WP T4 Replication and Knowledge Transfer

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

EUSALP Recommendations and contribution reports

D.T4.1.3.4 – Alpine strategies for Action Group 9: Energy Management Systems

Project acronym:	**Smart Altitude**
Project name:	**Alpine winter tourism territories demonstrating an integrated framework for a low-carbon, high-impact and resilient future**
Programme priority:	**Priority 2 - Low Carbon Alpine Space**
Programme specific objective:	**SO2.1 - Establish transnationally integrated low carbon policy instruments**

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Notes:			

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1. Executive summary / Brief

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. Among them, the efficient deployment of EMS solutions in three of the four living labs demonstrated the capacity of mountain resorts to set up systems that allow to better identify where and how energy consumption reduction measures can be taken and improve energy performance in their operations.

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.

2. Introduction

Three short reports aim to assess the convergence and contributions of the Smart Altitude project to EUSALP Action Group 9 (AG-9) with regard to energy efficiency, **EMS** and the deployment of smart grids respectively. Firstly, the work of AG-9 on these different topics will be reviewed. This will be followed by a brief review of the state of the art referring to other deliverables of the Smart Altitude project, then by a review of the work carried out in the project's Living Labs and their potential in relation to the themes addressed. Finally, the relevance of the outcomes of Smart Altitude's work for AG-9 will be highlighted and a series of recommendations will be made.

This second report focuses on **energy management systems (EMS).**

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 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.[1]

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

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

awareness and take impactful decisions. The approach is implemented in four real-field demonstrations and prepares for replication in at least 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.

3. Definition and State of the art

Energy efficiency and EMS

Energy efficiency means using less energy to provide the same level of energy services.[2] 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.[3]

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.[4] "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	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	**√**	

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

	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

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"[5]. 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"[6].

Building Energy Management systems also exist as specific EMS adapted to the building sector and described as follows[7]: "Building energy management systems (BEMS) are integrated building 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,

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

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

[7]

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"[8] and D.T3.2.1. "Territorial Maximization"[9], section 4-1 to 4-3 for EMS and 4.7 for smart metering. The latter explore in details 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.

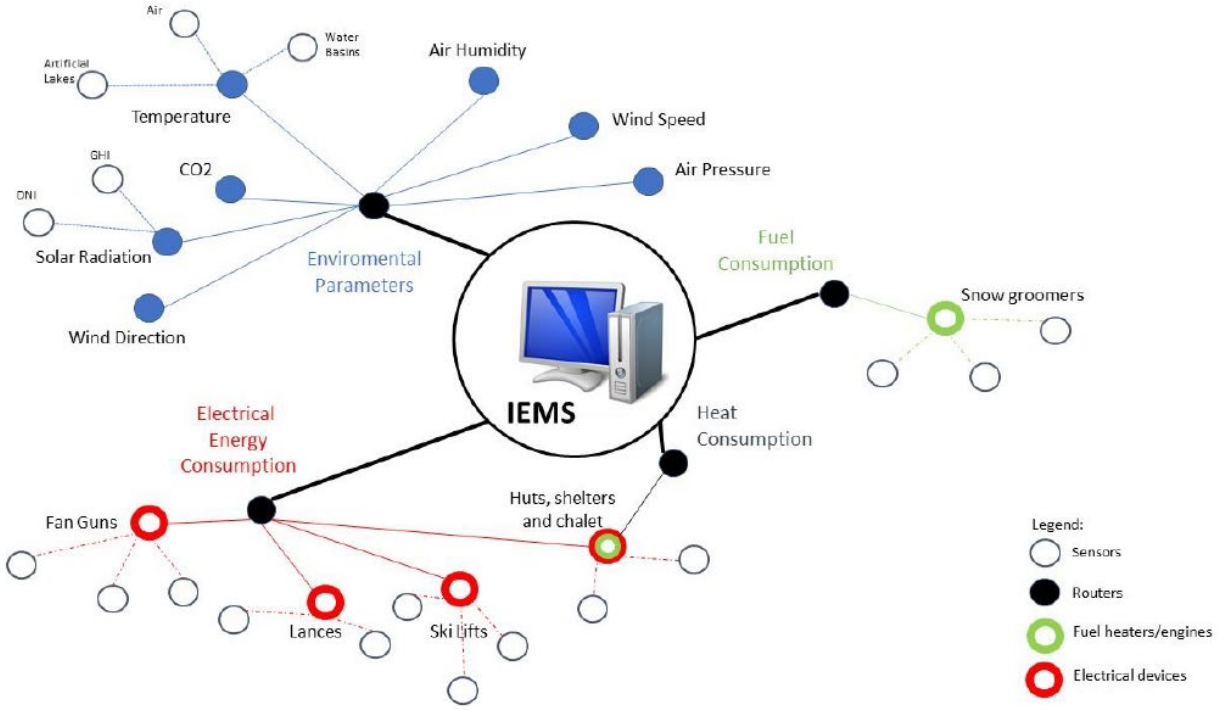

Figure 1—Generic structure for an IEMS for a ski resort.

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 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

[8] https://www.alpine-space.eu/projects/smart-altitude/en/project-results/measuring-visualizing-performance/live-monitoring-system-specifications.
[9] https://www.alpine-space.eu/projects/smart-altitude/en/project-results/smart-altitude-toolkit/territorial-maximization-report.

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.

4. Examples of deployment of EMS in Smart Altitude

The EMS in Madonna di Campiglio

The Trento-based company Energenius[10] 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.

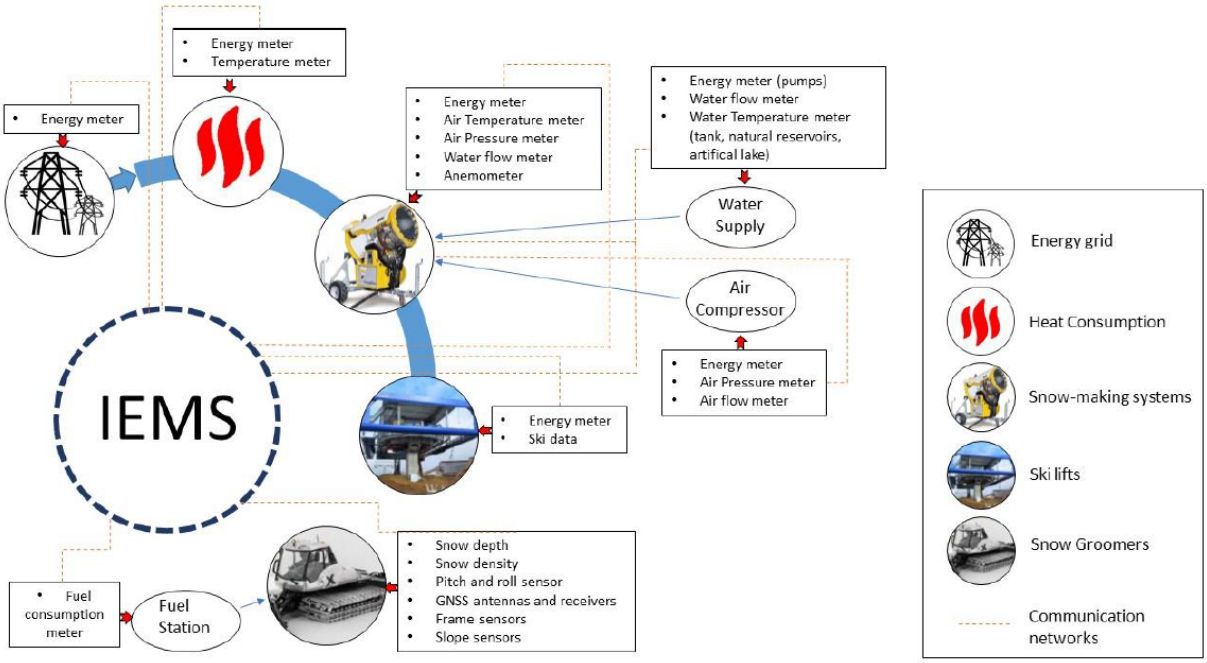

Figure 2—The IEMS implemented in Madonna di Campiglio

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

[10] "Energenius." [Online]. Available: http://www.energenius.it/.

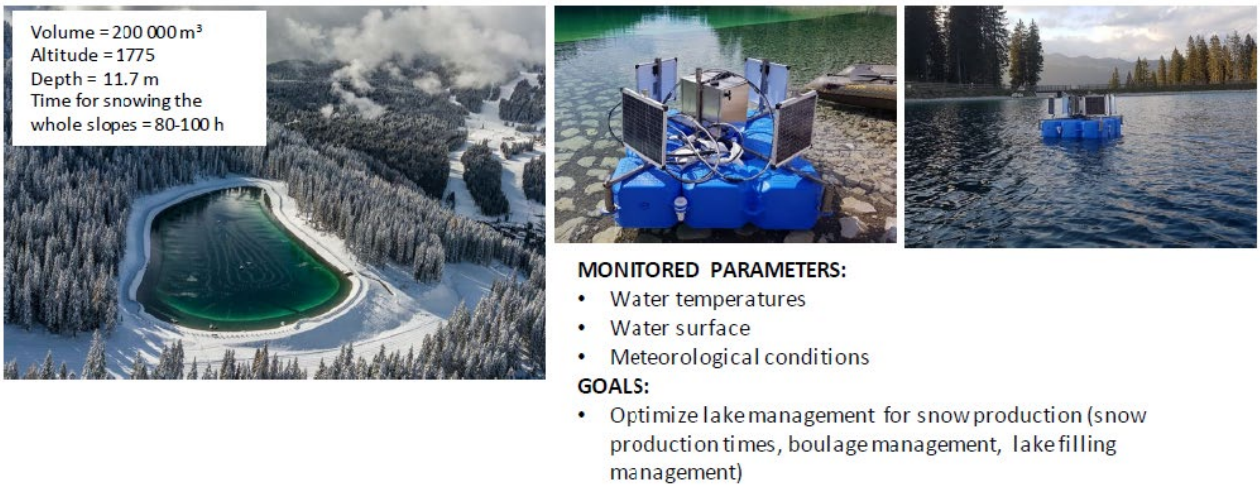

Figure 3—Monitoring Lake Montagnoli

The EMS in Les Orres

Over the last eight years, Les Orres mountain resort11 has become a "Smart Mountain" leader, deeply involved in innovative solutions for energy consumption and greenhouse gas (GHG) 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[12] available on the Smart Altitude website.

The EMS has been developed by Roquetude[13], 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.

[11] https://www.lesorres.com/en/committed-resort.
[12] https://www.alpine-space.eu/projects/smart-altitude/results/wpt2/the-iems-of-les-orres.pdf.
[13] http://www.roquetude.com/.

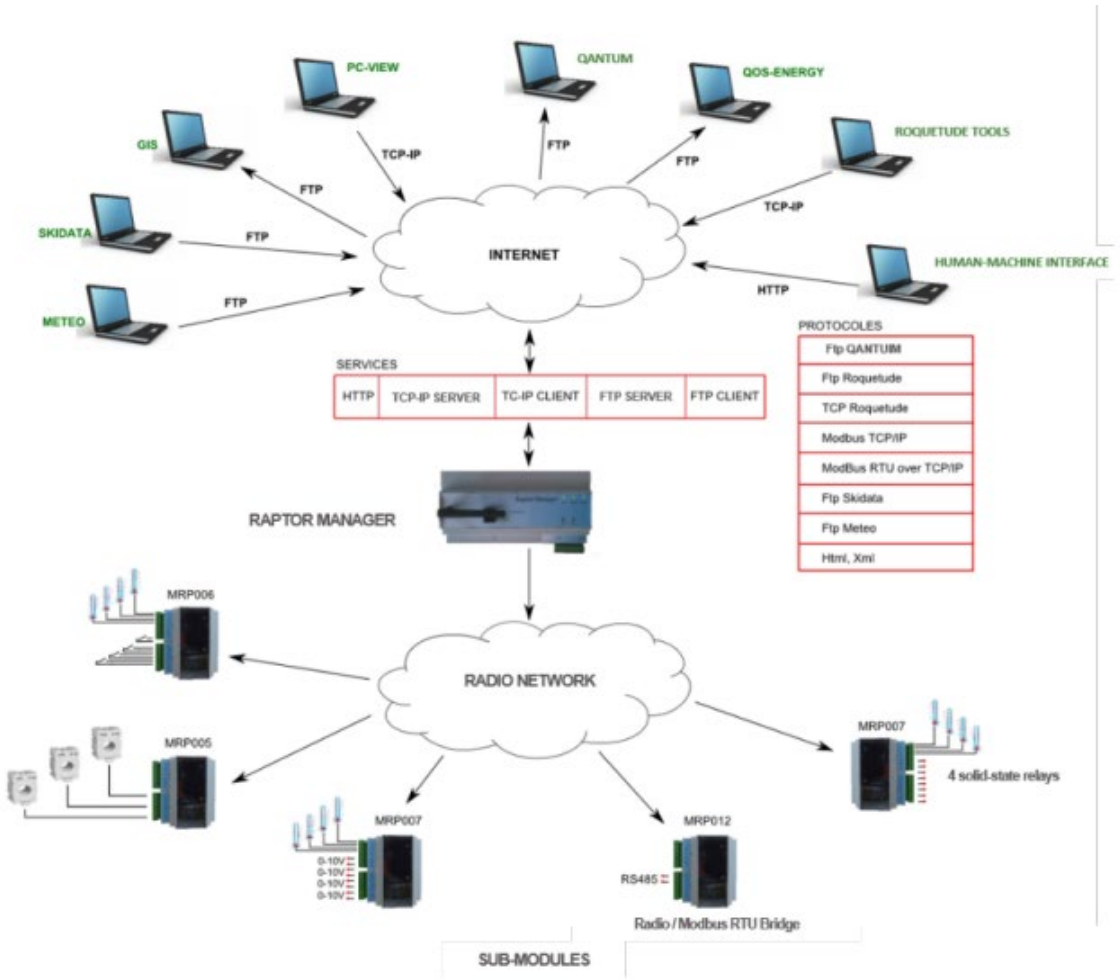

Figure 3—The Raptor network and EMS structure

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.

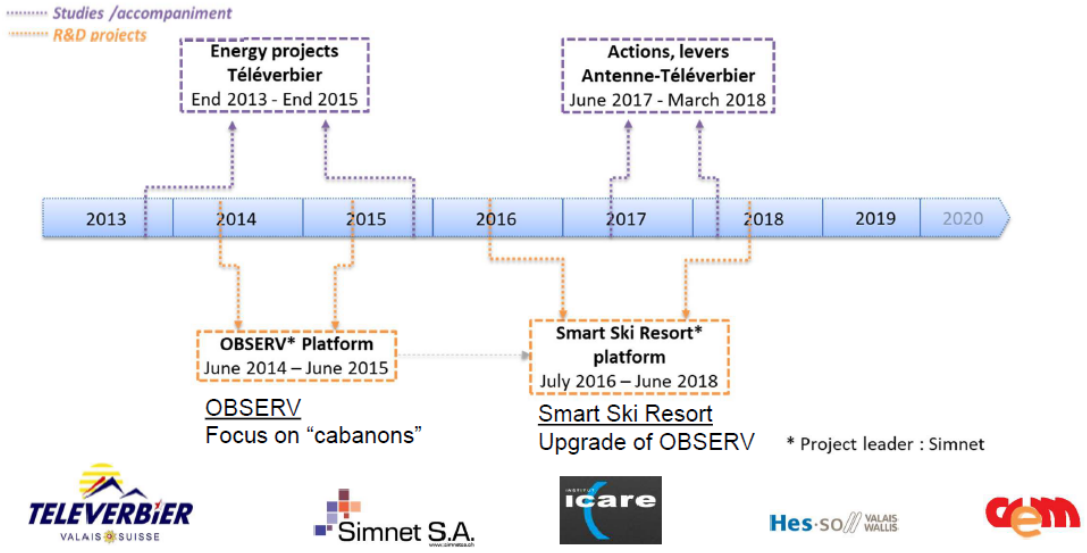

Figure 4—Step by step approach of EMS deployment in Verbier

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[14].

5. 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 innovation, bring technical solutions for the specific energy needs of the Alpine Region, and develop* ***energy***	**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***

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

efficiency processes and products *particularly adapted to the Alpine Region, especially in the housing and mobility sectors*	***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

6. Recommendations

To maximise the deployment and impact of the Smart Altitude approach with regard to implementing energy efficiency measures in the Alpine area, the project recommends AG-9 to (most relevant recommendations for EMS deployment in bold):

- 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.

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, including three reports for AG 9, whose activity is dedicated to energy efficiency and renewable energies.

By exploring the characteristics of energy management solutions and presenting the challenges of their deployment in mountain resorts, this report from the Smart Altitude project contributes to laying the foundations for future advances in efficient energy management in mountain areas.