WP T4 Replication and Knowledge Transfer

Activity A.T 4.1 Recommendations for low carbon winter tourism regions

D.T4.1.3 – EUSALP Recommendations & Contribution Reports

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Contribution of Smart Altitude to EUSALP AGs

1. Executive summary

This paper aims at identifying the interest for EUSALP to fast-track the deployment of the Smart Altitude approach throughout the Alpine region and to propose levers for action.

Given its purpose and the needs to be covered for its successful deployment, Smart Altitude project fits perfectly into the strategic objectives of EUSALP and is at the crossroads of almost all the EUSALP action groups: its achievements can contribute directly to the objectives of 5 of them (AG1 R&I ecosystem, AG2 Economic development, AG 6 Resources, AG 8 Risk governance, AG9 Energy) but can also rely on levers in the fields covered by 2 others (AG 3 Labour market, education and training, AG 4 Mobility) and constitute a case study for promoting the issues promoted by another 2 (AG5 Connectivity and accessibility and AG7 Green Infrastructure).

This report is the consolidation into a single document of five papers dedicated to the Smart Altitude recommendations for SUERA action groups, in order to eliminate duplication and provide a common introduction and conclusion.

2. Introduction

Smart Altitude is an Interreg funded project demonstrating an integrated framework for a low-carbon and resilient future in Alpine winter tourism regions.

The project developed a decision support toolkit providing a step-by-step approach to energy transition of ski resorts, tested in four Living Labs across France, Italy, Slovenia and Switzerland and now used across other replicating ski resorts.

Smart Altitude will close in April 2021, leaving available:

- The online Toolkit and a platform supporting ski resorts willing to adopt its approach.
- A series of implementation models providing guidance and examples for mitigation and adaptation in ski areas.
- A replication roadmap.
- A network of low-carbon winter tourism regions committed to support the transition towards sustainable and resilient winter tourism destinations across the Alpine Space.

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As its main objective, the EU Strategy for the Alpine Region aims to ensure that this region remains one of the most attractive areas in Europe, taking better advantage of its assets and seizing its opportunities for sustainable and innovative development in a European context[1].

- ***1st Thematic Policy Area***: economic growth and innovation with the objective: of ensuring fair access to job opportunities, building on the high competitiveness of the Region.
- ***2nd Thematic Policy Area:*** mobility and connectivity with the objective of sustainable internal and external accessibility to all.
- ***3rd Thematic Policy Area***: environment and energy with the objective of a more inclusive environmental framework for all and renewable and reliable energy solutions for the future.
- ***Cross-cutting Policy Area***: governance, including institutional capacity with the objective of establishing a sound macro-regional governance model for the Region.

Regarding these four major objectives, the Smart Altitude project is a highly relevant approach as a federating, pragmatic project adapted to the specificities of the resorts, which, by starting with energy policy, can generate a virtuous dynamic that extends to other components of their management.

- ***Growth and innovation*** – by developing an ambitious transformation of the practices of resorts in terms of energy management, Smart Altitude not only generates sustainable economic activity (creation of expert jobs, housing renovation programme, deployment of the necessary technical equipment), but also stimulates the innovation ecosystem to produce energy technologies adapted to the specificities of the resorts (mainly in the following areas: reduction of energy consumption, renewable energy production and storage, system integration).
- ***Environmental framework for all and renewable and reliable energy solutions for the future*** – all resorts, whatever their size and governance, are concerned by the energy policy, for both ecological and economic reasons. To be fully effective, the Smart Altitude approach must ultimately bring together all the stakeholders involved in a resort (lift operators, public authorities, property managers, individual residents, or visitors). By focusing on energy policy management, Smart Altitude offers resorts great potential for progress by aiming to equip them with central supervision/management systems. Such systems are essential for monitoring consumption, which makes it possible to identify areas for improvement and manage energy flows in real time, and for adapting equipment and systems in a context of very high seasonality. In addition, the solutions deployed are based on transversal digital technologies that can be adapted to the different components of a global approach to infrastructure management: in addition to energy flows, the management system could eventually integrate water and waste management, and even certain aspects of mobility by relying on low-speed networks (or more powerful networks in the future) to give the resorts the means to design and pilot an integrated environmental policy in real time.

[1] https://www.alpine-region.eu/node/21

- ***Mobility and connectivity*** – by promoting this overall approach, the Smart Altitude approach is naturally intended to encourage the transformation of mobility practices (intra-station and station/valley scales) in the long term to serve a low-carbon strategy.
- ***Governance*** – including institutional capacity with the objective of establishing a sound macro-regional governance model for the Region. Given its holistic spectrum of intervention and approach, the coordinated deployment of Smart Altitude at the Alpine space's level would be a good first lever for the launch of an energy transformation policy specific to the Alpine space.

It is fully logical that Smart Altitude has been carried out in the framework of the Interreg Alpine Space programme, as it directly serves several of its objectives. Its deployment could help to articulate this programme with the general strategy implemented in the framework of EUSALP.

During the 2021-27 programming period, the priorities envisaged for ASP at this stage are[2] the following:

- ***Priority 1 – Climate resilient and green Alpine region***
    - Promoting climate change adaptation, risk prevention and disaster resilience.
    - Enhancing biodiversity, green infrastructure in the urban environment and reducing pollution.
- ***Priority 2 – Carbon neutral and resource sensitive Alpine region***
    - Promoting energy efficiency.
    - Promoting the transition to a circular economy.
- ***Priority 3 – Innovation and digitalisation oriented green Alpine region***
    - Enhancing research and innovation capacities and the uptake of advanced technologies.
    - Reaping the benefits of digitisation for citizens, companies and governments.
- **Priority 4 – *Cooperatively managed and developed Alpine region***
    - Enhance institutional capacity of public authorities and stakeholders to implement EUSALP (Interreg specific PO).

The objectives and the nature of the Smart Altitude approach position this project at the crossroads of these different priorities:

- ***Priority 1***: the motivation for the Smart Altitude approach is to enable resorts to adapt their activities to the climate change that directly threatens their equilibrium. It is therefore directly involved in promoting the necessary changes and increasing the resilience of Alpine space's actors.
- ***Priority 2***: the core of the Smart Altitude approach is to optimise the energy consumption of the resorts, thus enabling them to take their share of the effort in a more responsible management of resources in Alpine space.

[2]NB : at the time of writing , this is a provisional version of the priorities (they are not validated by the Commission yet).

- ***Priority 3***: based on the mobilisation of technologies and digital infrastructures adapted to the specific context of the resorts, Smart Altitude is an archetypal project that mobilises the resources of digital innovation for the benefit of all the stakeholders.
- ***Priority 4***: by providing a pragmatic, articulated and replicable response to a challenge that concerns all the territories of the Alpine arc (climate change), Smart Altitude constitutes a natural object of cooperation to federate around a common problem. From this point of view, the institutional anchoring of the steering of the approach and its replication within EUSALP could constitute a demonstrator of the reinforcement of institutional capacities for the implementation of an Alpine macro-regional strategy.

3. Recommendations for action groups

3.1. AG1 – S3 Alpine Strategies

3.1.1. Context

Given the present and future challenges related to the impacts of climate change that the tourism sector operating in the Alpine Region will have to deal with, a stronger collaboration and effort on R&I actions is needed. In this framework, RIS3 strategies could fast-track and aid the adoption of long-term resilience and adaptation plans specifically tailored for the winter tourism sector, through the development of new technologies able to reduce the CO_2 emissions of the tourism sector. The adoption of these technologies, as demonstrated through the Smart Altitude project's experience, need to be accompanied by the establishment of local/regional and trans-regional working tables among different stakeholders in order to promote the development of long-term strategies.

Tourism in the Alpine Region is currently challenged by different elements, of which environmental and climate change are the most pressing ones. The overall volume of tourism in the Alps cannot be accounted for due to discrepancies in the statistical data collected at the national level, however it is possible to state that the regions located in the alps are among the most intensively visited areas in the European Union[3]. At present, especially the winter tourism sector is subject to an increasing pressure to adapt to the new climatic conditions. As the Interreg ClimAlpTour Project highlighted in its last report, since the 1980s, the average winter temperature (December–February) in the Alps has increased by 1 °C and inter-year variability has also become more pronounced, with winters with minimal snow falls, such as in 2006- 2007, alternating with winters with high snowfall, such as in 2008-2009[4]. The impacts of climate change on the winter season are far from linear but important changes are already.

[3] European Environment Agency. (2016). The Alpine Region – Transport, Climate Change and Tourism. Available at: https://www.eea.europa.eu/themes/regions/the-alpine-region/transport-climate-change-tourism/transport-climate-change-tourism/topics

[4] ClimAlpTour. (2011). Climate Change and its Impact on Tourism in the Alpine Space. Final project report of the Alpine Space Interreg project ClimAlpTour.

Research and Innovation Strategies for Smart Specialisation (RIS3), implemented as part of the cohesion policy by the European Commission have been a useful tool to develop a close connection between the Academic world, Public Authorities dealing with governance issues and the Business Sector. Indeed, these strategies implement a place-based policy thinking based on a bottom-up approach and a strong involvement of key strategic actors in the implementation of specialisation strategies5. The overall aim of RIS3 strategies is to prioritise investments and public resources on strategic sectors to foster a stronger place-based development model.

3.1.2. Definition and state of the art

> "Smart Specialisation is a place-based approach characterised by the identification of strategic areas for intervention based both on the analysis of the strengths and potential of the economy and on an Entrepreneurial Discovery Process (EDP) with wide stakeholder involvement. It is outward-looking and embraces a broad view of innovation including but certainly not limited to technology-driven approaches, supported by effective monitoring mechanisms.
>
> A S3 should prioritise domains, areas and economic activities where regions or countries have a competitive advantage or have the potential to generate knowledge-driven growth and to bring about the economic transformation needed to tackle the major and most urgent challenges for the society and the natural and built environment. The number and nature of these priorities will vary from region to region." (JRC – Smart Specialisation Platform)

In the previous programming period (2014-20) only a small amount of AR regions defined tourism as their priority for S3 Strategies. Specifically, when selecting the "economic domain" on the Eye@RIS3 platform of the JRC[6] only 10 regions (namely: Autonomous Province Alto-Adige/Südtirol, Autonomous Province Trentino, Autonomous Region Val d'Aosta, Autonomous Region Friuli-Venezia-Giulia, Bavaria, Region Provence-Alpes-Côte-D'Azur, Region Rhône-Alpes, Slovenia, Tyrol, Salzburg) defined tourism as their specialisation priority (Figure 1).

[5] Biagi, B., Brandano, M. G., & Ortega-Argiles, R. (2020). Smart specialisation and tourism: understanding the priority choices in EU regions. Socio-Economic Planning Sciences, 100883.

[6] Available at: https://s3platform.jrc.ec.europa.eu/

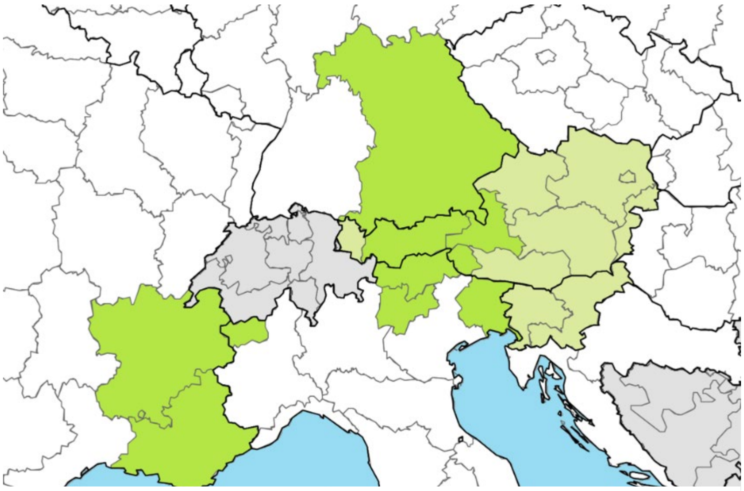

Figure 1 – Regions which defined tourism as one of the S3 priorities in the 2014-20 programming period

The situation is not different when selecting the policy objectives of the S3 regional strategies in the Alpine Region: only 3 regions (namely: Slovenia, Autonomous Province Alto-Adige/Südtirol and Region Rhône-Alpes) have defined "nature and biodiversity – ecotourism" as one of their priorities.

This could be the result of the multisectoral character of the sector (i.e. tourism is usually not defined as a sector for statistical purposes), which hinders the ability to assess its relatedness level and its overall impact at NUTS3 territorial scale, as well as the lack of coherent analytical data regarding tourism in the Alpine Region which constitutes an important obstacle for the assessment of governance models. This given, Smart Specialisation Strategies could potentially aid transforming and shaping towards a more sustainable use of natural resources within the tourism sector in the AR by fast-tracking of innovative solutions able to decarbonise specific sectors and touristic destinations.

3.1.3. Potential and challenges

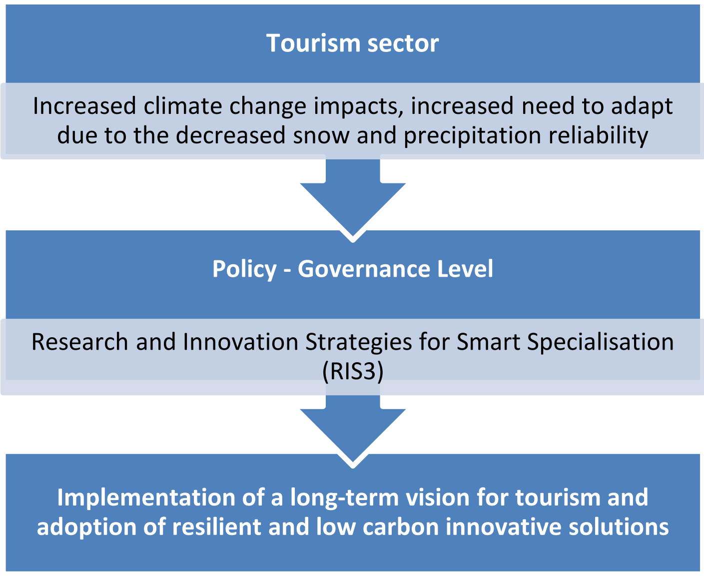

Figure 2 – Potential contribution of the governance level for the implementation of long-term adaptation plans in the AR.

Given the current increasing challenges faced by the winter tourism sector and the need to adapt to the new conditions as well as to implement long-term development plans, a large number of AR regions might be interested in investing on R&I actions related to the touristic sector (Figure 2). This investment and prioritisation will most likely have to be accompanied by specific policies able to: (i) manage the influx of tourists by increasing the readiness levels of both the current touristic locations as well as the potential ones; (ii) fast-track the adoption of low carbon innovative solutions by ski resort as well as by touristic location; (iii) fast-track the adoption of a long-term resilience and adaptation plans by municipalities, provinces and regions. Specific Objectives served by Smart Altitude

- Working on pilot projects with industry participation in smart specialisation areas to demonstrate the possibilities of scaling up innovations for the co-creation of joint value chains.
- Strengthening the capacity of research institutions, networks and infrastructures to act in an Alpine dimension.
- Taking into consideration the existing international research / innovation coordination activities of EUSALP.

3.1.4. Recommendations

Given the urgency to plan and define new strategies for winter tourism in the Alpine Region, the following recommendations underline the potential and role of cross-regional R&I actions. Specifically, the Smart Altitude project recommends to:

- Enhance multi-level cooperation on tourism with the EUSALP AG1, AG2 and AG9.
- Promote the interaction across the different stakeholders of tourism sector in the Alpine region through the establishment of a local/regional working table.
- Promote the identification of the tourism sector as a Smart Specialisation priority for the next programming period: in particular, Smartgrids are well identified in the new programming period by supporting the role of transnational R&I networks to strengthen smart energy. That is the reason why Smart Altitude aims at developing a specific chapter on S3 in Alpine regions to promote operational excellence in winter tourism destinations through concrete examples of best practices. The European context of a new programming period 2021-2027 of the FESI and also the European Green Deal, is clearly in favour of the development of an important chapter of S3 on Energy transition.
- Fast-track R&I transregional actions specific for the winter tourism sector mainly in 3 areas:
    - Reduction of energy consumption for equipment, installations, and building: technological breakthrough in energy consumption (e.g., LIDAR/snow grooming, H2 groomers …)
    - Renewable energy: production (advance in photovoltaic technologies like bifacial, thin materials and micro-hydroelectricity) and storage (advance in H2 technologies and Li-ion batteries).
    - System integration: advance in smart grid technologies taking into account high seasonality energy consumption and production, adaptation of smart city digital solutions to mountain territories (digital networks, IOT, digital integration and services).
- Develop a coherent long-term vision able to increase the resilience of alpine region communities to climate change.

3.2. AG 2 Economic development

3.2.1. Specific Objectives served by Smart Altitude

- to move higher up value chains or adjusting products and services to the green economy.
- to bridge different policies and efforts in order to stimulate the transformation of the industrial structure and drive job creation and growth.

- to support innovation by making better use of cluster initiatives.

3.2.2. Recommendations

The experience of the Smart Altitude project and of some national initiatives in terms of specific support for the transformation of mountain resorts proves that public investments in this area have significant economic potential:

- They allow the modernization of the business model of the economic actors involved in the operation of ski lifts by encouraging them to incorporate the challenges of energy transition into their operations and to enter into a logic of continuous improvement in this area;
- They create value for the local economic players working on the necessary transformations (energy renovation, modernization of communication infrastructures);
- They enable the creation of jobs dedicated to support the energy transition (see part on AG3).

As an example, within the framework of the "Stations de demain” (resorts for tomorrow) contract, the Provence-Alpes-Côte d'Azur Region set up a regional intervention mechanism with a budget of 50 million euros over the period 2016-2020 intended to relaunch the investment dynamics to encourage the emergence of intelligent, sustainable and connected resorts. The aim was to strengthen economic viability, tourism development and to commit the resorts to a perspective of digital, energy and ecological excellence. 19 "Stations de demain" contracts were signed, enabling 42 mountain resorts to benefit from financial support from the Provence-Alpes Côte d'Azur Region. According to the analyses carried out on this system, it was calculated that 1 euro of regional subsidy had generated 4 euros of investments in the resorts.

In order to ensure the optimal allocation of funds to launch similar dynamics at the scale of the Alpine space, the Smart Altitude project recommends **to set up a coordination mechanism at the EUSALP level** to ensure the optimal allocation on the programming period 2021-27 of the funds necessary to cover the corresponding needs of the resorts (which could come *a priori* from at least 3 different supports: the Interreg Alpine Space Program, LIFE programme-Clean Energy Transition sub-programme and Horizon Europe)[7].

3.3. AG 3 Labour market, education, and training

3.3.1. Specific Objective served by Smart Altitude

The dual vocational training systems of the Alpine states are very different concerning the actors, the contents and the structures involved. On this purpose, with a view to improve cross boarder cooperation and allow the exchange of best practices, the long-term aim is to establish a common macroregional educational space in which vocational professions and the related certificates are reciprocally acknowledged.

[7] LINK TO paper on regional recommendations

3.3.2. Recommendations

The success of the energy transition in the Alpine arc will depend on the development of a pool of skills to support the different levels of public actors in this specific field (regions and resorts). The aim is to equip the current and future actors with the necessary skills to systematically include low-carbon issues in both the political decision-making process and the operational management of the resorts. This would involve encouraging the creation of expert positions dedicated to supporting the transformation and the concomitant implementation of dedicated training courses at the Alpine space level to create a training programme for these experts. Therefore, Smart Altitude recommends to:

- Promote the creation of jobs necessary for the implementation of an energy transition in the Alpine space: mountain resorts usually lack of financial and human means to shape low-carbon energy strategies and to ensure their implementation. It is all the more difficult that this implementation implies to tackle several challenges: organizational transformation, fine planning of the changes to be made according to the new technological choices, their deployment duration and the need to deploy them in an agenda constrained by the activity cycles (off-season deployment, political cycles). Thus, their needs for experts are critical both for designing and implementing their low-carbon strategy. Whether it is consultants in private firms, jobs as energy managers within municipalities and ski-lift companies or energy renovation officers, the deployment of a low-carbon strategy in the Alpine space is potentially a major job creator.
- Create dedicated training courses to build these capacities: this could be done through the cooperation of the universities of the Alpine space in order to promote the sharing of skills, the networking and the visibility of the issues related to the implementation of low carbon strategies in mountain resorts. It would also allow to create European career paths for specialists in these matters and thus, to increase the attractiveness of their professions. This would involve encouraging universities to put in place training curricula dedicated to energy policy management in mountain resorts (which may include training on energy itself but also mobility and energy renovation and the presentation of Smart Altitude toolbox) for the experts but also for public decision makers as well as managers of ski resorts' operations.

3.4. AG 4 Mobility

3.4.1. Specific Objectives served by Smart Altitude

- To promote inter-modality and interoperability in passenger and freight transport by supporting and fostering the removal of infrastructure bottlenecks, by bridging missing links, coordinating planning and timetables of public transport, modernizing infrastructure and enhancing cooperation. AG4 is addressing this objective by focusing on infrastructure for sustainable transport in passenger- and combined transport as well as interconnecting public transport systems, focusing on operations and information and ticketing services.
- To support the modal shift from road to rail. The Alpine regions are particularly sensitive to negative environmental and social impacts caused by the excessive traffic flow of freight and passenger transport through the Alps. To tackle this challenge, the AG4 promotes the

harmonization and implementation of modal shift policies with a focus on toll systems.
- To develop cooperation and greater integration between the existing bodies and structures in the field of transport.

3.4.2. Recommendations

Changes in the mobility behaviour of individual players will play a key role in the carbon impact of their travel to resorts. Therefore, the provision of a free tool to help them optimise this footprint would be important. Smart Altitude recommends **the development of a transnational route calculator that could give individuals the possibility to accurately assess the carbon impact of their journey, but also to have all the necessary information to organise their entire journey by public transport**. This tool could be made available on the websites of the resorts and of all individual and collective accommodation providers in order to easily obtain the information needed to organise mobility. This will allow a particular effort to be made on the last kilometre, where the means of transport are generally little referenced (very local and only in season, such as bus shuttles). The objective is to provide a maximum of integrated and easy-to-use tools to offer means of organising decarbonised travel right down to the foot of the slopes.

3.5. AG 5 Connectivity and accessibility

3.5.1. Specific Objectives served by Smart Altitude

- Propose technical solution with focus on ICT
- Encourage the exchange of experiences in the EUSALP perimeter
- Offer ICT solutions for the work of the other action groups

The deployment of the Smart Altitude approach requires the capacity to collect, process and transmit data from sensors which must be sent to automatic systems that process and transmit them to supervision platforms. Technical solutions adapted to the specific geographical constraints of mountainous areas are therefore required: either optical fiber when available or LoRa networks (networks based on chirp spread spectrum modulation, which have low power characteristics like FSK modulation but can be used for long range communications).

3.5.2. Recommendations

Based on the solutions developed within the framework of the project, Smart Altitude constitutes a successful use case for the mobilization of ICTs for the energy transition in the Alpine region.

3.6. AG 6 Resources

3.6.1. Specific Objective served by Smart Altitude

"Integrated and sustainable water management" (sub-topic 3) – River restoration and sediment management through the implementation of the "green infrastructure" concept as a win-win strategy for the achievement of the objectives of both the EU Water Framework Directive and the EU Flood Directive. In the field of water-demand and supply management options for preventing potential conflicts among sectors and actors in case of peaks of demand and/or regional droughts shall be identified.

3.6.2. Recommendations

Mountain resorts are primarily concerned by the issues surrounding water resources and the conflicts of use that result from their scarcity due to climate change. Resorts experience lack of natural snow at times, due to changing weather condition and rising temperatures while wanting to extend the skiing season. Hence, they needed to look for alternative solutions such as artificial snowmaking to guarantee a longer ski-season, which however, brings its own challenges.

The snow-making process requires high energy and water. Especially the water consumption can impact on local water management and ecosystems along water bodies, if not carefully managed to ensure an optimal and sustainable use. It also faces competing uses from local agriculture. Therefore, tackling improvement potentials in this area have to be prioritized above all else.

In the framework of the smart altitude project, many innovative solutions have been developed to meet these challenges like: deployment of Intelligent water monitoring (temperature sensors in the water reservoir that provide real-time data on the water temperature at different depths, water surface and weather conditions to support the optimization of the artificial snow production process thus saving energy and water and recovering heat), low-energy snow canons and lances (e.g. a snow lance not requiring a compressor), GPS-guided snow-management to optimize snow-thickness, which substantially reduces the need for snowmaking,…

Building on these achievements, Smart Altitude recommends to ensure in the framework of AG 6 the promotion of the snowmaking optimization solutions tested in Smart Altitude as an important tool to limit conflicts of use around the water resource in the Alpine space.

3.7. AG 7 Green infrastructure

3.7.1. Specific Objective served by Smart Altitude

To allow the benefits of ecological connectivity to emerge at ecosystem and societal dimensions, enhancing resilience to threats such as climate change.

3.7.2. Recommendations

The Alpine region is a prime example of green infrastructure: "Green infrastructure is a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services such as water purification, air quality, space for recreation and climate mitigation and adaptation. This network of green (land) and blue (water) spaces can improve environmental conditions and therefore citizens' health and quality of life. It also supports a green economy, creates job opportunities and enhances biodiversity."[8]

The creation of participative dynamics around the preservation and enhancement of this area is therefore fully in line with the European Union's Green Infrastructure objectives. Indeed, the deployment of the Smart Altitude approach will require a broad mobilisation of all stakeholders

[8] https://ec.europa.eu/environment/nature/ecosystems/index_en.htm

in support of the objective of rationalising the consumption of resources (energy, water), thus contributing to the preservation of the ecosystem.

For a low-carbon strategy to be successful, buy-in from all stakeholders and changes in individual behaviour are key success factors. It is important to raise awareness of the fact that the future of the resort, of their living environment and of their territory depends to a large extent on individual and collective commitments. The main obstacle to overcome is the reluctance of users to adapt their individual behaviour because of inconvenience caused (comfort's loss when abandoning individual vehicle, noise from alternative energy resources such as turbines, modification of landscapes, resistance to change, ...)

Smart Altitude can therefore be considered as a case study of a citizen mobilization around a low-carbon strategy specific to the Alpine territories which contributes directly to the reduction of greenhouse gases and therefore to the preservation of the environment, and the actions engaged must be further developed, promoted, and generalized.

3.8. AG 8 Risk governance

3.8.1. Specific Objectives served by Smart Altitude

- Identification of good practice solutions in tackling challenges in natural hazard and climate change adaptation policy.
- Promoting, developing and implementing local, regional and international pilot projects and programs based on strategic priorities, and exploring funding opportunities on both EU as well as national/regional/private levels.

3.8.2. Recommendations

The logic of Smart Altitude is based on the implementation of a collaborative network between the resorts of the Alpine arc to catalyse the development of their low carbon strategies. The enhancement and extension of this approach could be put at the service of EUSALP risk governance. To this end, Smart Altitude recommends to:

- Set up an observatory for the energy transition in the Alpine space, which would make it possible to monitor the progress indicators of the resorts in this field, these indicators being based on the targets set in the National Energy and Climate Plans (NECPs) for mountain resorts. These indicators could be built on the basis of the set of Key Performance Indicators (KPI) defined in the Smart Altitude framework, namely the audit tool, called “Wi-EMT ” (Winter tourism Eco-energy Management Tool) which includes KPI’s related to an ecological, energetic and management evaluation for a ski resort.
- Building on Smart Altitude Web-based GIS[9], develop an aggregated tool, accessible in a

[9] Part of the Smart Altitude project is the development of a web-based GIS application to visualize territorial assets, untapped renewable energy potential and key performance indicators for the living labs and the replication sites. A geographic Information System (GIS) is a computer system designed to capture, store, manipulate and present spatial (or geographic) data. GIS can show many different kinds of data on one map, using any information that includes a location. In this way, people can compare different elements in order to understand how they relate to

single place for all the actors of the resorts to give access to the required information to assess their situation: one of the most important obstacles to progress in launching low-carbon strategies in the resorts is the lack of reliable information, both for the decision making of policy makers and for the information of stakeholders and therefore the determination of their individual behaviour. A structuring initiative at EU level to create the necessary tool would therefore have a major transformational impact.

- This tool, which would consist of an aggregation and interfacing of existing sources, could have several components:
  - A geographic information system that would make it possible to know, for a given territory, the main characteristics necessary to assess its situation in terms of energy transition (energy consumption, water consumption, number of inhabitants, structure of the building stock, etc.)
  - Scenario-building tools to simulate the impact of a given potential measure (simulation of the impact in terms of energy, economic impact, job creation, fiscal potential, etc.
  - A mapping tool of the different ongoing or completed projects on low carbon policies in resorts (based on WIKIAlps).

3.9. AG 9 Energy

3.9.1. Energy efficiency

Context

Given the present and future challenges related to the impacts of climate change that the tourism sector operating in the Alpine Region will have to deal with, a stronger collaboration and effort on R&I actions is needed. Setting up an Alpine energy efficiency cluster and greening the Alpine infrastructures are two key specific objectives of EUSALP Action Group 9 (AG-9) directly related to implementing energy efficiency measures in the Alpine area. By its actions implemented in its four technical workpackages, the Smart Altitude Alpine Space project generated a detailed process to deploy energy efficiency measures within a network of 26 mountain resorts engaged in a common action toward sustainable mountain tourism and economic development.

By its actions and replication program, Smart Altitude has paved the way for future developments that could usefully serve the strategy developed in the framework of EUSALP, in particular AG-9's contribution to the implementation of the EU Energy Efficiency Directive in the Alpine area.

The mission of EUSALP AG-9 is, by focusing on the promotion of energy efficiency and the production and use of local renewable energy in the Alpine Region, especially in the public and private sectors, to support a significant reduction of energy consumption in the housing and mobility sector, as well as in small and medium enterprises, promoting energy management and monitoring systems at different levels. AG-9 lists five specific objectives: 1) Setting up an Alpine

one another. The GIS application is one of the project tools that will support the prioritization of low-carbon operations.

energy efficiency cluster; 2) Greening the Alpine infrastructure; 3) Setting up an Alpine renewable energy cluster; 4) Support energy management systems in the Alpine Region; 5) Support a better use of local resources and increase energy self-sufficiency while reducing impacts on climate and the environment.[10]

Smart altitude, for its side, aims at enabling and accelerating the implementation of low-carbon policies in winter tourism regions. It will demonstrate the efficiency of a decision support tool integrating all challenges into a step-by-step approach to energy transition and deploying a comprehensive approach of low-carbon policy implementation based on impact maximization accounting for technical, economic and governance factors. It is based on common performance indicators, monitoring systems (snow processes, municipal infrastructure, renewables, buildings etc.) and Energy Management Systems (EMS) in mountain territories, to build a shared situational awareness and take impactful decisions. The approach is implemented in four real-field demonstrations and prepares for replication in 20 other Alpine Space territories.

The project targets policymakers, infrastructure operators, investors, tourism, and entrepreneurship organisations. Its outputs are as follows: 1) Territorial diagnosis method; 2) Online Smart Altitude Toolkit; 3) Living Labs; 4) Planning model for adaptation strategy implementation; 5) Replication roadmap and network of low-carbon winter tourism regions. The partnership and activities ensure the approach suitability across the Alpine Space, promote new innovations and skills, and enable policymakers to plan and prioritize measures increasing the resilience of mountain areas.

Definition and state of the art

Energy efficiency means using less energy to provide the same level of energy services.[11] In 2018, as part of the 'Clean energy for all Europeans package', the new amending Directive on Energy Efficiency (2018/2002) was agreed to update the policy framework to 2030 and beyond, with an energy efficiency target for 2030 of at least 32.5% relative to the 2007 modelling projections for 2030, to be achieved collectively across the EU.[12]

In its specific objectives, AG-9 mentions as main targets three priority sectors: building/housing, energy management systems, and mobility. Among these, mobility is out of the scope of Smart Altitude and EMS is the subject of a specific report.[13] In terms of geographical outreach, Smart Altitude focuses on a specific target, namely mountain resorts and the local communities that support them, thus contributing to the wider reach of AG-9.

[10] https://www.alpine-region.eu/action-group-9

[11] EIA–https://www.eia.gov/energyexplained/use-of-energy/efficiency-and-conservation-in-depth.php.

[12] https://ec.europa.eu/energy/topics/energy-efficiency/targets-directive-and-rules/energy-efficiency-directive_en.

[13] Smart Altitude deliverable D4.1.3.4. See : https://www.alpine-space.eu/projects/smart-altitude/en/project-results/replication-and-knowledge-transfer/a.t4.1-recommendations.

As mentioned in Smart Altitude D.T3.1.1.[14] "Decision-making tree" deliverable, The strategies that could be set in place to improve the energy usage in a ski resort are: (i) Calculate the specific electricity consumption – Audit Process, (ii) Monitor the consumption data – through the implementation of an Energy Management System (EMS), (iii) Implement energy savings measures, (iv) Implement renewable energy sources (RES) (Motiva, 2008). The following table lists the types of measures (highlighted in **bold**) that could be taken to improve **energy efficiency** (EMS implementation excluded) in mountain resorts:

Climate Mitigation Measures		Energy efficiency – EMS excluded
Ski resort	Monitor and implement an EMS	
	Implement renewable energy sources	
	Assess ski lifts energy efficiency and implement speed control measures	
Snowmaking equipment	Replace snow-making cannons with modern technology and automation	√
	Implement an automated snow-making system	
	Plan which kind of snow-cannon is the most effective for the ski resort (Fan gun, Hybrid/tower, Hybrid/high-pressure)	√
Grooming and slope maintenance	Implement automatic systems (pump stations, compressed air production, snow-making equipment)	
	Plan which kind of snow mobile is most suited for the ski resort (two-stroke snowmobiles, four-stroke snowmobiles)	√
	Replace old grooming machines with newer ones	√
Buildings (tourism housing, operational & public buildings)	Assess the energy consumption of the ski resorts building and **improve the heating system and ventilation**	√
	Replace indoor and outdoor lighting with energy-efficient lightbulbs and an automated lighting control	√
	Improve the **energy efficiency of building envelopes**	√
	Implement **renewable energy sources** for heating and electricity	
	Implement building **EMS**	

Table 1 – Energy efficiency measures (adapted from D.T3.1.1. Table 2)

[14] https://www.alpine-space.eu/projects/smart-altitude/en/project-results/smart-altitude-toolkit/decision-making-tree

Common to most of these measures is the deployment of an EMS, that allows both to collect precise energy consumption data and automate or perform real-time control and optimisation measures. For more information on EMS, you can refer to D.T1.2. Report "Live monitoring systems specifications"[15] and D.T3.2.1. Report "Territorial Maximization"[16], section 4-1 to 4-3 for EMS and 4.7 for smart metering, where the state of the art of EMS systems are explored in detail.

Regarding specific equipment energy optimization, we also refer the reader to the following sections of the very exhaustive D.T3.2.1. Report:

- Snow making: 4.4
- Ski lifts: 4.5
- Snow groomers: 4.6

Deployment of energy efficiency measures in Smart Altitude

Several types of buildings have been subject to the deployment of energy efficiency solutions in the framework of Smart Altitude: operational buildings, public buildings and tourism housing. Operational buildings are generally included in the resort EMS (Les Orres, Madonna di Campiglio), and solutions deployed for operational buildings are applicable to public buildings in the framework of general energy management services offered by public organizations (Les Orres) or private companies.

Tourism housing energy efficiency at Les Orres living lab

The main point of interest is tourism housing for which systems have been deployed in livings labs Krvavec (hotel) and Les Orres (UCPA – tourism hosting for the youth).

The principle of energy management for a tourism building at Les Orres is presented below:

[15] https://www.alpine-space.eu/projects/smart-altitude/en/project-results/measuring-visualizing-performance/live-monitoring-system-specifications.

[16] https://www.alpine-space.eu/projects/smart-altitude/en/project-results/smart-altitude-toolkit/territorial-maximization-report.

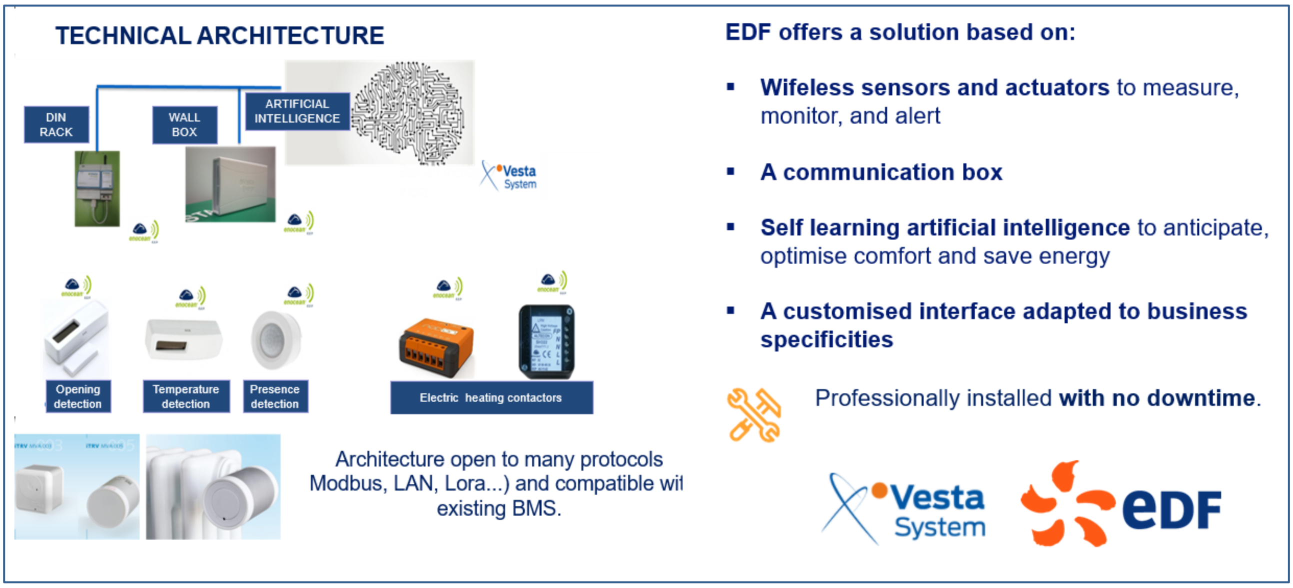

Figure 3 – Principle of a tourism housing building heating regulation in Les Orres by EDF

The expected energy consumption reduction of the building is as follows:

- Electric consumption: 20%, 120 MWh/year
- GHG emissions: 6 tCO2eq/year

Tourism housing energy efficiency at Krvavec living lab

A detailed heating cost reduction solution for a hotel has been implemented in the Kravec Living Lab. The solution and its results are summarised as follows[17]:

“A series of energy efficiency solutions were installed. In the hotel, thermostatic valves, controlled via a computer or mobile application, were installed on radiators. Through the program, each room is heated according to a pre-set temperature. If the room is not booked, the system itself switches off the room heating via the hotel program. In case of a reservation, the room starts to be heated an hour before the arrival of the guest. The SELTRON WDC20 system, which controls the temperature of the water that flows into the heating system depending on the outside temperature, has been installed in the boiler room. If the environmental temperature is low, the regulation system will deliver a higher temperature to the heating water. In the boiler room, the circulating pumps were also replaced for economy reasons. The Clausius application has been installed along with the GWD communication module. Receptionist, hotel management and maintenance staff can manage hotel heating entirely via the Clausius mobile application and/or as a web application. These changes have resulted in an approximate 20%reduction in oil/gas consumption, improved customer comfort and easier management of the heating system, leading to higher customer satisfaction and reduced staff working hours.”

[17] https://www.alpine-space.eu/projects/smart-altitude/en/project-results/smart-altitude-living-labs/krvavec/heating-costs-reduction.

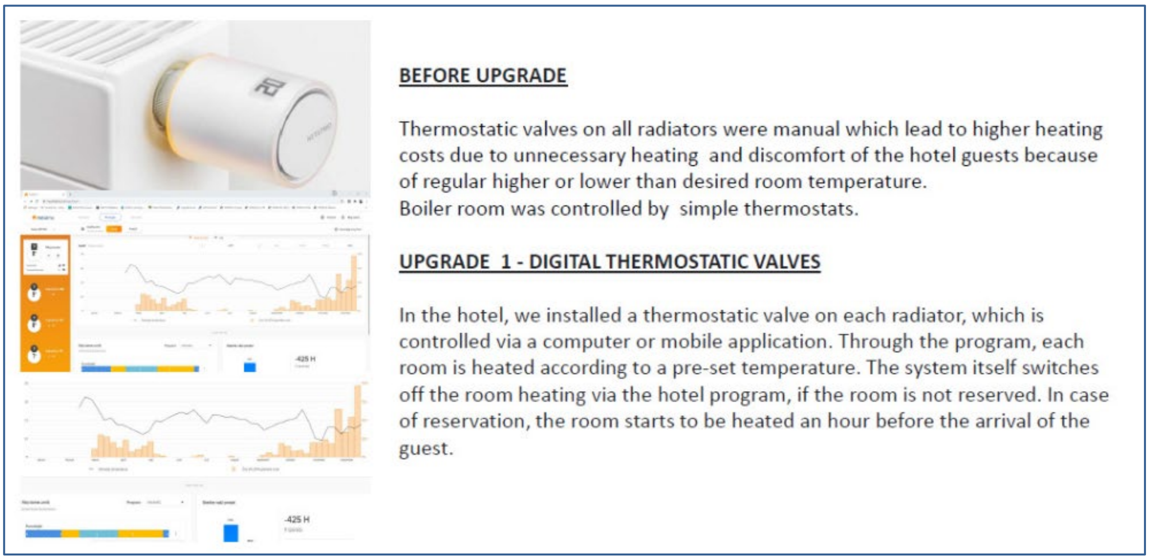

Figure 4A – Upgrade 1

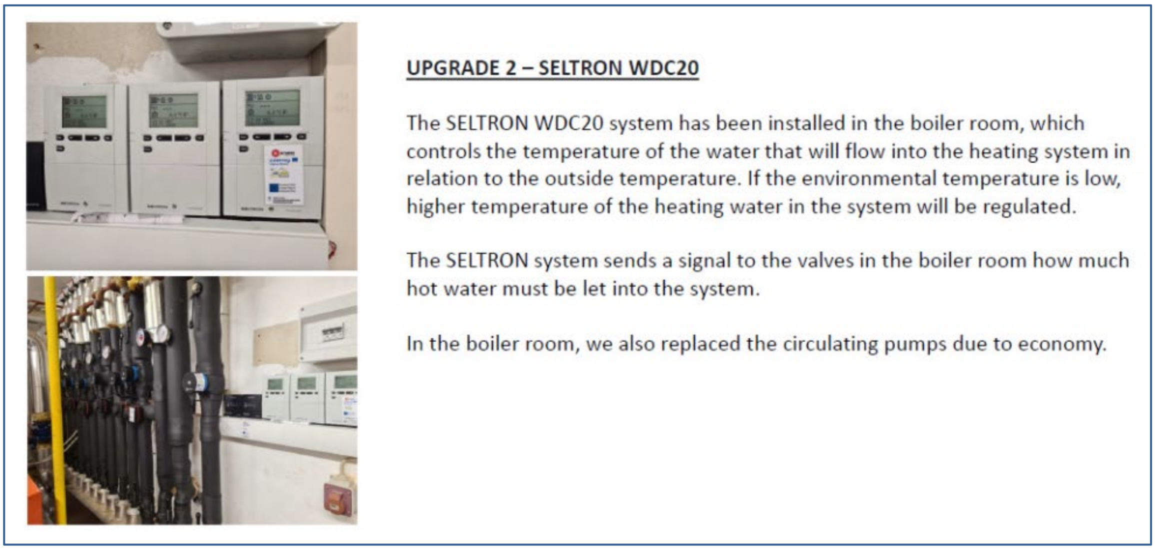

Figure 4B – Upgrade 2

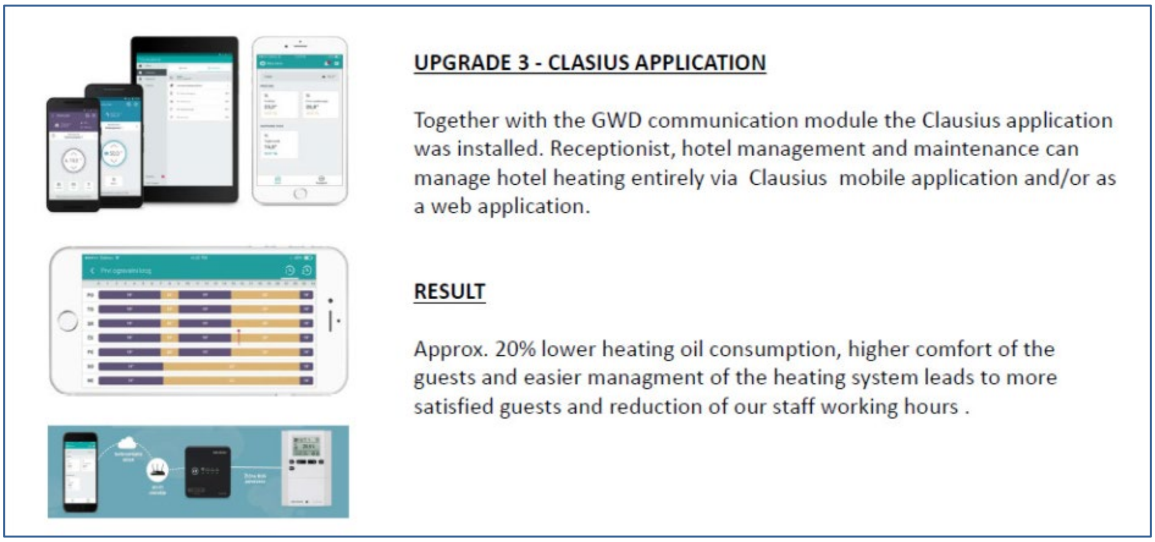

Figure 4C – Upgrade 3

Figure 4A, 4B, 4C – Hotel energy efficiency system implemented in Krvavec (Slovenia)

Energy efficiency at the Verbier living lab

The figure below, taken from the Living Lab Verbier approach, illustrates the drivers for implementing an energy efficiency policy at the ski area level.[18]

[18] https://www.alpine-space.eu/projects/smart-altitude/en/project-results/smart-altitude-living-labs/verbier.

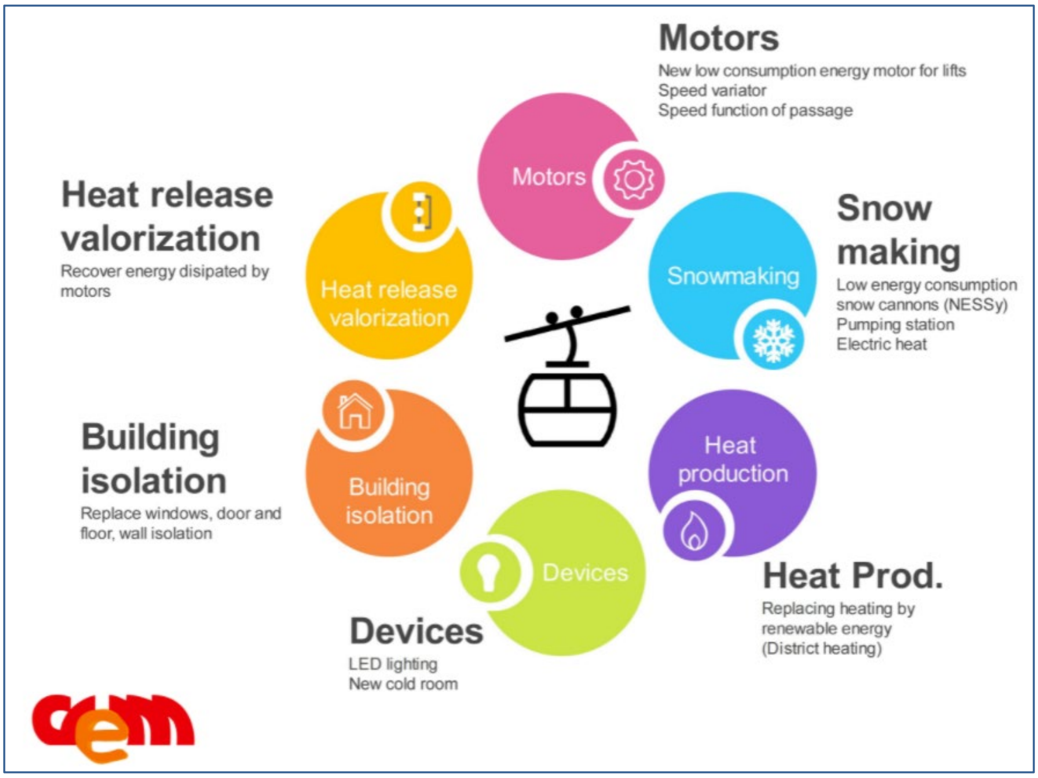

Figure 5 – Energy optimization drivers at Verbier

Figure 6 below illustrates CREM/Verbier's approach of the energy efficiency implementation process in the ski resort.

1. <u>Establish</u>
Energy-climate state and key performances indicators
2. <u>Identify</u>
Action levers in energy efficiency and GHG reduction
3. <u>Set</u>
Objectives in line with company's master plan
4. <u>Update</u>
Actions plan and integrate heat strategy
5. <u>Communicate</u>
On our way toward **ISO 50'001** Energy management system

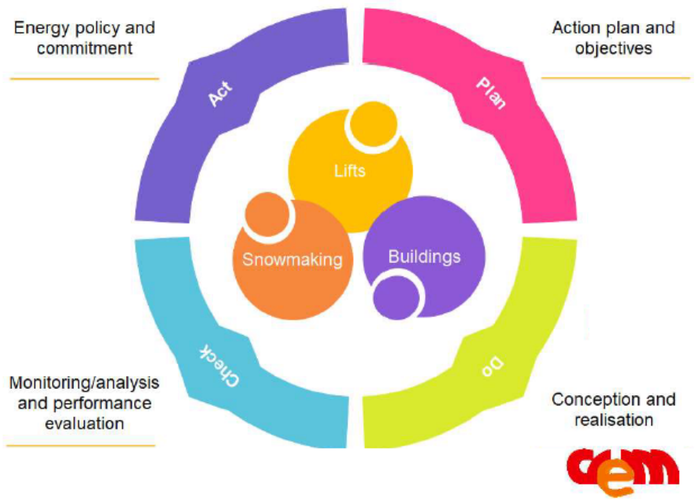

Figure 6 – Energy efficiency implementation process at Verbier

Some of the most visible actions for energy efficiency and minimizing the environmental impact of the resort at Verbier are communicated to the general public, as presented in Figure 7 below.

Figure 7 – Energy efficiency actions at Verbier as presented to tourists and ski practitioners

Some results of these actions:

- ***Lift speed Regulation*** – Depending on the crowd, the speed of the lifts can be adapted, allowing for the **reduction of 10% of energy**.
- ***Optimization of the diesel engines of the Snow-Grooming Machines*** – With the help of the company Alp Evolution, all the engines of grooming machines have been optimized, therefore **decreasing the consumption of fuel by 8%**.

Energy efficiency assessment tools

Smart Altitude WebGIS

Part of the Smart Altitude project is the development of a web-based GIS application to visualize territorial assets, untapped renewable energy potential and key performance indicators for the living labs and the 20 or more replication sites which together form the core of a community of Alpine sites committed to a common approach to energy efficiency. A geographic Information System (GIS) is a computer system designed to capture, store, manipulate and present spatial (or geographic) data. The Smart Alitude WebGIS[19] can show many different kinds of energy-related data on one map, using any information that includes a location. In this way, people can compare

[19] https://www.alpine-space.eu/projects/smart-altitude/en/project-results/measuring-visualizing-performance/webgis

different elements in order to understand how they relate to one another. The GIS application is one of the project tools that supports the prioritization of low-carbon operations. It is integrated into the Smart Altitude Toolkit for policy makers and other stakeholders.

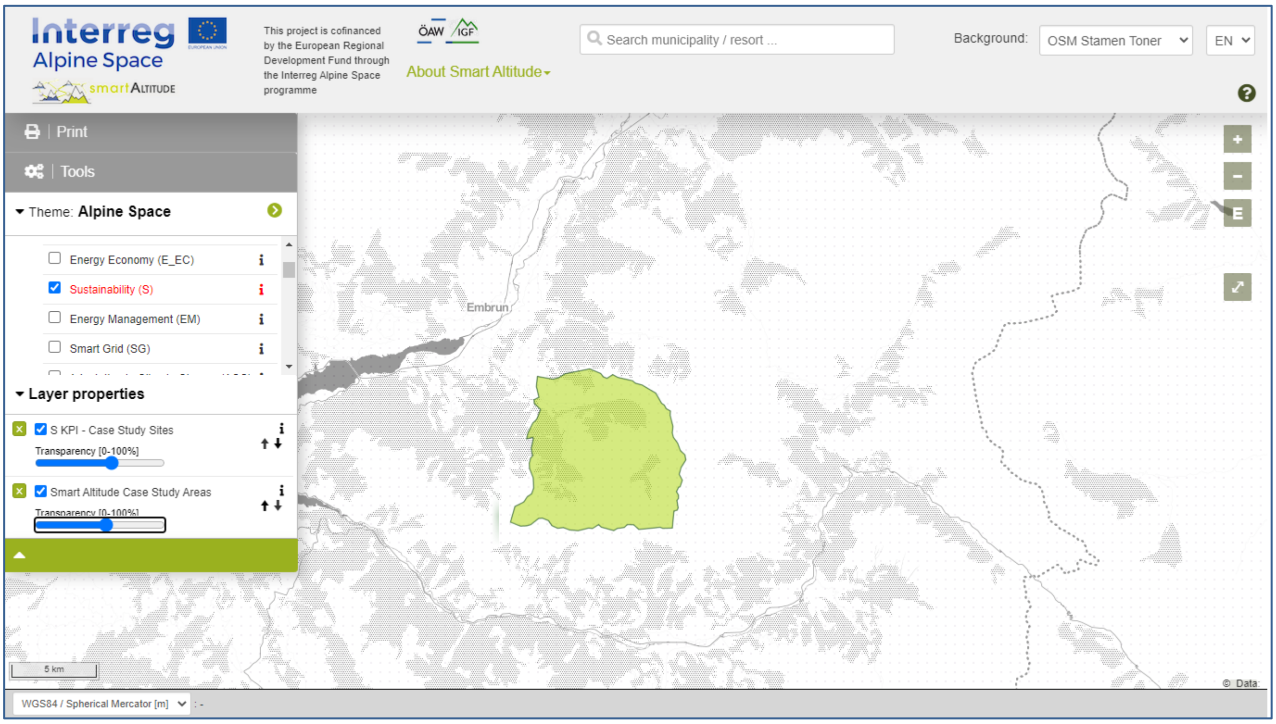

Figure 8 – View of the WebGIS interface.

The green area represents the sustainability performance (green = good) of Living Lab Les Orres

As seen in figure 8, based on a set of key performance indicators (KPIs) [20] that have been defined in Smart Altitude, the level of performance of participating sites (here Les Orres living lab) can be color-coded. Numerous layers for renewable energy potential and other environmental indicators can be superimposed. This KPI set is part of a new audit tool, called "Wi-EMT" (Winter tourism Eco-energy Management Tool) that has been developed for this purpose[21]. A questionnaire divided in 7 sections collects the data necessary to assess the KPIs. From this questionnaire and the KPIs evaluation, an individual report is addressed to ski resorts operators participating to the Smart Altitude replication process.

KPIs and Wi-EMT assessment tool

Wi-EMT is an audit tool for the ski resort operators to evaluate the ecological, energetic and management status, identifying the priorities of intervention in a comparative perspective with other ski resorts. The input data are collected from a QUESTIONNAIRE filled by the ski resort. The

[20] https://www.alpine-space.eu/projects/smart-altitude/en/project-results/measuring-visualizing-performance/key-performance-indicators-report.

[21] https://www.alpine-space.eu/projects/smart-altitude/en/project-results/smart-altitude-toolkit/wi-emt.

questionnaire is a self-evaluation questionnaire, and it is not validated by any third part. Each ski resort doesn't know the specific parameters of others, keeping them confidential.

The outputs are as follows:

- ***SKI RESORT ID*** – Main features that characterize the size, infrastructure and operation of the ski resort.
- ***SKI RESORT KPIs*** – Measurable values that demonstrates how effectively the ski resort is achieving key business objectives.
- ***EVALUATION REPORT*** – A report that includes the ski resort ID and the ski resort KPIs. In this way it provides supervision of the level of energy efficiency, sustainability and management in the ski resort and compares its performance with an Alpine Space reference. Beside a supervision and a comparison of the performance, the report provides a value database for further measurements of energy improvement, able to strengthen competitiveness at international scale. The Evaluation Report is divided into 9 main sections: Energy Efficiency, Energy Economy, Sustainability, Energy Management, Smart Grid, Adaptation to Climate Change, Self-Evaluation, Future Outlook, Overall Result.

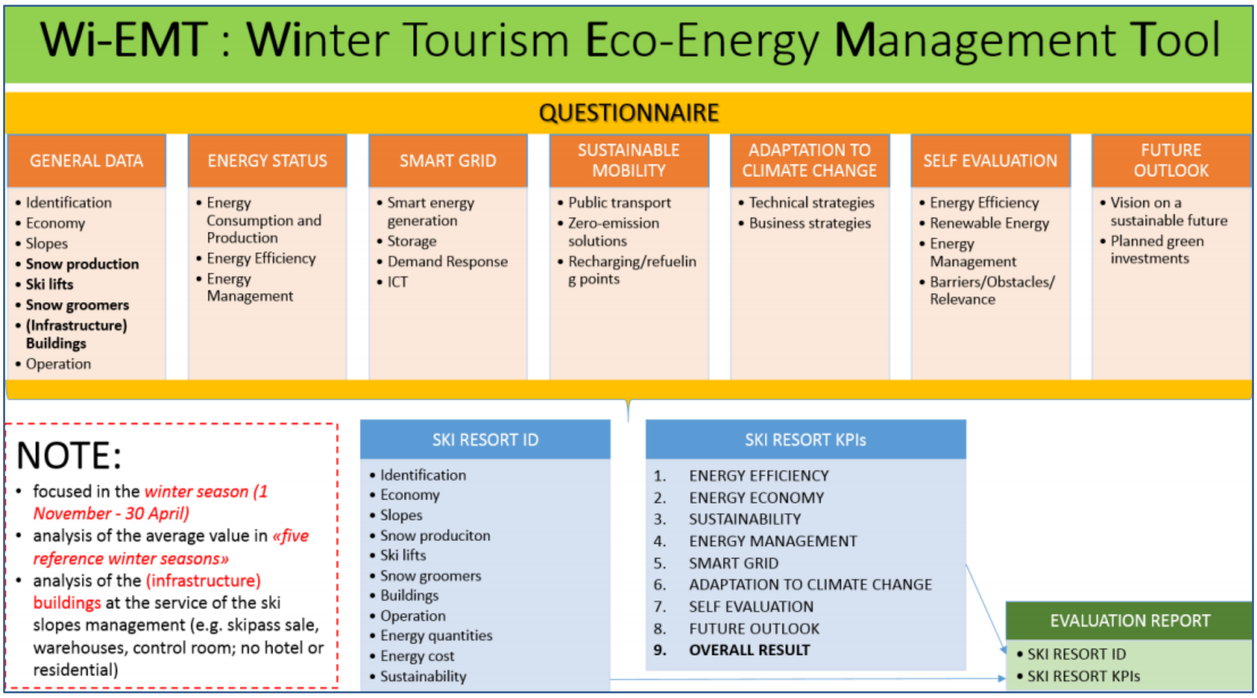

Figure 9 – Overview of the Wi-EMT

AG9 specific objectives vs. Smart Altitude achievements

The table below presents the relation that can be drawn between the 5 specific objectives of AG9 and the Smart Altitude project's actions and achievements. **Grey cells indicate AG9 specific objectives and related Smart Altitude actions not examined in the present report**.

AG9 Specific objective	Smart Altitude action
Setting up an Alpine energy efficiency cluster. This cluster should serve as a forum for cooperation and	Setting up a Replication roadmap and a Network of low-carbon winter tourism regions. This action has

innovation, bring technical solutions for the specific energy needs of the Alpine Region, and develop **energy efficiency processes and products** particularly adapted to the Alpine Region, especially in the housing and mobility sectors	resulted in the creation of a network of 26 Alpine resorts involved in a common approach to reducing energy consumption and GHG emissions, and links with other network initiatives (WikiAlps). The project has established close links with the different categories of stakeholders, i.e. local, regional and European (EUSALP) decision-makers, in order to draw up a body of recommendations based on its studies and feedback on the scale of the Alpine space.
Greening the Alpine infrastructure: focusing on energy efficiency in the building sector and promote harmonised, affordable and operational assessment tools to be used by public authorities in order to boost sustainable and low-carbon buildings in the Alpine Region.	Demonstrating the efficiency of a decision support tool integrating all challenges into a step-by-step approach to energy transition. *Several initiatives have been deployed in Smart Altitude Living labs for tourism housing energy efficiency, especially in Krvavec (Hotel) and Les Orres (Youth Centre). In additions, operational and public buildings have also been integrated in EMS solutions (Kvavec, Madonna di Campiglio, Les Orres, Verbier). All these approaches are documented and made available.*
Setting up an Alpine renewable energy cluster while taking into account ecological, economical and land use issues and considering societal trade-offs	**Creation of a Network of low-carbon winter tourism regions supporting the attractiveness of sustainable winter tourism.** It provides recommendations suited for regional, national, Alpine and European levels while developing guidance on the adoption of Sustainable Energy Action Plans (SEAPs) at local level. The integration of renewable energies in the sustainable development model is part of the smart grid approach developed in Les Orres, including hydroelectricity and photovoltaic energy. The Smart Altitude dashboard develops KPis and platforms (WebGIS) including the renewable energy potential of winter tourism areas.
Support energy management systems in the Alpine Region by developing, sharing and installing energy efficiency and decentralised monitoring systems at the local level and by promoting regional energy monitoring.	**Monitoring system for live performance assessment and decision-making.** This activity specifies the monitoring system on energy usage and production for the Living Labs. The integrated monitoring system agglomerates energy data from multiple sources (snow processes, buildings, renewables, municipal infrastructure) and performance indicators. It is developed for implementation in the three Living Labs to prioritize low-carbon operations.
Support a better use of local resources and increase energy self-sufficiency while reducing impacts on climate and the environment.	**Visualizing clean energy potential against economic and governance factors:** setting up the Smart Altitude WebGIS: Web-based GIS application development on energy infrastructure, uses and renewable potential. **« Smart Mountain Grid" Living Lab (Les Orres):** Test of a demand and production balancing system,

	based on user involvement with an 'energy management service' (B2B and B2C) and a self-production/consumption approach optimizing local renewables.

Table 2 – Evidence of relations between AG9 specific objectives and Smart Altitude actions

3.9.2. Energy Management System (EMS)

Definition and state of the Art

Energy efficiency and EMS

Energy efficiency means using less energy to provide the same level of energy services.[22] In 2018, as part of the 'Clean energy for all Europeans package', the new amending Directive on Energy Efficiency (2018/2002) was agreed to update the policy framework to 2030 and beyond, with an energy efficiency target for 2030 of at least 32.5% relative to the 2007 modelling projections for 2030, to be achieved collectively across the EU.[23]

In its specific objectives, AG-9 mentions as main targets three priority sectors: building/housing, **energy management systems**, and mobility. Among these, this report focuses on **EMS deployment**. In terms of geographical outreach, Smart Altitude focuses on a specific target, namely mountain resorts and the local communities that support them, thus contributing to the wider reach of AG-9.

As mentioned in Smart Altitude deliverable D.T3.1.1.[24] "Decision Tree", the strategies that could be implemented to improve energy use in a ski resort are: (i) Calculate specific electricity consumption—audit process, (ii) **Monitor consumption data—by implementing an energy management system (EMS)**, (iii) Implement energy saving measures, (iv) Implement renewable energy sources (RES) (Motiva, 2008).The following table lists the types of measures (highlighted in bold) that could be taken to improve **EMS implementation** in mountain resorts:

	Climate Mitigation Measures	Energy efficiency linked to EMS deployment
Ski resort	**Monitor and implement an EMS**	√
	Implement renewable energy sources	
	Assess ski lifts energy efficiency and implement speed control measures	√

[22] EIA–https://www.eia.gov/energyexplained/use-of-energy/efficiency-and-conservation-in-depth.php.
[23] https://ec.europa.eu/energy/topics/energy-efficiency/targets-directive-and-rules/energy-efficiency-directive_en.
[24] https://www.alpine-space.eu/projects/smart-altitude/en/project-results/smart-altitude-toolkit/decision-making-tree.

Snowmaking equipment	Replace snow-making cannons with modern technology and automation	
	Implement an automated snow-making system	√
	Plan which kind of snow-cannon is the most effective for the ski resort (Fan gun, Hybrid/tower, Hybrid/high-pressure)	
Grooming and slope maintenance	**Implement automatic systems (pump stations, compressed air production, snow-making equipment)**	√
	Plan which kind of snow mobile is most suited for the ski resort (two-stroke snowmobiles, four-stroke snowmobiles)	
	Replace old grooming machines with newer ones	
Buildings (tourism housing, operational & public buildings)	**Assess the energy consumption of the ski resorts building and improve the heating system and ventilation**	√
	Replace indoor and outdoor lighting with energy-efficient lightbulbs and an **automated lighting control**	√
	Improve the energy efficiency of building envelopes	
	Implement renewable energy sources for heating and electricity	
	Implement building EMS	√

Table 3 – Energy efficiency measures (adapted from D.T3.1.1. Table 2)

Common to most of these measures is **the deployment of an EMS**, that allows both to collect precise energy consumption data and automate or perform real-time control and optimisation measures.

EMS definition and description

The ISO 50001 standard, published in June 2011, provides a functional definition of the EMS as "a set of interrelated or interacting elements to establish an energy policy and energy objectives, and processes and procedures to achieve those objectives"[25]. From a structural view, the EMS can be defined as "a system of computer-aided tools used by operators of electric utility grids to monitor, control, and optimize the performance of the generation or transmission system"[26].

Building Energy Management systems also exist as specific EMS adapted to the building sector and described as follows: "Building energy management systems (BEMS) are integrated building

[25] T. H. Marvin, *Effective Implementation of an ISO 50001 Energy Management System (EnMS)*. Milwaukee, Wisconsin, 2014.

[26] Advances in Renewable Energies and Power Technologies, Imene Yahyaoui Ed., Elsevier, 2018

automation and energy management systems, utilizing IT or ICT, intelligent and interoperable digital communication technologies promoting a holistic approach to controls and providing adaptive operational optimization. The system may have multiple levels from individual sensors and actuators to users' interface, to facilitate data collection, analysis, diagnose, trend finding, and decision-making. BEMS could provide flexible access to the building automation systems from several different platforms and locations. By using service-oriented abstractions to connect building, systems, and people, BEMS dynamically control indoor climate in a cost-effective manner and ensures the comfort, safety, and wellbeing of the occupants in building".

Smart Altitude's EMS approach is described in D.T1.2. Report "Live monitoring systems specifications"[27] and D.T3.2.1. "Territorial Maximization"[28], section 4-1 to 4-3 for EMS and 4.7 for smart metering. The latter explores in detail the state of the art of EMS systems and its application to mountain resort operations. We refer the reader to this document for a more comprehensive view and understanding of the technologies used.

The figure below, extracted from the above-mentioned D.T3.2.1. report, illustrates the components of an **Integrated Energy Management System** dedicated to data collection at the ski operation level.

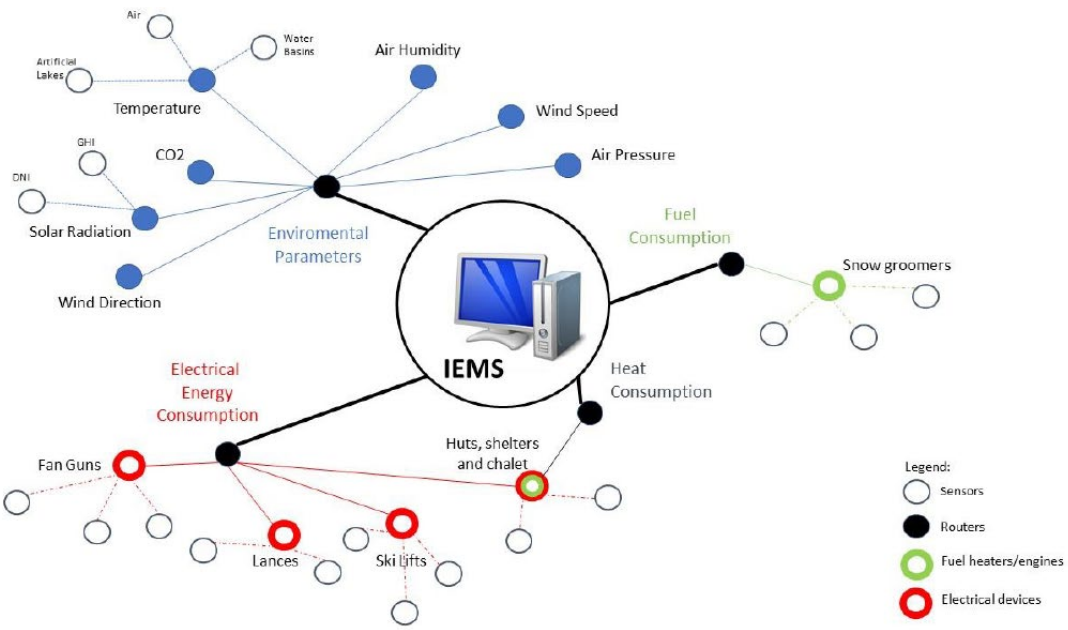

Figure 10 – IEMS generic structure for a ski resort.

In fact, there are two different conceptions of EMS: one focused on the collection of real-time and historical information, and the other on the steering of systems, the latter representing a functionally broader view. The first approach is presented in Figure 1 above. In this view, the EMS represents an essential step in understanding the consumption of the resort and therefore allows

[27] https://www.alpine-space.eu/projects/smart-altitude/en/project-results/measuring-visualizing-performance/live-monitoring-system-specifications.

[28] https://www.alpine-space.eu/projects/smart-altitude/en/project-results/smart-altitude-toolkit/territorial-maximization-report.

the identification of points for improvement and measures to be taken to reduce energy consumption.

In the extended approach, the EMS becomes not only a measurement and control system, but also a complete management system that allows remote action in real time, through control systems, on the various equipment responsible for energy consumption. The control is carried out either by decision of the operator who issues orders to the remote actuators, or by previously defined regulation or load shedding rules.

The first approach is an essential step in the reduction of energy consumption, the second a major advance in the management of installations. Both approaches have been implemented in Smart Altitude and will be presented in the following section. We will see in the third report that the ultimate step is the extension of the EMS to the management of smart grid, for which the notion of balancing energy demand and production is key.

Examples of deployment of EMS in Smart Altitude

The EMS in Madonna di Campiglio

The Trento-based company Energenius[29] has developed a unique integrated energy monitoring system for the Madonna di Campiglio living lab. The EMS collects all the data recorded by various sensors installed in the resort in a single platform. This data includes the energy flows and the most important physical and thermodynamic parameters of the main actors of a ski resort such as: lifts, groomers, snowmaking systems, water supply conditions, weather forecasts and indoor temperatures.

To facilitate the visualisation of the data flow, the resort area was divided into several sub-areas, mainly based on the lift stations, in order to visualise the temporal variations in more detail. This type of monitoring makes it possible to analyse the historical and real time data series and to identify the most effective improvement measures. This allows a high level of environmental excellence to be maintained, through careful monitoring of consumption and emissions.

[29] “Energenius.” [Online]. Available: http://www.energenius.it/.

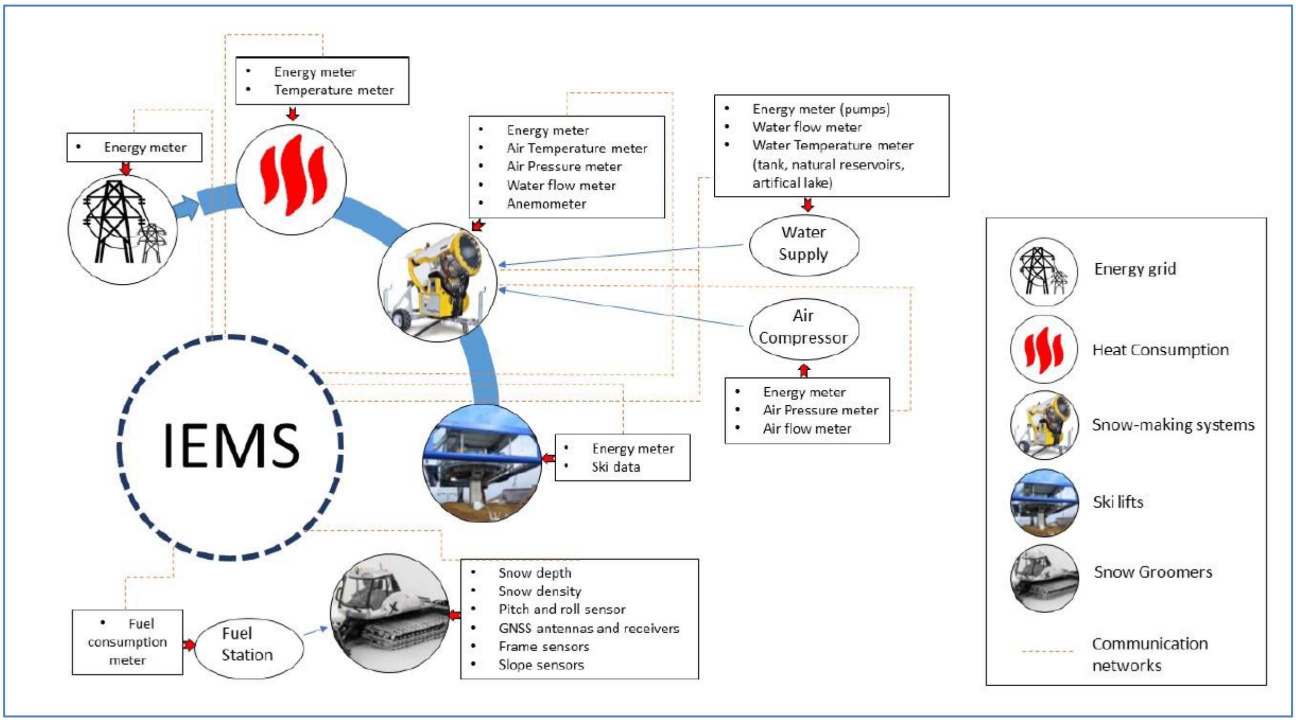

Figure 11 – The IEMS implemented in Madonna di Campiglio

The EMS deployed in Madonna di Campiglio also integrates the monitoring of Lake Montagnoli, an artificial lake used for snow production.

Figure 12 – Monitoring Lake Montagnoli

The EMS in Les Orres

Over the last eight years, Les Orres mountain resort[30] has become a "Smart Mountain" leader, deeply involved in innovative solutions for energy consumption and greenhouse gas (GHG)

[30] https://www.lesorres.com/en/committed-resort.

emissions reduction. The main actions oriented towards energy management have been carried out in the framework of two INTERREG Alpine Space projects, ALPSTAR and SMART ALTITUDE.

In 2012, fully aware of the weight of its energy consumption from an environmental and economic point of view, Les Orres was the first alpine mountain resort to carry out a complete audit of its energy consumption (snow making, ski lifts, technical buildings and amenities) and set up an integrated energy management system. These two operations were carried out as part of the Interreg Alpine Space ALPSTAR program from 2012 to 2014. Since then, Les Orres has not stopped improving its systems and has been working with its partner EDF on the implementation of a mountain microgrid approach as part of the Smart Altitude project. The EMS is fully described in a document[31] available on the Smart Altitude website.

The EMS has been developed by Roquetude[32], a French Engineering SME based in Southern Alps, who designed the Raptor solution. Semlore's electrical grid includes 18 transformers supplied by two independent 20,000 V connection points to the public electric grid. The two branches of the private grid are interconnected to ensure optimum efficiency and security of the power supply. Interconnection can be changed to dynamically adapt the configuration of the grid to seasonal needs.

[31] https://www.alpine-space.eu/projects/smart-altitude/results/wpt2/the-iems-of-les-orres.pdf.

[32] http://www.roquetude.com/.

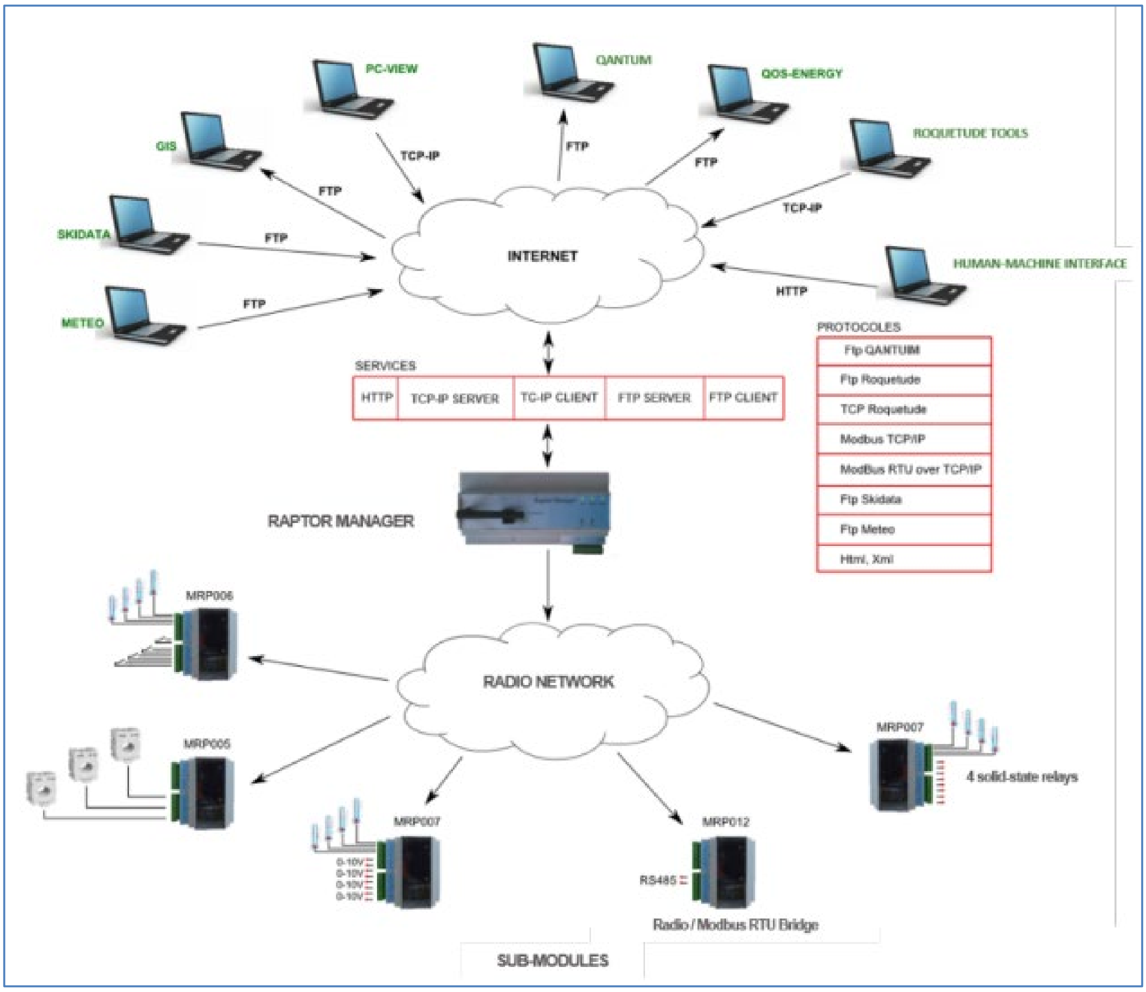

Figure 13 – The Raptor network and EMS structure

The Raptor network is an 868 MHz radiofrequency mesh network. Sub-metering modules collect the data measured by one or several sensors and transfer it by IP or 868 MHz radiofrequency to automata called raptor managers. Each raptor manager includes an SQL database and an embarked web server. The data is collected from the sub-metering modules via the radio network, then processed and transferred via IP protocol to the Roquetude dedicated supervision platform and/or a third-party data supervision platform such as Qantum by QOS Energy, a cloud-based data intelligence platform designed to drive up the performance of renewable plants and energy installations. Each Raptor transfers orders coming from the supervisor to the sub-metering modules and extensions (i.e. radio/modbus gateways), thus applying calendar-programmed or threshold-defined or manual load shed instructions to its target equipment (ski lift engine, compressor, snow-making gun or lance, building heating zone…) The supervision platform is also interconnected with external data sources such as meteorological information or ski lift frequentation by coupling to the Skidata access control system.

The deployment of the EMS in Les Orres made it possible to reduce the electricity consumption by 20%, the electric bill by 25%, and the GHG emissions by 100t eqCO_2 annually.

The EMS deployed in Verbier

In 2016, Téléverbier SA introduced a sustainable development strategy by developing solutions to reduce environmental impacts and promoting a wise use of resources. This strategy resulted in the implementation of an energy management platform named OBSERV, as part of SFOE's Smart Ski Resort project, with support from Simnet SA and CREM.

OBSERV provides extensive real time monitoring and control of the buildings and ski lifts energy consumption and data historization (e.g. hourly passages and energy consumption of lifts), for analysis and optimization of the entire ski resort. Since then, there have been constant efforts to further expand the energy optimization program. Téléverbier SA, the resort operator, introduced various energy saving measures such as speed regulation of ski lifts, snow groomers motor optimization, replacement of electric or fossil heating system by renewable solutions, or sustainable public transportation solutions, all selected in close collaborations with local actors.

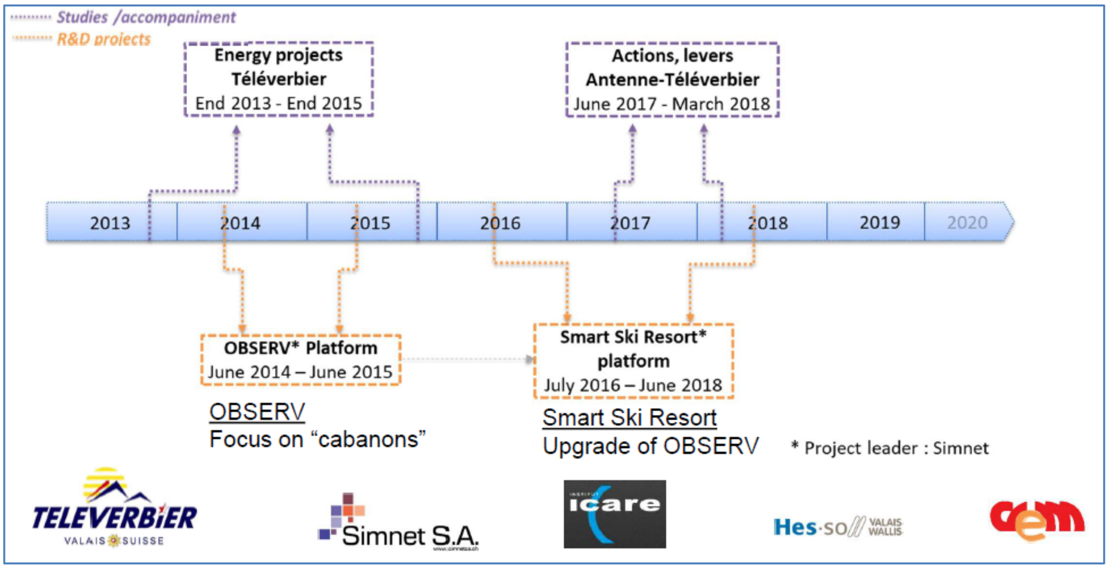

Figure 14 – Step by step approach of EMS deployment in Verbier

The ski resort, which consumes around 8 million of kilowatt-hours of electricity per year, is supplied exclusively by Valais' local hydroelectric production. Téléverbier SA further develops renewable energy production solutions on its territory, such as solar energy.

The Verbier living lab work, results and reports are available on the Smart Altitude website[33].

AG9 specific objectives vs. Smart Altitude achievements

The table below presents the relation that can be drawn between the 5 specific objectives of AG9 and the Smart Altitude project's actions and achievements. **Grey cells indicate AG9 specific objectives and related Smart Altitude actions not examined in the present report**.

[33] https://www.alpine-space.eu/projects/smart-altitude/en/project-results/smart-altitude-living-labs/verbier.

AG9 Specific objective	Smart Altitude action
Setting up an Alpine energy efficiency cluster. *This cluster should serve as a forum for cooperation and innovation, bring technical solutions for the specific energy needs of the Alpine Region, and develop **energy efficiency processes and products** particularly adapted to the Alpine Region, especially in the housing and mobility sectors*	**Setting up a Replication roadmap and a Network of low-carbon winter tourism regions.** *This action has resulted in the **creation of a network of 26 Alpine resorts involved in a common approach to reducing energy consumption and GHG emissions**, and links with other network initiatives (WikiAlps). The project has established **close links with the different categories of stakeholders**, i.e. local, regional and European (EUSALP) decision-makers, in order to draw up **a body of recommendations based on its studies and feedback on the scale of the Alpine space**.*
Greening the Alpine infrastructure: *focusing on **energy efficiency in the building sector** and promote harmonised, affordable and operational assessment tools to be used by public authorities in order to boost sustainable and low-carbon buildings in the Alpine Region.*	**Demonstrating the efficiency of a decision support tool integrating all challenges into a step-by-step approach to energy transition.** *Several initiatives have been deployed in Smart Altitude Living labs for **tourism housing energy efficiency**, especially in Krvavec (Hotel) and Les Orres (Youth Centre). In additions, **operational and public buildings have also been integrated in EMS solutions** (Kvavec, Madonna di Campiglio, Les Orres, Verbier). All these approaches are documented and made available.*
Setting up an Alpine renewable energy cluster while taking into account ecological, economical and land use issues and considering societal trade-offs	**Creation of a Network of low-carbon winter tourism regions supporting the attractiveness of sustainable winter tourism.** *It provides recommendations suited for regional, national, Alpine and European levels while developing guidance on the adoption of Sustainable Energy Action Plans (SEAPs) at local level. The integration of renewable energies in the sustainable development model is part of the smart grid approach developed in Les Orres, including hydroelectricity and photovoltaic energy. The Smart Altitude dashboard develops KPis and platforms (WebGIS) including the renewable energy potential of winter tourism areas.*
Support energy management systems in the Alpine Region *by developing, sharing and installing energy efficiency and decentralised monitoring systems at the local level and by promoting regional energy monitoring.*	**Monitoring system for live performance assessment and decision-making.** *This activity specifies the monitoring system on energy usage and production for the Living Labs. The **integrated monitoring system** agglomerates energy data from multiple sources (snow processes, buildings, renewables, municipal infrastructure) and performance indicators. It is developed for implementation in the three Living Labs to prioritize low-carbon operations.*

Support a better use of local resources and increase energy self-sufficiency while reducing impacts on climate and the environment.	**Visualizing clean energy potential against economic and governance factors:** *setting up the Smart Altitude WebGIS: Web-based GIS application development on energy infrastructure, uses and renewable potential.* **« Smart Mountain Grid" Living Lab (Les Orres):** *Test of a* ***demand and production balancing system****, based on user involvement with an 'energy management service' (B2B and B2C) and a self-production/consumption approach optimizing local renewables.*

Table 4 – Evidence of relations between AG9 specific objectives and Smart Altitude actions

3.9.3. Smart Grids

Definition and State of the art

In its specific objectives, AG-9 mentions as main targets three priority sectors: building/housing, **energy management systems**, and mobility. Among these, this report focuses on **Smart girds,** and more specifically **on microgrids** that could be deployed in mountain resorts and areas.

Definitions

Smart grids are energy networks that can automatically monitor energy flows and adjust to changes in energy supply and demand accordingly. When coupled with smart metering systems, smart grids reach consumers and suppliers by providing information on real-time consumption.[34]

Microgrids are smart grids at local level. Microgrids have been identified as a key component of the smart grid in order to improve system energy efficiency and reliability and to provide the possibility of grid-independence to individual end-user sites. As defined by the Microgrid Exchange Group (MEG), "A microgrid is a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode."[35]

In this report, Smart grid refers to a microgrid implementation using smart grid technologies.

Presentation of the Smart grid/microgrid approach

An exhaustive presentation of smart grids, including general considerations on the context, deployment and challenges and possible application to mountain resorts, is discussed in Smart Altitude deliverable D.T3.2.1. "Territorial Maximisation" report, section 5[36]. We refer the reader to this document for a full review. Below are some key considerations to help understand the implications of smart grid deployment.

[34] European Commission – https://ec.europa.eu/energy/topics/markets-and-consumers/smart-grids-and-meters_en
[35] US Department of Energy, DOE Microgrid Workshop Report, 2011.
[36] https://www.alpine-space.eu/projects/smart-altitude/results/wpt3/d.t3.2.1.pdf .

The main benefit of setting up a Smart Grid is the massive integration of intermittent renewable energies. By modulating energy consumption according to the available power, Smart Grid technologies make it possible to maintain a reliable, durable and secure electricity supply. The setting up of a microgrid requires the implementation of a communication infrastructure between all the different electrical systems in a defined area, via smart meters collecting and transmitting energy production and consumption data in real time. Data analysis and processing platforms allow the real-time monitoring of the electrical status of the local electricity network. This computer supervision makes it possible to trigger automatic activation of production, consumption or storage flexibilities, upwards or downwards depending on their respective availability, in the search for an optimal balance between demand and supply of energy passing through the distribution network.

Figure 1 below presents the main components of the Nice Grid project[37] led by several players including Enedis, EDF, Saft, GE Grid Solutions.

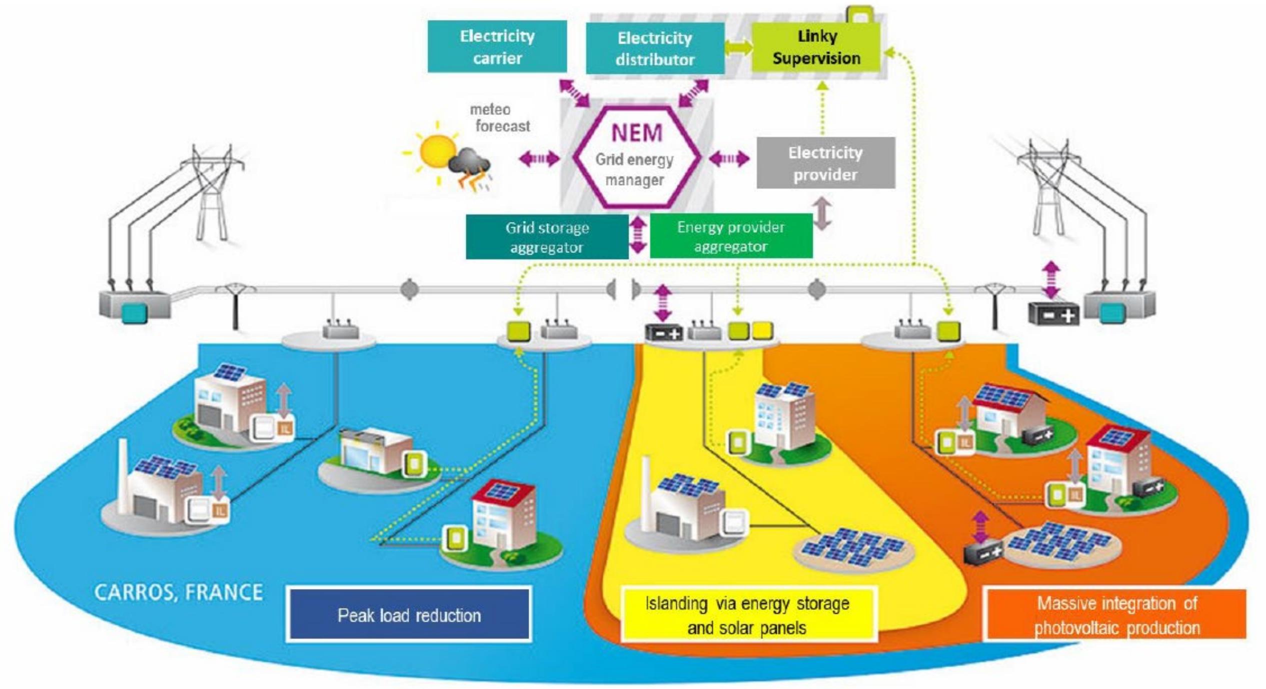

Figure 15 – The "Nice Grid" Smart Grid -- Adapted from Thomas Drizard, ENEDIS

In its characteristics and dimension, the Nice grid experiments provides a useful model for a mountain grid: it involved 2,500 homes and businesses equipped with Linky smart meters, photovoltaic panels for a total production capacity of 2.5 MWh, storage capacities by batteries, distributed at different points on the electricity grid capable of storing 1 MW for 30 minutes. The

[37] Guillaume Foggia, M. Muscholl, Jean-Christophe Passelergue, P. Gambier-Morel, Cyril Vuillecard, et al., The Nice Grid project: Using Distributed Energy Resources to Reduce Power Demand through Advanced Network Management. 2014 CIGRE Session, Aug 2014, Paris, France

Nice Grid project: included an islanding experiment consisting of running the grid in complete autonomy, for a given period of time, without any electricity input from the external grid.

The "NEM" (Network Energy Manager) makes it possible to solicit various aggregators, which optimise responses to the constraints observed on the network, depending on the time of day. These responses correspond to local flexibility offers made to participants. They encourage them to shift their consumption when solar production is high, and/or to reduce their consumption during cold peaks. For example, in the summer, in the event of overproduction of photovoltaic energy, they can take up the residential flexibility offers of the aggregator, which proposes "solar bonuses" (solar off-peak hours between 12 noon and 4 p.m.), remote activation of the water heater for voluntary customers, and storage of electricity in batteries. Conversely, in winter, during consumption peaks, the NEM can take up offers of lower heating via the Linky meter or proposals for battery discharge, from the grid battery aggregator.

As seen, in a Smart Grid, all local actors therefore play a role in ensuring this balance between production and consumption, according to predefined scenarios and priorities. Energy consumers are also called upon: they are invited to limit their energy consumption when energy production is low by deferring their electrical use to periods when availability is high.

Smart grid deployment modelling in Smart Altitude

Mountain Smart Grid

Energy consumption and production in mountain areas have several particularities with respect to the electricity network, which are outlined below:

1) A highly seasonal frequentation, and therefore of energy consumption, with a very specific winter evening/night consumption peak linked to snow production;
2) Low summer consumption (e.g., resort operations in Les Orres: energy demand of around 250 kW against a winter power peak up to 5 MW);
3) Widely varying conditions in the composition of the energy mix and renewable energy generation capacity depending on geographical location. In some locations, local hydroelectric generation capacity exceeds energy needs. Photovoltaic, geothermal and wind generation capacities can also vary considerably. In Les Orres, the production potential is mainly hydroelectric (23 GWh) and more marginally solar (423 MWh). Wind power does not seem relevant compared to other sites and resorts. Local biomass resources are also used for heating communal buildings, and gas heating for part of the heating installations in tourist accommodation buildings;
4) Seasonal imbalance between consumption needs and production capacity: needs are higher in winter when production capacity is low (low water flow, low photovoltaic production due to the short duration of sunshine and the greater prevalence of solar masks).

The mountain grid approach by Les Orres and EDF

Les Orres resort has been a pioneer in the implementation of an energy management system in the Alps within the framework of the ALPSTAR programme, over the period 2012-2014. On this occasion, Les Orres carried out a complete energy assessment of the station's operations and set up an energy management system with the contribution of two design offices: Eco-mesures[38] and Roquétude[39]. This action has made it possible to reduce **energy consumption by 20%, greenhouse gas emissions by 100 t CO_2 and the station's energy bill by 25%**.

Since then, Les Orres has become the "Mountain resort of tomorrow" pilot of FLEXGRID, a programme for the deployment of smart grid solutions led by the Provence-Alpes-Côte d'Azur Region and operated by the Capenergies competitiveness cluster. The resort and the commune of Les Orres have continued their commitment to the deployment of responsible energy solutions, alongside their partners EDF and Enedis, and the commune of Les Orres has become the leader of the Alpine Space SMART ALTITUDE project to extend its EMS to model a smart mountain grid.

The diagram below shows the components of Les Orres smart grid with the central role that a local energy pilot would play, interacting with the resort's EMS, the public lighting supervisor and the various monitoring and control equipment that will be installed in public and private facilities and tourist accommodation buildings.

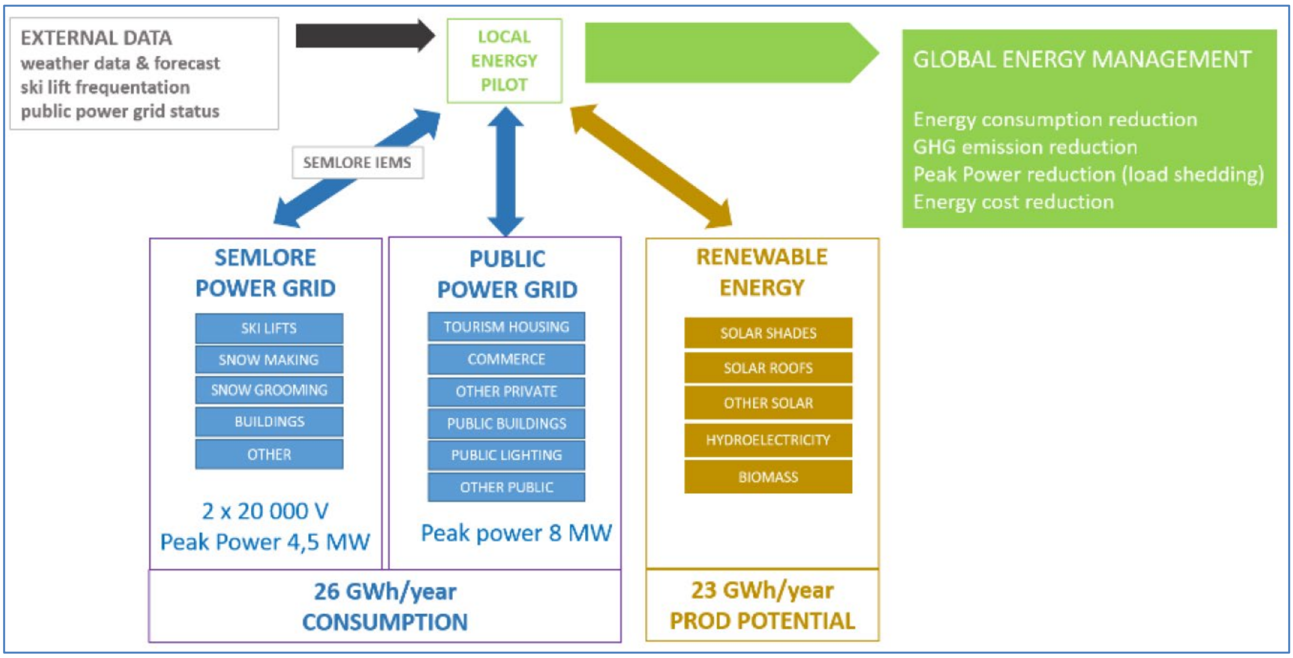

Figure 16 – Principle of organization of Les Orres mountain grid

The resort of Les Orres has specific features that do not necessarily correspond to the conditions faced by all Alpine resorts:

1) In France, electricity is more decarbonated and less expensive than in most countries in the Alpine region;
2) Consequently, most of the heating in tourist accommodation is electric, which reinforces the interest in integrating this component into a smart grid approach because of the strong capacity to regulate and reduce energy demand that it represents.

[38] https://www.eco-mesures.fr/
[39] http:/www.roquetude.com/

3) The typology of actors can vary considerably from one country to another, and even within the same country. Les Orres has the advantage of having a semi-public operator with the municipality as main shareholder, which facilitates the integration between the public (municipality) and the semi-public (resort operator) in a common Smart Grid approach. However, the integration of the private part is complex to implement, due to the multitude of actors involved (multi-owner tourist accommodation).

The following diagram is a simplified process flow proposal of the functional design of a mountain microgrid, adaptable to any configuration.

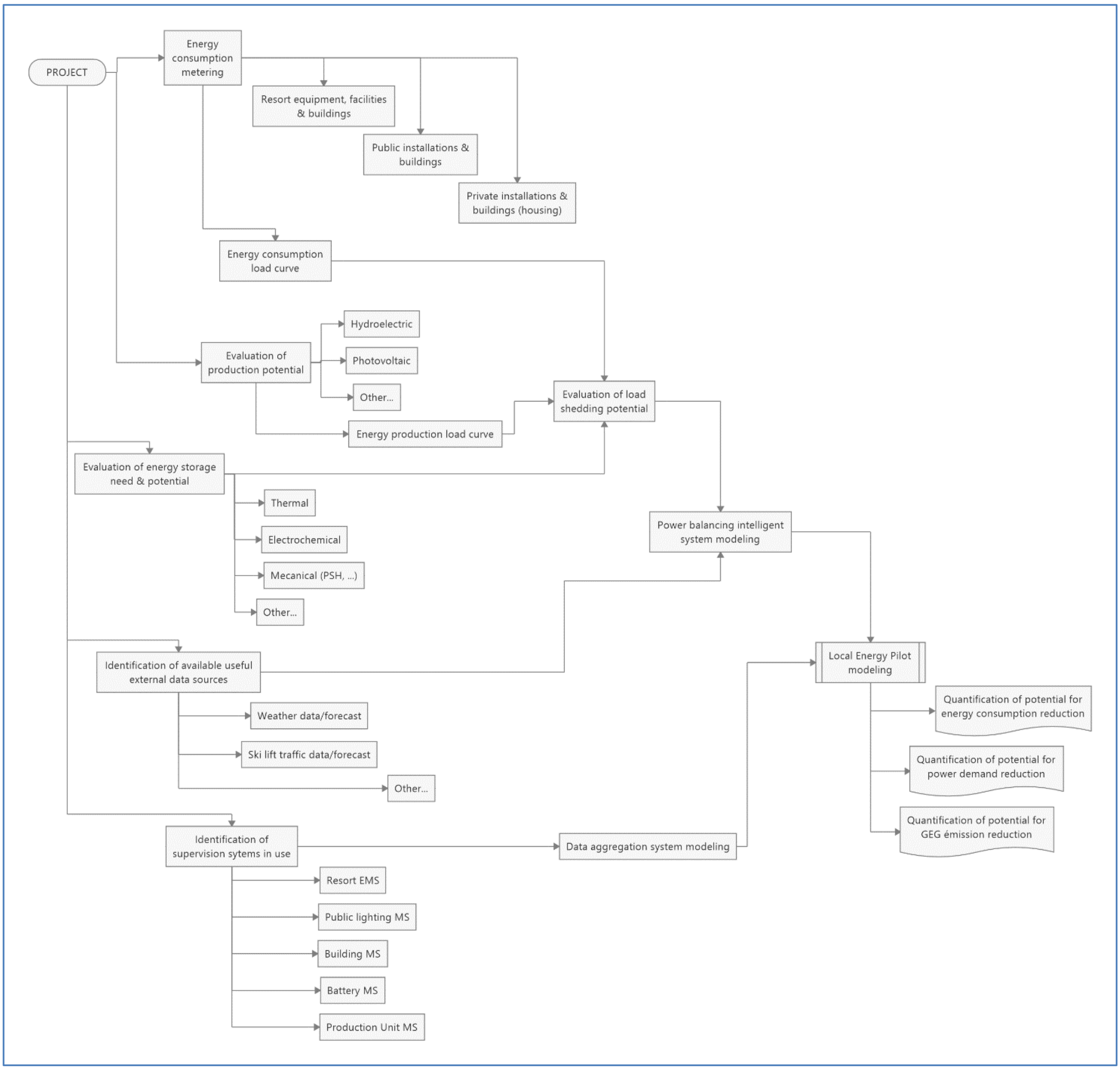

Figure 17 – Simplified process flow of a mountain smart grid.

Real-time knowledge of the power available in the area concerned is an essential element in the operation of a smart grid. The total available power is the sum of the available power from several sources: 1) locally produced and self-consumed energy (e.g., a self-consumed photovoltaic system), and 2) the public electricity network, depending on the power subscribed by each consumer.

For each energy delivery point within the smart grid perimeter, it is important to have real-time access to the available power, i.e. the difference between the consumed power and the subscribed power at any given time. The power subscribed by the Les Orres ski lift operating company (SEMLORE) is approximately 5 MW, whereas the total cumulative power of all the resort's electrical equipment is 12.5 MW (see Figure 3). There can therefore be large differences in available power depending on the equipment in operation. SEMLORE's EMS allows the power consumed by its equipment to be displayed in real time.

In Les Orres, the EMS was limited to the equipment of the ski lift operating company (SEMLORE). In the implementation of a smart grid, many other consumers can be involved in the process. The integration of new actors allows for a more efficient operation of energy scenarios, with a much greater capacity for load shedding and power/demand balancing. These can include:

- Tourist accommodation (heating systems, hot water production, ventilation...);
- Public lighting;
- Charging stations for electric vehicles;
- Swimming pools (water heating);
- Ice rinks (cooling systems);
- Cinemas (heating, lighting);
- Shops (heating, lighting);
- Restaurants (heating, cooking systems, hot water production);
- Offices (heating, hot water production), etc.

Power production/demand balancing

According to Les Orres' renewable energy potential study, an annual production of approximately 24 GWh/year could be achieved.

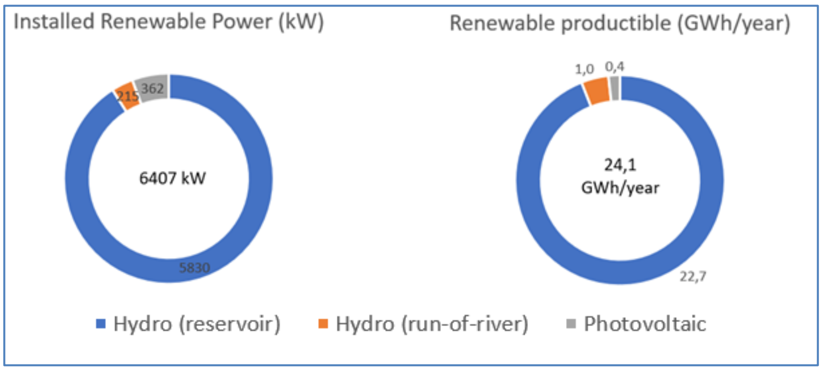

Figure 18 – Les Orres potential for installed power and annual energy production

By extending the scope of the smart grid to the entire Les Orres ski resort, and in particular by including tourist accommodation, electricity consumption is much higher (26 GWh/year). At first sight, 92% of the ski resort's electricity needs could be covered by local renewable energy. However, the imbalance between the RE production capacity due to seasonal climatic conditions and the peak consumption induced by the variation in tourist numbers does not allow to fully cover the needs by local RE production, in the absence of high-capacity storage solutions to compensate for such imbalances. This does not prevent the optimisation of consumption from being modelled in a local grid vision by using the flexibility capacities offered by the multiplicity of players and uses (load management) and the mix between RE and energy supplied by the public grid, which has a high level of decarbonisation in France.

To model the integration of tourist accommodation and public energy consumption in the mountain smart grid, we used studies carried out on 3 types of tourist accommodation and the pilot deployment of an energy control solution on the UCPA building (social tourism accommodation centre), along with the public lighting control solution of Les Orres.[40]

With the integration of public lighting and the UCPA centre into the scope of the Mountain Smart Grid, the total load management capacity of the Smart Grid is distributed as follows:

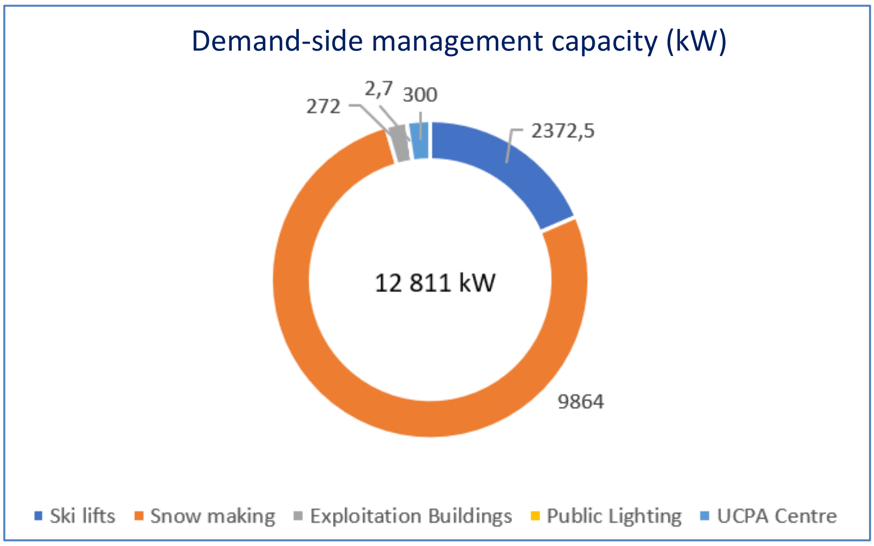

Figure 19 – Demand side load management potential in Les Orres

The total installed power at SEMLORE (ski lifts, snowmaking system, operating buildings) is around 12.5 MW whereas the subscribed power is only 5 MW. There is therefore a high reduction rate between the total installed power and the maximum power demand. This is due, on the one hand, to the time lag between the periods of use of the different types of equipment and, on the other hand, to the flexibility and optimization capacities of the power demand offered by the EMS.

[40] Please refer to D.T2.3.1. Report available on https://www.alpine-space.eu/projects/smart-altitude/en/project-results/smart-altitude-living-labs/les-orres

In addition to this installed power are public lighting (2.7 kW) and the UCPA Centre (300 kW). Theoretically, if all the residential buildings (17,000 beds) in the resort were equipped with a solution similar to the one implemented in the UCPA centre, the total peak shaving capacity related to tourist accommodation would be around 21 MW (assuming electric heating and hot water production systems similar to those of the UCPA centre). The theoretical shedding capacity of tourist accommodation (21 MW) is therefore much higher than that of the ski lifts (2.3 MW) and snowmaking systems (9.8 MW). However, it is important to take into account that for comfort reasons, load management is usually carried out by switching off the heating systems sequentially in groups of systems over periods of 10 minutes.

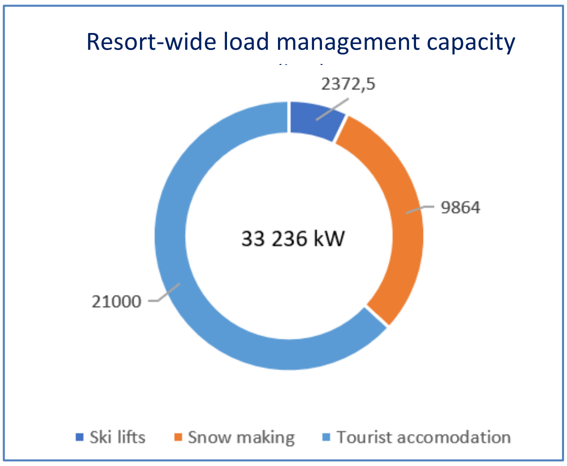

Figure 20 – Theoretical total load management capacity

Review of possible obstacles to deployment

Technical issues

No mention has been made here of the development of the Local Energy Pilot of the smart grid. There is certainly a great deal of development to be done, particularly in terms of interconnection between the production and consumption systems of renewable energy sources in order to achieve the best possible supply/demand balance and peak load shedding, which is one of the major interests of the approach. For more information, please refer to figure 1 in which the NEM (Grid Energy Manager) is the equivalent of the Local Energy Pilot envisaged for Les Orres, and to the extensive literature on EMS, SCADA and interoperability issues (for example a technical review[41]).

The main problem encountered is the communication of the energy driver with local IT systems, i.e. interoperability problems. Locally deployed systems do not always use standard protocols (e.g. Modbus), which requires bridges between proprietary protocols and processing platforms. For example, in the case of tourist accommodation, the integration between the consumption control system and the reservation platforms.

[41] Lee Cardwell and Annie Shebanow, The efficacy and challenges of SCADA and smart grid Integration, *Journal of Cyber Security and Information Systems, **1**:3, 2016.* Full article available on: https://www.csiac.org/journal-article/the-efficacy-and-challenges-of-scada-and-smart-grid-integration/.

However, it appears that the main challenges are economic and inter-relational rather than technological.

Regulatory issues: Local energy community: an opportunity for grid deployment?

Article 22 of the revised EU Renewable Energy Directive (EU) 2018/2001[42] states the following about local renewable energy communities:

1. Member States shall ensure that final customers, in particular household customers, are entitled to participate in a renewable energy community while maintaining their rights or obligations as final customers, and without being subject to unjustified or discriminatory conditions or procedures that would prevent their participation in a renewable energy community, provided that for private undertakings, their participation does not constitute their primary commercial or professional activity.
2. Member States shall ensure that renewable energy communities are entitled to:
   a. produce, consume, store and sell renewable energy, including through renewables power purchase agreements;
   b. share, within the renewable energy community, renewable energy that is produced by the production units owned by that renewable energy community, subject to the other requirements laid down in this Article and to maintaining the rights and obligations of the renewable energy community members as customers;
   c. access all suitable energy markets both directly or through aggregation in a non-discriminatory manner.
3. Member States shall carry out an assessment of the existing barriers and potential of development of renewable energy communities in their territories.

The Electricity Directive leaves it to Member States to decide whether or not to allow citizens' energy communities to own or operate electricity networks. This freedom left to Member States has important potential consequences.

We can see that there is now a framework that obliges Member States to facilitate the establishment of local energy communities, building on existing network infrastructure, but allowing them to implement the energy exchanges required within a smart grid. Until now, particularly in France, the energy exchange arrangements in the context of collective self-consumption were much more restricted and not adapted to the effective implementation of a mountain microgrid.

However, there may still be regulatory obstacles to the deployment of a smart grid in a mountain resort such as Les Orres, where one of the players (Semlore) operates a private network. Below is presented a summary of the analysis of Article 22 by the French National Energy Regulatory Commission (CRE) and how the cohabitation between local energy communities and the national electricity system is envisaged.[43] We underline (bold) in the text below the point raised by CRE that could be discussed.

"It is difficult to envisage situations in which consumers and producers would do without public electricity distribution and transmission networks altogether. On the contrary, the deployment of renewable energies in a much more diffuse way than in the centralised model prevailing until now requires a more proactive and intelligent management of the networks. Even with the changes underway, the nature of the networks gives them a decisive advantage over a multitude of closed systems, making it possible to pool resources and increase production as well as consumption. Thus, it is important to remember that the deployment of collective self-consumption and more

[42] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2001&from=EN.

[43] https://www.smartgrids-cre.fr/encyclopedie/les-communautes-energetiques-locales/communautes-energetiques-et-systeme-electrique-national-quelle-cohabitation

broadly the mobilisation of citizens and communities within energy communities should mean a more intelligent use of these networks rather than an alternative to them.

Energy communities have been thought of and should thus be seen as facilitators of the deployment of renewable energy production sources and as means of access to electricity markets, not as alternatives to public networks. **Thus, the law of 8 November 2019 on energy and climate has specified that renewable energy communities, but also citizen energy communities (with reference to the recast of the Renewable Energy Directive to date) cannot own or operate a grid."**

In the case of Les Orres, the smart grid would result on the interconnection between the private grid of Semlore (itself connected to the public grid) and the public grid to which public and private consumers (municipality, tourism housing owners and co-owners, …) and/or renewable energy producers (municipality, other public or private producers) are connected. The question remains to be asked.

Economic issues: evaluating the value of load management

in order to guarantee a national balance between production and consumption, and to integrate increasingly intermittent renewable energies, load management capacities—meaning balancing electricity supply by reducing load demand rather than increasing electricity generation—must be increased. A target of 6 GW in 2023 has thus been set at the French level. In 2017, this capacity reached 1.9 GW. To enter the load management service markets, a minimum power of 1 MW is required. To reach this minimum power, it is possible to aggregate different load management capacities. From an environmental viewpoint, load management allows to avoid having to run additional energy production resources that are generally highly GHG emitters, such as coal or gas power plants.

By participating in this mechanism, the players must modulate their energy consumption according to the requests they receive. Depending on the markets affected, this solicitation is known a few days before, a few hours before or a few seconds before the load demand adjustment to be carried out. The associated financial remuneration therefore depends on this reaction time and the capacities involved. Two different financial valuations are then possible:

- In power on a half-hourly step: 9 €/MW
- In energy: 50 €/MWh

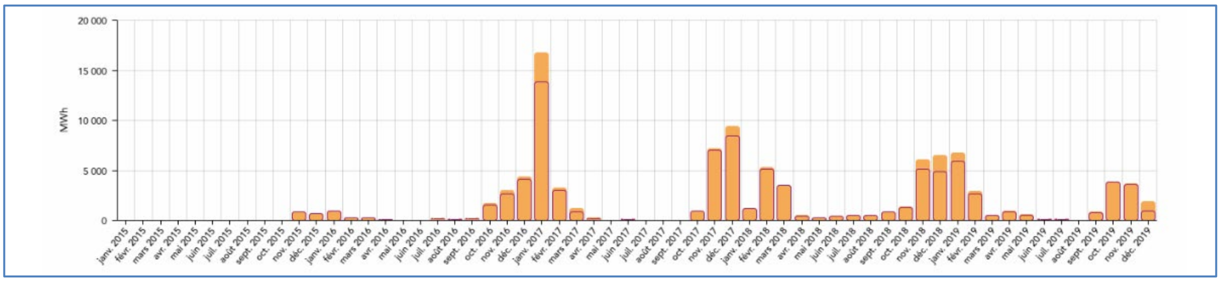

Figure 21 – Monthly load demand reduction volumes declared on the load management market

Hourly, daily and seasonal variations are observed on the load management market. It can be noted that the need for load demand reduction mainly coincides with the winter period. In a ski resort, the ski lifts, the snowmaking system and the tourist accommodation should therefore theoretically present a real value in terms of demand-side management and peak shaving capacity. However, as mentioned before, there is no additional capacity to play with the resort operations' energy consumption (ski lifts, snow making and heating) than what is currently done with the EMS. Therefore, we could only consider the theoretical total of 21 MW offered by the tourist accommodation.

in order to make peak shaving and energy demand management capacities profitable, it is necessary to have a good knowledge: 1) of daily operations so as not to disrupt the priorities and imperatives of the categories of use as well as the comfort needs of the users, the smooth running of the resort's operations remaining an absolute priority; 2) of the tariff incentives offered by the energy suppliers; 3) of the financial remuneration offered by licensed load demand aggregators.

As for this last case, dynamic demand management generally involves energy demand reduction of about 77% (percent of heating and water heating in housing) for periods not exceeding 10 mn over one hour. It is very likely that the consumption reduction induced by tourism energy management systems (> 20%) added to the flexibility induced by the microgrid with regard to tariff incentives and max power subscribed would be much more interesting. A complete study should be performed for financial optimization, with some elements discussed in the D.T2.3.1[44].

Stakeholder engagement and governance issues

Implementing a microgrid at the resort level requires the involvement of several categories of stakeholders with very different interests and concerns. The main actors are as follows:

The municipality – It manages a number of energy consuming facilities (public buildings, swimming pool, rescue centre...); it invests in the deployment of renewable energies (photovoltaic, hydroelectricity); its financial capacities are limited: it must optimise its investments and operating costs, and the current models of collective self-consumption are not favourable to the optimisation of the use of local public finances.

The resort operator – It must minimise his costs and maximise his revenues. His primary concern is to make profitable productive investments and to optimise his operations. Setting up or joining a microgrid management organisation, such as a local energy community, involves more risks: mobilising part of its staff, non-productive investments, in a structure with shared governance, and with a high degree of uncertainty about the final profitability of the operation. Finally, it already has an energy management system that satisfies most of its needs, even though being part of the operation would allow it to optimise its energy consumption costs.

Collective tourist housing operators (hotels, etc.) – They have the capacity to make management decisions. It is in their interest to minimise their energy costs. Having an energy management system is of great interest. Joining a microgrid type management structure may appear to be of marginal interest with high risks in relation to the local system in place or to be deployed.

Co-owners of condominiums – It is difficult to mobilise them on operations of common interest. They see their own direct interest first and foremost and participating in an operation that does

[44] Op. cit. Please refer to note 8.

not guarantee them an immediate benefit is not very attractive to them. Thetwo benefits they can expect is 1) a guarantee of stability of the electricity price over a long period (as in a collective self-consumption operation), and 2) an increase in the asset value of their flat.The financial aspects of the operation, more specifically the cost benefit/risk balance, must be studied very carefully for the enrolment of stakeholders to be successful. It is very likely that co-owners will not be part of the operation.

AG9 specific objectives vs. Smart Altitude achievements

The table below presents the relation that can be drawn between the 5 specific objectives of AG9 and the Smart Altitude project's actions and achievements. **Grey cells indicate AG9 specific objectives and related Smart Altitude actions not examined in the present report**.

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Setting up an Alpine renewable energy cluster while taking into account ecological, economical and land use issues and considering societal trade-offs	**Creation of a Network of low-carbon winter tourism regions supporting the attractiveness of sustainable winter tourism.** *It provides recommendations suited for regional, national, Alpine and European levels while developing guidance on the adoption of Sustainable Energy Action Plans (SEAPs) at local level. The integration of renewable energies in the sustainable development model is part of the smart grid approach developed in Les Orres, including hydroelectricity and photovoltaic energy. The Smart Altitude dashboard develops KPis and platforms (WebGIS) including the renewable energy potential of winter tourism areas.*

Support energy management systems in the Alpine Region *by developing, sharing and installing energy efficiency and decentralised monitoring systems at the local level and by promoting regional energy monitoring.*	**Monitoring system for live performance assessment and decision-making.** *This activity specifies the monitoring system on energy usage and production for the Living Labs. The* ***integrated monitoring system*** *agglomerates energy data from multiple sources (snow processes, buildings, renewables, municipal infrastructure) and performance indicators. It is developed for implementation in the three Living Labs to prioritize low-carbon operations.*
Support a better use of local resources and increase energy self-sufficiency while reducing impacts on climate and the environment.	**Visualizing clean energy potential against economic and governance factors:** *setting up the Smart Altitude WebGIS: Web-based GIS application development on energy infrastructure, uses and renewable potential.* **« Smart Mountain Grid" Living Lab (Les Orres):** *Test of a* ***demand and production balancing system****, based on user involvement with an 'energy management service' (B2B and B2C) and a self-production/consumption approach optimizing local renewables.*

Table 5 – Evidence of relations between AG9 specific objectives and Smart Altitude actions

Global recommendations for AG9

To maximise the deployment and impact of the Smart Altitude approach with regard to implementing energy transition measures in the Alpine area, the project recommends AG-9 to:

- Apply the Smart Altitude approach to sustainable mobility at 3 levels (intrastation, station/valley, and station/conurbation), and cooperating in technical solutions, processes and products for energy efficiency with a special focus on the housing and mobility sectors.
- Provide support for local energy management systems by expanding the deployment of energy consumption supervision systems to the municipality or valley area (integrated energy management system, smart grid, sensors, cloud infrastructures, sub-metering modules, PLCs, supervision platform, …)
- Support mountain resorts in their implementation of energy efficiency and self-sufficiency solutions by further developing the toolbox and support platform for replicators beyond the Smart Altitude project.
- Invest in the recruitment of experts within the EUSALP structures to ensure the management and coordination of the network of European actors in the field of energy transition in resorts in order to organise the sharing of good practices, data, training and the visibility of initiatives in this field.
- Facilitate cooperation between energy innovation clusters with their R&I organizations and alpine areas.
- Facilitate cooperation between professional organizations for alpine sports and tourism and energy innovation clusters with their R&I organizations.

- Facilitate the citizens' involvement in energy policy: building on the concept of energy communities introduced by the Clean energy for all Europeans package, it could be desirable to define a model adapted to the energy specific characteristics of the Alpine space (seasonal consumption, geographical constraints, presence of big operators and individual consumers, …). Such framework would make it easier for citizens, together with other market players, to team up and jointly invest in energy projects. The network of these Alpine energy communities could be facilitated by EUSALP to ensure sharing of synergies and feedback about projects involving civil societies.
- Promote a labelling logic specially designed for mountain resorts based on the data monitored by the observatory for the energy transition in the Alpine space: It would enable resorts to promote their efforts in terms of a low-carbon strategy to enhance their attractiveness and to mobilise internal stakeholders around good practices and a proven transformation model. Thus, the work carried out in the framework of Smart Altitude could contribute directly to the effort undertaken in the framework of EUSALP to build a Charter for Sustainable Resorts by informing on the best practices identified and on the conditions of their transferability. While the environmental dimension of sustainable tourism drives the various analyses and actions, it seems absolutely necessary to develop a concrete and operational contribution to mobilise as much as possible the alpine tourist destinations and resorts in the elaboration of their sustainable development strategies. Smart Altitude therefore has a key operational role to play on the theme of labelling and certification.

Conclusion

Through its concerted action, based on the systematic exploration of the state of the art of energy efficiency technologies and their deployment in 4 pilot sites representative of the diversity of the Alpine space, the Smart Altitude project has demonstrated the interest and feasibility of reducing the carbon footprint and energy consumption in mountain resorts. This work has resulted in the development of reliable common criteria and indicators to measure the efforts undertaken, the implementation of a detailed process to achieve the objectives, a collection of feedback from the 4 living labs and the organisation of a replication programme to which 26 Alpine resorts have already subscribed.

Several reports have been written to develop recommendations for regional, national and European policy makers to facilitate the energy transition of mountain resorts in the Alpine region. Of these, five were specifically aimed at the EUSALP Action Groups, highlighting the contribution of Smart Altitude to EUSALP's AGs activities and its potential for replicating a well-designed replication approach directed to decision makers in high intensity winter tourism mountain territories.

The Smart Altitude replication approach has been integrated as a field of application within the AlpGov 2 project[45] Mainstreaming replication approach. It seems therefore logical to mobilize ASP 2021-2027 funding to build on the achievements of Smart Altitude to serve EUSALP Action groups objectives.

[45] AlpGov 2 is a project that “aims at enhancing EUSALP's governance structures and mechanisms to push the Strategy towards a future of embedding into the mainstream policies for regional development and cohesion”. More information at https://www.alpine-region.eu/projects/alpgov-2