optimized set up of replicable local self-consumption schemes representing the two options provided by Italian law
- financially sustainable energy benefits due to the exploitation of renewable sources
- assessment of the legal and regulatory aspects to be improved for a more effective and easier implementation of the two considered self-consumption schemes

The full pilot report including results and lessons learnt can be download here.

PILOT CLASSIFICATION ACCORDING TO ENERGY COMMUNITIES

The EU's Horizon 2020 Bridge Local Energy Communities Taskforce has defined 10 classes of Energy Communities as shown in the following table. The classes 1-5 represent different rates of renewables within the community's energy mix, the classes 6-10 specific cases of community organisation. As the classification of the ALPGRIDS pilots shows, the same Energy Community can be classified in one of the classes 1-5 and, eventually, in one or more of the classes 6-10.

Source: Peeters, L., Karg, L. et al., Bridge Taskforce Local Energy Communities Intermediate Report, September 2019

N°	Name	Description	ALPGRIDS Pilots
Class 1	Collective generation and trading of electricity	all types of territorial or commercial groupings of generators – whether active on the market or under feed-in mechanisms (often called Virtual Power Plants)	
Class 2	Generation-Consumption Communities	certified sourcing of electricity in a closed group of generators and consumers - not necessarily in proximity but including local or regional energy markets	Grafing (DE)
Class 3	Collective residential & industrial self-consumption	generation, storage and consumption in residential cases with multiple dwellings; includes Tenant-Power (Mieterstrom) - models	St Julien and Val de Quint (FR)
Class 4	Energy positive districts	districts with residential and business entities operating their energy supply systems under their own regime	Savona (IT), W.E.I.Z. Campus (AT)
Class 5	Energy islands	real islands or parts of the distribution system that can be operated stand-alone (e.g. cellular system as in SINTEG, holonic model as in PolyEnergyNet)	In future: Thannhausen (AT), Selnica (SL)
Class 6	Municipal utilities	existing organizations for energy production, supply and grid operation under citizens' control – directly (e.g. cooperative) or indirectly (e.g. controlled by local government)	Drôme (FR), Thannhausen (AT), Grafing (DE), Selnica (SL), Municipality of Udine (IT)
Class 7	Financial aggregation and investment	a "community" of investors joins to scale the amount of or manage the investment in generation systems (without further involvement in organisation etc.)	
Class 8	Cooperative Financing of Energy Efficiency	citizens jointly investing in efficiency means of SMEs and municipalities, possibly in their own region (e.g. contracting / ESCO, crowd-funding	
Class 9	Collective service providers	all types of commercial groupings of energy services (e.g. grouping of EV charging stations, aggregation of demand side management services)	Savona (IT)
Class 10	Digital supply and demand response systems	all types of digitally controlled energy systems (e.g. implemented with blockchain), these days possibly operated as a sandbox-model	

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ALPGRIDS' OUTLOOK

The project focuses on creating a **transnational enabling environment** to foster Microgrid solutions supporting in particular the creation of local Energy Communities.

In particular, ALPGRIDS focuses on

- developing a common understanding of Microgrids and their benefits
- creating an enabling policy environment for Microgrids
- replicating the Microgrid model in the AS and beyond

This document provides an overview of the efforts undertaken by the project partners with the support of external stakeholders to develop a common understanding of Microgrids. More activities were undertaken to further support the target groups:

- implementation of 7 pilot projects whose functioning is measured and/or simulated
- experience sharing workshops / reviews and recommendations for enhancing planning tools (SECAP equivalent) and financing instruments (ERDF, National and regional schemes)
- demonstration of Microgrids to policy makers through site visits, roundtables
- EU policy roundtable
- replication programme open to 13 promoting organizations outside the consortium
- summer school for newly graduated students in June 2022
- capitalization workshop

For more information: https://www.alpine-space.org/projects/alpgrids/en/home

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HINTS AND TIPS

A supportive and evolving legislative framework: Many member states have already taken regulatory action to encourage the development of Energy Communities, nevertheless the transposition of EU directives is still ongoing and may lead to further changes for instance about the governance, scope and responsibilities of the community. Obstacles such as regulations complicating, strongly restricting or forbidden energy communities to use the existing public local grid for the exchange of energy need to be modified. A thorough review is needed when planning your project. ALPGRIDS project partners located in your country can share their experience.

A game-changer for local authorities: Local and regional authorities can support "local community energy" dynamics in various ways: involving an entire district in changing its energy supply mode and consumption patterns, teaming up with individuals and cooperatives in identifying, financing or operating Energy Community projects, and engaging citizens in the local planning of energy infrastructure and policies.

No one fits all approach: Microgrids are like a set of fingerprints, with no two being exactly alike. Several key variables need to be taken into account when designing and operating a Microgrid such as: outcome(s) being envisioned (improved power reliability, reduced power cost, local energy transactions, …), different Microgrid technologies that have their own unique advantages, limitations, costs, utility tariffs, energy management of the installation.

Good governance principles: Working to meet our low-carbon energy targets often involves complex solutions (changes in land use; access to and shared use of resources; access to funding, etc.) requiring the involvement of multiple players at different levels and across sectors. In order for Energy Communities to be successful, 5 "good governance" principles are advocated:

- **Transparency:** Communicate and make information easily accessible and understandable to all stakeholders and the general public.
- **Participation:** Ensure the widespread participation of all stakeholders, every step of the way – from the design to the implementation of the project.
- **Accountability:** Clarify everyone's role and objectives.
- **Effectiveness:** Clearly identify the objectives and expected results, and evaluate the impact.
- **Coherence:** Ensure coherence between the different actions (from various stakeholders).

Applying these principles will help you to implement your community project successfully

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LINKS AND CONTACTS

Bridge: A cooperation group for all LCE Smart-Grid and Storage projects funded under Horizon 2020, established in November 2015. It is composed of four Working Groups: Business Models, Consumer Engagement, Data Management and Regulation. http://horizon2020-story.eu/bridge/

ERANET SMART ENERGY SYSTEMS: https://www.eranet-smartenergysystems.eu/

Guidelines for local and regional policy makers: How cities can back renewable Energy Communities? By Energy cities available at: https://energy-cities.eu/publication/how-cities-can-back-renewable-energy-communities/

PEGASUS MED project: https://pegasus.interreg-med.eu/news-events/news/detail/actualites/pegasus-final-report-on-cost-benefit-analysis/

Renewables Networking Platform: A multi-level governance discussion project to boost rethink analyse improve re-design re-focus renewable energy policies. https://www.renewables-networking.eu/home

SHREC/Interreg Europe: https://www.interregeurope.eu/shrec/

White Paper: Microgrid Business Models and Value Chains - Schneider 2017: https://download.schneider-electric.com/files?p_Doc_Ref=998-2095-03-10-17AR0_EN

White Paper: Energy modernization through Microgrids – Siemens 2014: https://Microgridknowledge.com/white-paper/energy-modernization-through-Microgrids/

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ANNEX

GLOSSARY OF TERMS

AS	Alpine Space
CEC	Citizen Energy Communities. Notion defined in, and used by, the Directive on common rules for the internal market for electricity (EU) 2019/944[1]) for designating Energy Communities characterised, in contrast to REC, by broad membership, no geographical limitation, a single energy vector (electricity), no limitation of technology, i.e. allowing also non-renewable energy sources to be included.
CHP	Central Heat and Power (plant)
DSO	Distribution System Operator (of the electric grid)
EU	European Union
H2020	Horizon 2020. The EU Research and Innovation funding programme for the period 2014 to 2020, https://ec.europa.eu/programmes/horizon2020/what-horizon-2020
KPI	Key Performance Indicator
MICROGRIDS	(a) Local (combinations of) grids for the exchange and distribution of one or more forms of energy, such ac or dc electricity at different voltages, heat / cold in different temperatures ranges, different gases (e.g. hydrogen, methane) / liquids (e.g. mixtures of higher hydrocarbons such as kerosine) whose chemical conversion into other substances goes along with the generation of motional force and / or heat, or base materials for chemical industry (e.g. ammoniac, hydrocarbons); (b) which group several producers, consumers and optionally storage on the same territory; (c) which might be able to be operated temporarily or constantly disconnected from the respective upstream grids; (d) which can be controlled as a single entity; (e) and which are organised by local Energy Communities complying partially or fully with the definition of CEC or REC. The notion of Microgrids will be specified more precisely for the Alpine Space within the project ALPGRIDS.
MVM	Multi-Vector Microgrid. Combination of Microgrids for different forms of energy (energy vectors) which are interconnected by one or more energy converters.
REC	Renewable Energy Communities. Notion defined in, and used by, the Directive on the promotion of the use of energy from renewable sources (Renewable Energy Directive 2018/2001/EU[2]) (RED II) for designating Energy Communities characterised, in contrast to CEC, by limited membership, geographical limitation of consumption to proximity of generation, different energy vectors (electricity, heat, cold, gas), and limitation to technologies making exclusively use of RES.
RES	Renewable energy sources
PV	Photovoltaic

[1] 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
[2] https://ec.europa.eu/energy/topics/renewable-energy/renewable-energy-directive/overview_en;
text of the directive: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2001

HIGHER EFFICIENCY OF MULTI-VECTOR MICROGRIDS

Different forms of energy do not have the same value. Energy consists of exergy and anergy and the exergy determines the part of the energy which can be converted in other forms of energy. For instance, the chemical energy of a fuel cannot be fully converted into electricity, a part of it is always converted into heat. For this reason, it is efficient to make use as much as possible of the heat which is inevitably generated when electricity is generated by fuel combustion. Another efficient option is to use the fuel straightforwardly as a chemical, e. g. hydrogen for ammonia production – and to generate electricity not from a fuel, but from PV, wind- or hydropower.

MVM allow for establishing exergy cascades making use of different forms of energy with successively lower exergy content. This is more efficient than independent supply of different forms of energy. Again, the classical example is a CHP which converts a fuel into electricity and heat in a more efficient way than two separate plants, one providing heat, the other electricity, would do. But successive use of heat at different temperature level is also an example of an exergy cascade. Integrating heat pumps in such schemes which make use of low-exergy ambient heat can allow for very complex supply schemes, e. g. joint generation of heat and cold if both are needed in the same time period.

STORAGES IN AND HIGHER SELF-SUFFICIENCY WITH MULTI-VECTOR MICROGRIDS

MVM can be combined with energy storages, thus allowing for a higher level of local energy self-sufficiency at lower cost. The classical energy storage is a heat storage integrated in a local district heating grid. If the latter is fed by a CHP plant which is electricity demand-driven, the heat storage is in some sense an indirect (mono-directional) storage for electricity, because it allows the electricity demand-driven operation of the CHP without major efficiency losses. Without the heat storage, electricity demand-driven operation would cause waste of heat in times of low heat demand and high electricity demand. As heat storages are relatively cheap compared to electricity storages such as batteries, a CHP with a sufficient heat storage driven in electricity demand mode can be more economic than a CHP without a sufficient heat storage driven in heat demand mode and a battery for matching the electricity generation to the demand.

Heat storages are not the only storages that can increase the local energy self-sufficiency and cost-effectiveness of MVM. Other examples are fuel storages, e.g. for hydrogen or methane, cold storages or intermediate products of material production such as ammonia for local mineral fertiliser production.

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