

## WP T2 Smart Altitude Living Labs

### A.T2.2 “Multi-energy consumption reduction”

#### Living Lab (Krvavec)

#### D.T2.1.1 Report on Integrated Energy Management System



## Table of content:

1. INTRODUCTION .....	3
2. SKI RESORT KRVAVEC .....	4
2.1. SKI LIFTING .....	6
2.1.2. SKI RESORT LIGHTING.....	7
2.2. SNOW GROOMING .....	8
2.3. SNOW PRODUCTION.....	9
2.4. BUILDINGS.....	11
3. NEW MONITORING SYSTEMS.....	13
3.1. IEMS PLATFORM.....	13
3.2. ATASSplusSYSTEM UPGRADE.....	15
3.4. SNOW HOW: FLEET MANAGEMENT .....	16
3.5. TRACKING AND DIGITAL SERVICES .....	17
3.6. DIGITAL SKI RESORT MANAGEMENT .....	19
3.7. DIGITAL COMMUNICATION .....	19
3.8. DIGITAL TWIN FOR SKI SLOPES .....	19
4. CONCLUSION.....	20

# 1. INTRODUCTION

Ski resort managers are faced with multiple challenges posed by global warming and its impacts on snow cover and water resources. One of the consequences is an increasing need for energy and water for the production and distribution (grooming) of artificial snow in addition to the other energy needs of a ski resort, including the operation of ski lifts and heating of technical buildings and tourist accommodations. At the same time, there is an increasing demand from political, economic and environmental actors and general public for ski resorts to reduce their greenhouse gas emissions (GHG) and save energy. In this context, improvement of energy efficiency and integration of renewable energies through endogenous resources is a necessity. Smart Altitude aims at enabling and accelerating the implementation of low-carbon policies in winter tourism regions.

This deliverable will assess the potential for energy consumption reduction related to a set of strategic equipment, from requirements phase to operation and maintenance procedures. Proposed solutions will include an asset management approach, demand management based on WP1, expected/unexpected impacts (e.g. rebound effects), potential for new activity and further local innovation. This deliverable describes the interventions carried out during the Smart Altitude project in the Krvavec Living Lab. Infrastructural characteristics of the ski resort are described in the first part by dividing the analysis into 4 assets: ski lifting, snow production, snow grooming and buildings. The second part covers installed equipment and digital solutions and results of innovations.

The deliverable then provides a detailed description of the existing monitoring systems, the innovative approach of the Smart Altitude project in monitoring and managing data including also the new monitoring systems that are planned for installation.

## 2. SKI RESORT KRVAVEC

Ski resort Krvavec is the second biggest Ski resort in Slovenia, situated in Kamnik-Savinje Alps. Krvavec has a long tradition in winter tourism with more than 30 km of ski slopes and is considered the most popular ski resort in Slovenia. In the summer time, Krvavec is a green oasis providing pristine nature and recreational possibilities for families, hikers and bikers.



*Figure 1: Ski resort Krvavec*

Ski resort Krvavec is situated at a low altitude, and thus the supply of natural snow is an increasing challenge and forces the ski resort to intensive use of technical snow.

Inspection reviews has shown that ski resorts Krvavec has a very unsustainable power system and approach, with an extensive use of energy for cable car, ski lifts, all the vehicles and for the production of technical snow.

The main goal of the Krvavec ski resort is therefore to reduce and optimize the use of energy for a better, more sustainable and environmentally friendly management of the resort and its resources.

Krvavec ski resort aims to reduce the use of energy in the main three areas - production of technical snow, operation of ski lifts and heating. The goal is primarily to be achieved with an installation of energetically more efficient systems and equipment with a smart control of energy consumption.

For Ski resort Krvavec the factors for planning and execution of the above improvements and innovations are:

- (1) the need to adjust to the local climate change;
- (2) to be a more competitive ski resort;
- (3) to promote innovative solutions of partner companies;
- (4) a necessity to tackle the global climate crisis and
- (5) compliance with local and regional politics and goals.

The ski resort management believes that the main advantages of planned energy efficient low-carbon innovations are:

- (1) reduction of operating costs, especially the costs of power and gas;
- (2) improved image and branding of the resort for marketing purposes;
- (3) better customer experience;

The resort project team has carefully selected the suppliers of the equipment that has been or will be installed during *Smart Altitude* project and keeps constant contact with all the partners. The suppliers have proved to be well informed and interested in the application of latest innovations as well as prepared to offer new ideas and listen to the needs of the ski resort.

The main goals of the project can only be achieved with competent, creative people, ready to face new challenges and respond to the demands of modern times. We will aim to:

- motivate, educate and train our employees and in this way, increase their contribution and affiliation with the company,
- develop new products that will contribute to a more comprehensive offer of the resort throughout the year and increase the competitiveness,
- develop new markets and make our presence in the existing markets stronger - increase market share,
- comply with or surpass legal and other regulation and standards to provide the highest safety at the ski resort,
- achieve the results that will satisfy all parties and stakeholders.

## 2.1. SKI LIFTING

In pursuit of the goal to achieve more efficient energy consumption of ski lifts, the first and most important step is planning and the most important parameters needed for that step, are relevant information on ski lifts engines that have to correspond to the needs and conditions to provide the smooth and safe operation.



Figure 2: Cable car

In the field of skilifting equipment there is a lot of opportunity for improvement and the detailed review of the field has shown available and adequate solutions.

Suggested solutions that will be applied in the near future are:

- *For the purpose of optimized planning and adequate response in case of a failure, monitoring of passengers presence in cable car will be possible*

When the cable car has a failure it is difficult to establish which cable cars are occupied, that is even more difficult in bad weather conditions. It is essential that the rescue teams can quickly establish which cable cars are occupied. Adeunis sensor IoT Motion can detect presence of passengers in cable cars and so the rescue teams know where to intervene.

- *Monitoring the operation of ski lifts*

When a fuse of a ski lift fails, the whole track is blocked. It is essential that the failure is identified as soon as possible, so that the ski lift can be operational. Appropriate sensors and a digital upgrade can enable automatic detection that can save valuable time for the intervention.

- *Digital control of ski lifts*

Presently there is no digital support for ski lifting management at the Krvavec ski resort. With appropriate sensors and electronic devices digital control of ski lift electric motors will be enabled. This would also enable the use of dynamo technology, so ski lift motors while executing the function of braking would also act as generators.

## **2.1.2. SKI RESORT LIGHTING**

At a typical ski resort, lighting represents between 5 and 10 % of all energy consumption and can be a very good starting point for energy savings. Optimization of columns installation, adjustment of the ski slopes terrain in the summer and use of more appropriate lighting are the most viable and efficient measures. It is reasonable to install automated lighting with sensors that can adjust to the ambient light.

At this point Krvavec does not offer night skiing even though it has offered it in the past and will, according to the trends, most likely offer it in the future.

The ski slope lighting under the 4 chair ski lift and 6 chair ski lift is currently covered with reflectors that are obsolete and extremely energy consuming. The part of the ski slope that is planned for night skiing as well as the whole cabin car route will be equipped with smart energy saving lighting, that can be individually and dynamically adjusted to the current conditions. The use of LED lighting with installed sensors will be applied and managed through a central digital platform.

The existing lighting of all spaces on ski lifts was also obsolete and extremely energy consuming. All reflectors and lights are being replaced with smart LED lights that use more than 10 times less energy and enable individual volume adjustment and individual on and off switch. The use of LED lighting with installed sensors will be applied and managed through a central digital platform.



## 2.2. SNOW GROOMING

The system of snow grooming will get much attention in the near future.

Snow groomers are extensively energy consuming, they weight more than 14T and use more than 200l gas oil in a single working night.

RTC Krvavec has 6 snow groomers, all running on diesel engine, which means that they use outdated technology, are very energy consuming and not environmentally friendly.

New snow groomers that are available on the market are energetically much more efficient and use environmentally friendly solutions. Since the purchase of new snow groomers is a demanding and extensive investment process that takes time, we also have to focus on the measures and improvements that can be achieved in the short term, the innovation process has started with installation of GPS and other sensors on the snow groomers and with a system for tracking and collecting data through communication channel CAN. An appropriate digital upgrade for managing vehicles was installed. This system can be used on every snow groomer brand and for all the ski slopes.

The process will continue with the best digital solution for fleet management.

The future of snow grooming is based on environmentally friendly new technologies and this is a prototype of a snow groomer with a hydrogen fuel cell drive that is suggested as the most efficient alternative to the old diesel snow groomers.



*Figure 3: HySnowgroomer*



## 2.3. SNOW PRODUCTION

Ski resort Krvavec has a very complicated system of snow production. Geographical position, climate with rapid temperature changes, diverse wind and weather conditions are very important for the optimization of snow production process.

Most of the snow production equipment at Ski resort Krvavec is outdated, since only 20 out of 100 snow cannons are digitalized.

The 20 snow cannons are digitally supported with a digital upgrade ATASSplus, that fits the specific needs of ski resort Krvavec.

The picture presents the digital twin that is enabled by ATASSplus system on Krvavec:



Figure 4: digital twin ATASSplus system on Krvavec

Eighty snow cannons are obsolete and in need to be replaced or upgraded. The 28 cannons that are in this moment manually operated and can be upgraded are currently in the re-fitting process and will be included in the existing ATASSplus system. The 18 cannons that cannot be upgraded will be replaced.

Out of all available options, the installed ATASSplus software developed by TechnoAlpin is a product that meets the ski resorts expectations the most. The system itself manages snowmaking procedures using input data (outside temperature, humidity, wind, snow depth, snow gun condition, water flow,...), is user friendly and can be further upgraded if needed.

#### Advantages are:

- 30% less water needed to cover the slopes with technical snow
- 40% less working hours, safe management (from the office)
- Optimal snow depth on the slopes – less snow groomer hours
- 30% electrical power reduction

## 2.4. BUILDINGS

Buildings required for the operation of the ski resort such as ski lift and cable car stations, maintenance facilities, management offices are relatively small energy consumers, but even small measures can additional increase energy savings.

As part of *Smart Altitude* project RTC Krvavec has already executed a line of modifications that reduce the energy consumption in heating systems and are based on advanced digital solutions.

Thermostatic valves were installed on each radiator in the hotel. They are being managed through the computer or mobile application. The program enables heating of each room at the preset temperature. If the room is not booked, the system automatically shuts off the heating. In case of reservation, the system automatically turns on the heating of the room one hour before the announced arrival of the guests.

SELTRON WDC20 system was installed in the boiler room. It controls the temperature of the water entering the heating system and manages it in accordance with the outside temperature. When outside temperature is low, higher temperature of the water in the system will be regulated.

In the boiler room the circulating pumps were replaced for economy reasons.



*Figure 5: Hotel Krvavec boiler room* Together with the GWD communication module the Clausius application was installed. Receptionist, hotel management and maintenance can manage hotel heating entirely via Clausius mobile application and/or as a web application.

The results of these changes:

- approx. 20% lower heating oil/ gas consumption,
- higher comfort for the guests and
- easier management of the heating system
- reduction of staff working hours.

For additional reduction of energy consumption all the lighting in the buildings is being replaced with smart LED lights that use more than 10 times less energy and enable individual volume adjustment and individual on and off switch. The use of LED lighting with installed sensors will be applied and managed through a central digital platform.

## 3. NEW MONITORING SYSTEMS

### 3.1. IEMS PLATFORM

At present, RTC Krvavec does not have advanced systems or platforms for managing, monitoring and planning the energy use and needs - IEMS platform (integrated system for energy management).

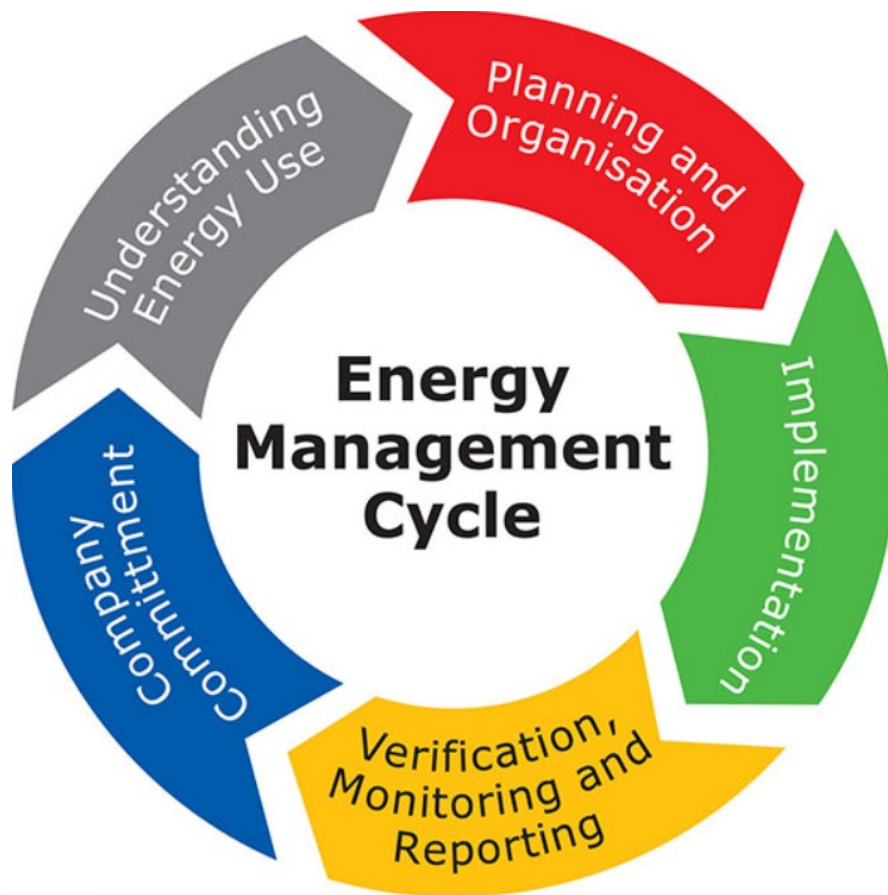


Figure 6: energy management cycle

Energy management includes engineering, planning, use and to some extent the maintenance and operation of integrated power systems.

The first step in managing the energy consumption is recognizing and analyzing the possibilities of energy savings and taking decision to implement it in the most viable way.

The second important step in the project of upgrade is the study and definition of all the demands for energy management and control. Energy management systems (EMS) are one of the new technologies that enable collection of energy use information in the real time with monitoring, grading and visualization of energy consumption.

IEMS platform offers integrated information covering the whole ski resort and where relevant, its surroundings and can enable ski resort management to make efficient and sustainable decisions.

The advantages of integrated platform are:

- The use of one control panel for the demonstration of all surveillance parameters
- The possibility of creating KPIs with cross-reference of information from different systems
- The possibility of recognition of complex algorithms for forecasting and optimization of snow production, snow grooming and ski lift managing
- The possibility of alarms
- The possibility of regular reporting

RTC Krvavec will develop contemporary, digital and integrated system for energy monitoring that will collect in one platform all the data, recorded by the variety of existing and new sensors, installed at the ski resort. This data include energy flows and most important physical and thermo-dynamical parameters of main ski resort points, such as ski lifts, snow production systems, water supply, weather forecast and temperature in closed spaces.

All required and specific information for the future platform will be gathered with appropriate sensors that will collect data about:

- Ski resort operation
- Energy and water consumption
- Extraction and consumption of locally renewable energy
- Properties of water in the artificial lake
- Performance characteristics of ski lifts
- Basic information from snow groomers warehouse



### 3.2. ATASSplusSYSTEM UPGRADE

The existing **ATASSplus** developed by TechnoAlpin is a digital solution system for an efficient production of snow.

The software collects data from snow cannons and meteorological stations and optimizes the snow production according to the conditions. It constantly monitors and evaluates the use of resources, the optimized water and air management also enables extensive resource savings.

Due to the temperature inspection of the whole area ATASSplus enables energetically efficient snow production on specific parts of the slopes. Statistical data in real time enable constant monitoring of water and energy consumption and prevent excessive consumption.

The evaluation of data enables precise and effective snow production planning. ATASSplus system also enables additional data analysis and quick response to short term changes in relevant conditions.

SnowManager part of the ATASSplus displays the depth of snow coverage in centimeters. With this innovative solution SnowManager automatically calculates the needed amount of snow, according to the minimal snow coverage pre-setting. As soon as the set parameter is achieved, the snow team will be informed and if so programmed, the production of snow will be stopped automatically. ATASSplus prevents excessive snow production. As a result the operating costs can be optimized and the slopes can be covered with technical snow of consistently high quality.

TechnoAlpin software is constantly being updated and optimized in close cooperation with ski resort. The control system is constantly expanded with additional functions. Management and surveillance of the snow production process is constantly simplified through annual systems upgrades. The system will be upgraded with an advanced digital solution ATASSplusSlopeManager, which will also integrate other relevant systems.

### 3.3. ATASSplusSlopeManager upgrade and establishing of a digital twin of the ski slopes

ATASSplusSlopeManager offers general information for the whole system and provides breakdowns for individual slopes. Quick view enables view of the current flow and current average temperatures, extended view offers additional information. The details of every individual machine can thus be detected quickly and accurately.

For testing purposes different conditions for any snow cannon can be simulated. The temperature and humidity can be simulated for individual snow cannons or for a combination of snow cannons.

This system also enables collection of data from snow groomers and many other sensors.

Development of a digital twin of the ski slopes in the form of 3D snow coverage map is suggested as an upgrade of ATASSplusSlopeManager.



Figure 7: Visualization of the Snowvision digital solution

This digital twin enables smart snow production management and cuts snow production costs and enables increased number of skiing days. It also improves ski resorts safety on ski slopes. The ski resort will automatically and constantly monitor the state of snow coverage and make smart decisions on snow production management.

### 3.4. SNOW HOW: FLEET MANAGEMENT

PRINOTH fleet management is an integrated system for digital management of snow grooming fleet, including snow groomers, snowmobiles and other vehicles. Regardless of the producer of the vehicles the data on the vehicles position and other data can be monitored in real time. PRINOTH is a fast and effective tool that enables higher fleets effectiveness and cuts costs.

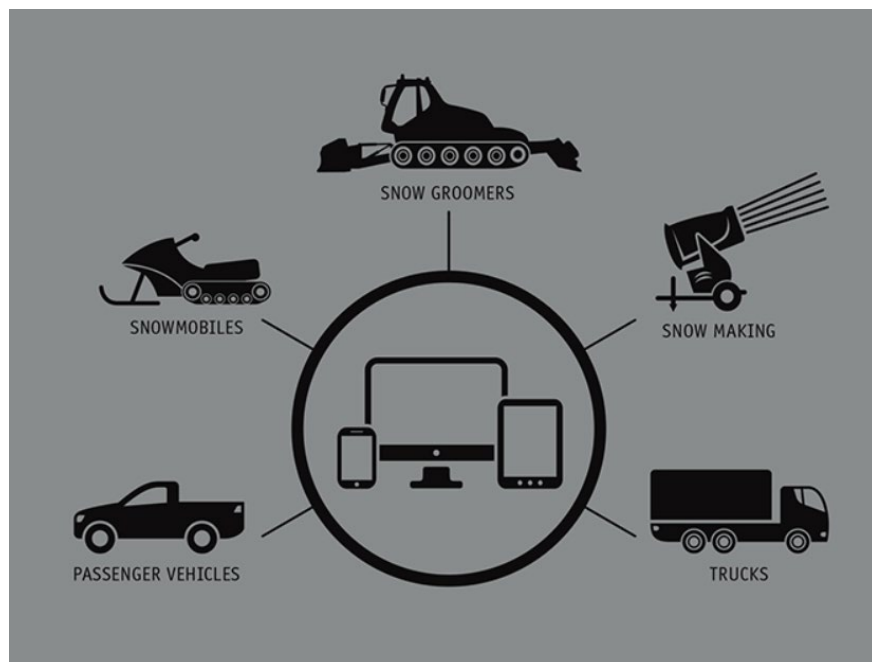


Figure 8: Fleet management scheme

Precise recording of data and individually adjustable assessment of data enables precise collection of information that are needed to optimize vehicles operation as well as optimizes the work of the operator. With this information the fleet manager gets access to the work hour schedule and maintenance intervals and can plan the work more effectively.

The advantages of the system:

- Optimization of the route
- Optimal use of vehicles
- Reduced fuel consumption
- Increased coverage
- Faster transfer of data to operators

### 3.5. TRACKING AND DIGITAL SERVICES

In the winter season thousands of people visit ski resort daily. This number of visitors regularly leads to long waiting time at ski lifts, in the restaurants, at ski hiring and other services. This causes negative customer experience and negatively effects ski resorts image.

A solution for tracking and its application for smart phones contribute to a more positive customer experience and help the management in making reasoned decisions on ski resort improvements.

Tracking and Digital Services in Ski Resorts



Figure 9: Visualization of tracking and digital solutions

The tracking solution offers insight into the number of people, their distribution and the duration of their stay in combination with other relevant factors like the weather or the day of the week. The data can also be compared to past seasons data. In this way management can optimize and adjust decisions to actual or expected number of visitors.

Appropriate measures can be taken to improve general customer experience. For example, the decision can be made where to open additional ski lift or a restaurant.

The tourists can access information and additional functions through a smart phone app. The application shows waiting lines on ski lifts and in the restaurants. The skiers can find ski lifts with least waiting time.

As a result the distribution of skiers is more even around the ski resort.

### **3.6. DIGITAL SKI RESORT MANAGEMENT**

Online mobile application can be installed for digital management. This application would enable real time collection of organized and detailed data and provide advantages such as:

- Digital data collection (paperless business)
- Digital inspection of ski slopes
- Digital accident reports
- Status check of the ski resort
- Digital reporting on preventive cable car inspections, ski lifts, snowcannons...
- Inspection and management of signs on the ski slopes
- Planning of cleaning and maintenance of the buildings
- Checking conditions for ski equipment rental

Advanced system of smart cameras is to be installed. With the help of advanced technologies they automatically recognize dangerous situations and inform the responsible decision makers about them or even take some measures on their own.

In this moment there are cameras installed at all ski lifts. They mostly monitor access and exit operation. Additional cameras for ski slope coverage, accident detection, ski lift operation, number of people at an individual ski lift... are needed.

### **3.7. DIGITAL COMMUNICATION**

According to the legislation, every station and every ski resort must have a separate internal communication.

At present Ski resort Krvavec has completely obsolete communication via landlines. The communication system should be digitalized and instead of present outdated communication equipment smart phones should be used.

Additional challenge is in the obsolete UKV system. This is a 35 year old analog system that is not connected to the parking spaces. It should be replaced with a contemporary digital internet communication connection system that will enable quality information exchange between the ski slopes, ski lifts and parking spaces in the valley.

### **3.8. DIGITAL TWIN FOR SKI SLOPES**

SNOWsat GIS Data Manager is a tool for an easy management and updating of geospatial data. It enables a complete map of ski slopes with all information needed for a performance optimization.

Geographical information system (GIS) of the ski slopes includes all specific data needed for every day operation: terrain profile, edges of the slopes, snow cannon positions, areas covered with technical snow, roads, buildings... GIS data are basis for business activities (construction activities, snow production and snow grooming planning...) on the slopes.

SNOWsat GIS Data Manager supports coordination of all decision makers, since they all have access to the data. It increases effectiveness and opens new possibilities for savings.

Key system solutions:

- Central management of all geodetic data
- Individual data adjustment to current conditions
- Cost savings
- Data basis for further calculations
- Updated digital image of ski slopes
- Unified database of information and knowledge
- Increased safety
- Marking of dangerous places, orientation points...

## 4. CONCLUSION



Climate change and the call to reduce greenhouse gas emissions and the need for more efficient use of renewable energy for a more resilient winter tourism regions are forcing ski resorts in the European Alps to search for “smart” solutions in the transition toward sustainable, low carbon, eco-friendly economy.

Once introduced, digitalization process will not stop, on the contrary - it will grow, deepen and become an even more essential part of the process. For this reason advanced counties have been actively investing in development of needed infrastructure that will enable the use of digital technology and thus improve quality of service and resilience of ski resorts to different factors.

Last years pandemic, has been a catalyst and accelerator of the existing and active digital development. Ski resorts have a shared responsibility to actively invest their resources and capacities to develop their infrastructure, implement digital tools, use digital practices and manage digital processes.

Ski resort Krvavec is situated at a low altitude, and thus the supply of natural snow is a challenge and forces the resort to intensive use of technical snow.

The inspection has shown that at present the resort has very unsustainable solutions, with an extensive use of energy for cable car, ski lifts, for the vehicles and for the production of technical snow.

A key challenge is therefore optimization of energy consumption for a better, more sustainable and environmentally friendly ski resort.

Ski resort Krvavec aims to reduce the energy consumption for snow production, ski lift management and heating. This goal is being achieved with installation of energy efficient systems and equipment for snow production, ski lifts and heating generators and with a smart control of energy consumption. Energetically demanding snow cannons will be replaced with more environmentally friendly ones.

The use of suggested new digital technologies will support the transfer to an even smarter and digital ski resort, which will increase optimization of energy consumption for a better, more sustainable, environmentally friendly management of ski resort and lead the way to a complete digital transformation of Krvavec.

The new system aims to use the digital tools to the best of their abilities and achieve long term competitive advantages in the fields of customer experience, service development, cultural heritage protection, tourist offer, improved sports, recreational, culinary and other offer.

RTC Krvavec plans to become smart, fully digital ski resort and for this purpose digital strategy will be a key part of the long term planning document and will provide the foundation for economic, special and social development of RTC Krvavec.

