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Figure d'illustration : Verbier ski resort

Interreg Alpine Space Smart Altitude

D.T2.4.1 Energy efficiency in Verbier

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EPFL
VILLE DE MARTIGNY
Hes·SO VALAIS WALLIS

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1. Overview of the project

1.1. Smart Altitude: CREM/Verbier Information

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The total budget for the Swiss part of the project amounted to CHF 171 000, distributed as follows:

Table 1 : Swiss budget

	Smart Altitude Swiss budget
ARE	CHF 50 000
SETI	CHF 30 000
Val de Bagnes	CHF 20 000
Téléverbier SA	CHF 51 000
Crem – own services	CHF 20 000
TOTAL	**CHF 171 000**

Duration of the project in Europe: from 17.04.2017 to 11.05.2021
Duration of the project in Switzerland: from 01.2019 to 09.2021

In Switzerland, the work is co-financed within the framework of the new regional policy (NPR) of the State Secretariat for Economic Affairs (SECO) through the Regional Development Fund and is supported by the Federal Office for Spatial Development (ARE).

1.2. Objectives and progress of the project

The project on the Swiss side was organized around the following work packages (WP):

1. Work package 1
   a. Description of the steps towards ISO 50 001 certification
   b. Energy-climate balance and evaluation of energy savings and GreenHouse Gas (GHG) emissions reduction
   c. Proposal for a Key Performance Index (KPI) and analysis of the KPIs for the Verbier ski area
   d. Definition of objectives in relation with the ski area master plan and the energy master plan of the Municipality
   e. Update of the action plan
2. Work package 2
   a. Identification of action levers for energy saving and GHG emissions reduction
   b. Elaboration of sustainable and innovative energy concepts
   c. Support and realization of subsidy applications
3. Work package 3
   a. Support the municipality of Val de Bagnes in the integration of Téléverbier in its energy master plan and associated action sheets as a key player in the territory
   b. Development of the actions of the energy policy program 2018-2022, in partnership with the industrial services, Altis SA, and Téléverbier in order to increase the score of the label “Cité de l'énergie”
4. Work package 4 - see online results (https://www.alpine-space.eu/projects/smart-altitude/en/home)
5. Work package 5 - see online results (https://www.alpine-space.eu/projects/smart-altitude/en/home)

Work packages 1 to 3 are developed below.

1.3. WP 1: Feedback on standard ISO 50 001

The ISO 50 001 certification aims to improve the energy performance of any organization. The undeniable advantage of this standard is to provide a detailed repartition of the ski area's energy consumption. This allows to target and prioritize high-impact actions to implement in terms of reducing consumption and therefore costs. Thus, within the framework of the project, a state of the art of certified ski lifts was carried out and feedbacks collected.

What emerges from the feedback is that the implementation of this standard seems to present a certain number of challenges. Thus, the implementation of associated tools such as the data monitoring system is a point that often comes up during the exchanges. In addition, this data is often difficult to obtain due to the multiplicity of people who can provide it. Even once the certification was obtained, it emerged that the update is long and laborious.

Secondly, the feedback highlighted that the workload associated with ISO 50 001 certification is significant. The Quality Safety Environment Energy managers are the first to be concerned. A significant part of their working time is dedicated to obtaining certification and then monitoring energy management. This is truer since these companies often have several other certifications (14 001, 19 001, etc.), which means that they must perform many audits.

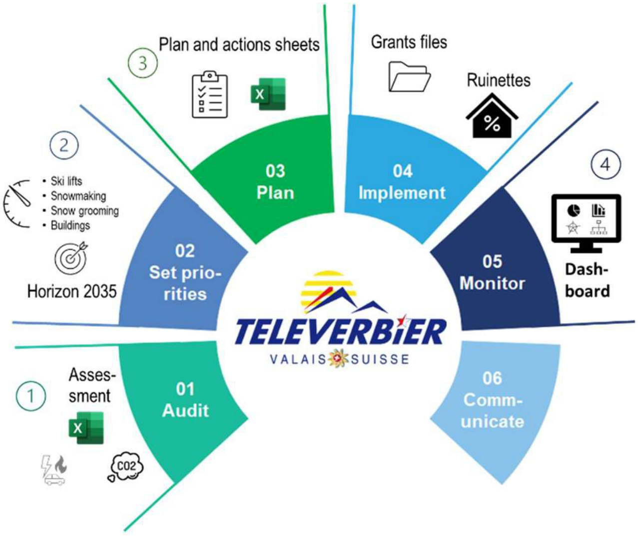
This leads to the third observation, which is financial and human. The company must have the financial means to support such an energy management approach, but also the human resources necessary for its implementation, monitoring and audits of the approach.

1.4. WP1 - 2: from assessment to actions levers

The Smart Altitude toolbox (https://smartaltitude.eu/) has been developed and adapted to the specific situation of Téléverbier SA.

The figure on the right shows the six-stage diagram of the Smart Altitude toolbox developed with the European partners, detailled with elements developed on the Swiss side.

Stages one to three and five are presented below. The "04 implementation" part is developed in chapter 4 below



.*Figure 1 : The Smart Altitude toolbox for Switzerland*

01 Assessment

The "Assessment" tool collects all energy consumption data and calculates the GHG emissions related to the operation.

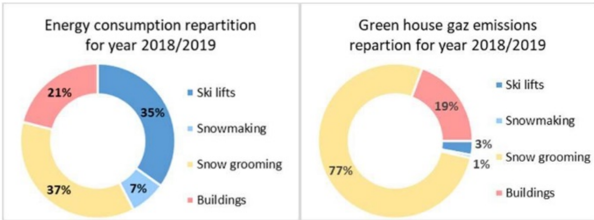


Figure 2 : Repartition of energy consumption and G HG emissions by post

02 KPI and objectives

Once the assessments completed, a set of KPI is established. The KPI allows, on the one hand, to cancel out the impact of external factors on consumption (weather, frequentation, etc.) and, on the other hand, to set clear objectives on a certain time horizon. An example for the building sector is presented below.

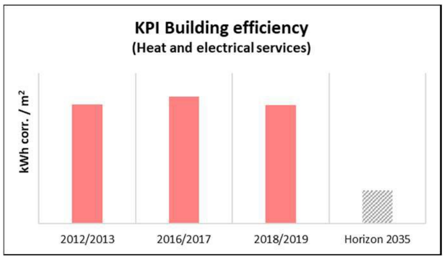


Figure 3 : Building efficiency KPI (Heat + electrical services)

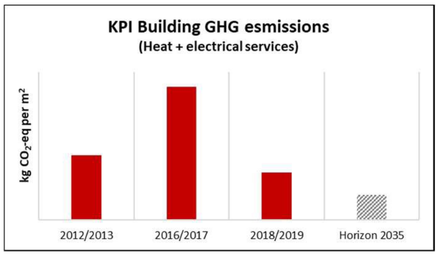


Figure 4 : Building GHG emissions KPI (Heat + elec. services)

03 Plan and action sheets

The action plan lists the measures to be implemented and serves as a suggestion box for implementing effective measures to reduce consumption and GHG emissions. The "action plan" tool allows to follow the measures implemented in each post.

05 Dashboard

Energy monitoring platforms, such as those used by Téléverbier (Observ, SISAG), allow for a fine monitoring of consumption, to identify deviations, to follow the evolution of the KPI and to evaluate the impact of the measures in a consistent manner. This is the cornerstone of energy management approaches.

1.5. Action plan for building

Within the framework of the project, the emphasis was placed on the building section in which important action levers were identified. The ISO 50 0001, Plan-Do-Check-Act method is decomposed below.

1 Heat master plan PLAN

The master plan of Téléverbier ski lifts replacement has been taken over and completed with the building renovation strategy. This new master plan allows anticipation and mutualization of renovation projects for the ski lifts and buildings.

2 Renovation scenarios tool DO

A tool for creating building renovation scenarios allows Téléverbier to estimate the impact of its projects and to determine the efforts to be made.

3 Energy accounting tool CHECK

Energy accounting for buildings has been set up to monitor and control building consumption and improve energy management. It allows to quickly define the priorities for renovation, to identify energy deviations and to ensure that the renovations have reached their energy efficiency objective.

4 Energy audits and concepts ACT

Within the framework of the project, several energy audits of buildings have been realized and concrete action levers have been identified to reduce energy consumption and GHG emissions. Thanks to those audits, renovation works have been anticipated and subsidies files realised to activate investments.

For example, the building “Les Ruinettes” has had its oil-fired boilers replaced by a renewable wood pellet supply and various energy optimization measures have been set up.

Figure 5 : Ruinettes energy concept

Also, a sustainable and innovative energy concept has been proposed for the Ruinettes area, with the support of Altis SA, the industrial services of Val de Bagnes, the spin-off Kaemco and the engineering firm Energie-solaire SA. In this zone, renovation projects of the hotel “Le Mouton Noir” and of the water treatment plant are in progress. As all these infrastructures are located close to each other, a concept for a mini district heating network has been proposed.

This concept is based on a varied energy supply, composed of the wood boilers of “Les Ruinettes” building, the heat rejections of a datacenter, the production of thermal solar panels as well as the installation of ice-cold heat pumps. This concept would allow to supply the whole area with heat.

1.6. WP3: Municipality and « Cité de l'énergie »

Crem organized and animated a meeting between the three main territorial actors of Val de Bagnes. The group named "sustainable development working group" was held with the objective of investigating the possibilities of collaboration and possible strategic alignments in terms of sustainable development.

Coordination axis 1: Optimization and reduction of energy consumption

The ski area master plan is the tool for sharing strategic visions. Together with the muncipality's territorial energy master plan, they form a solid basis for developing strategies in a coherent manner. Moreover, the actors wish to integrate Téléverbier in the "Cité de l'énergie" program. This will benefit both parties, allowing the municipality to gain some precious points towards the European energy award gold label and Téléverbier to benefit from a new communication channel, therefore gaining visibility.

Coordination axis 2: Waste management and Mobility

The Verbier 2030 project, supported by the municipality, will allow, during the next meeting, to develop in detail this coordination axis presented as strategic by the concerned actors.

The setting up of this sustainable development working group, which is going to be reunited at least twice a year, will therefore make possible to develop shared and coherent strategies between all actors in the areas.

1.7. Project contribution

The systemic methodology developed with the European partners and applied to create tools for monitoring performance and implementing actions ensures an easier updating of the data and facilitates the steps towards ISO 50 001 energy management certification. The Interreg Alpine Space Smart Altitude project has thus demonstrated in four demonstrators the effectiveness of developing, through a global and systemic approach, a toolbox of decision support. It facilitates the implementation of relevant and effective policies and measures to reduce energy consumption and GHG emissions.

The perspectives opened by the project are various. On the one hand, thanks to the systemic methodology used, the replicability of the project is ensured and allows to lay a solid foundation for increasing the resilience of mountain areas, and in particular of ski-lift companies, by repeating the process among interested companies. In addition, the Smart Altitude toolkit is now available to all ski lifts willing to make their energy transition. Thus, they can already start or reinforce their energy efficiency and renewable energy development processes.

On the other hand, at the Swiss level, this project provides tools and systemic approaches that should be implemented at the level of ski lift associations. Indeed, the energy and sustainable development strategies of this sector are not clearly defined yet. However, it seems obvious that the ski lifts, a major sector of Swiss tourism, must also make the energy transition undertaken by society. These strategies could be integrated and formalized more clearly in the regional master plans and be the subject of binding laws for obtaining subsidies, for example.

1.8. Project follow-up

Thus, the Interreg Alpine Space Smart Altitude project has laid a solid foundation on which effective and coherent strategies can be defined. This can be done both at the local level by ski lifts wishing to make their energy transition, and at the regional level by integrating the recommendations into the strategies already defined at this level. But above all, these bases should be deployed at the level of the domain's umbrella associations, which must promote a more sustainable, four-season tourism and provide their members with the necessary tools to achieve it. The Smart Altitude project will be pursued with Téléverbier to update and monitor its actions, and then in the longer term with the umbrella associations and the regional authorities.

2. Energy Efficiency implementation model

2.1. Action levers in ski lift companies in favour of energy transition

Context

TéléVerbier SA has been identified for the following reasons:

- Their proactivity in energy efficiency initiatives, such as:
  - A development strategy emphasizing efficiency and project sustainability.
  - A roadmap planning the energy efficiency measures to be implemented in the short and medium term.
  - The implementation of a Dashboard for real-time energy monitoring and regulation, OBSERV platform. This platform is being developed as part of the SFOE's P+D Smart Ski Resort project and is supported by Simnet SA.
  - Their willingness to participate in exchanges of experience, with European projects such as Smart Altitude.

The issue of energy efficiency in a more comprehensive manner is proposed, in order to broaden the range of possible actions by including measures such as the substitution of fossil fuels, the regulation of installations, the production of renewable energy or the recovery of heat waste. This approach also has the advantage of offering much greater potential in terms of replicability, as the various lifts have their own development strategy and planning. This approach therefore provides a broader vision, making it possible to integrate financing levers.

General methodology – Energy management of ski lifts

This integrated approach offers much more potential for project identification and fits perfectly into an Energy Management approach for ski lifts.

The strategic and operational aspects are closely linked to the monitoring of the installations, which allows the identification of priority measures to be implemented and which then gives a feedback on the effectiveness of the measures undertaken.

Energy Management, as defined in the ISO 50'001 standard, allows the achievement of the objectives set by proposing the following iterative process:

- Commitment to action: definition of objectives, in terms of efficiency and/or reduction of greenhouse gas emissions.
- Planning: identification of measures to achieve the set objectives.
- Implementation: this phase consists of the implementation of the measures identified during the planning phase.
- Verification: the verification phase consists of monitoring the impacts related to the measures implemented and, if necessary, allows a redefinition of the strategy.

The following figure shows the integration of an Energy Management approach encompassing all the main areas related to the operation of a lift company:

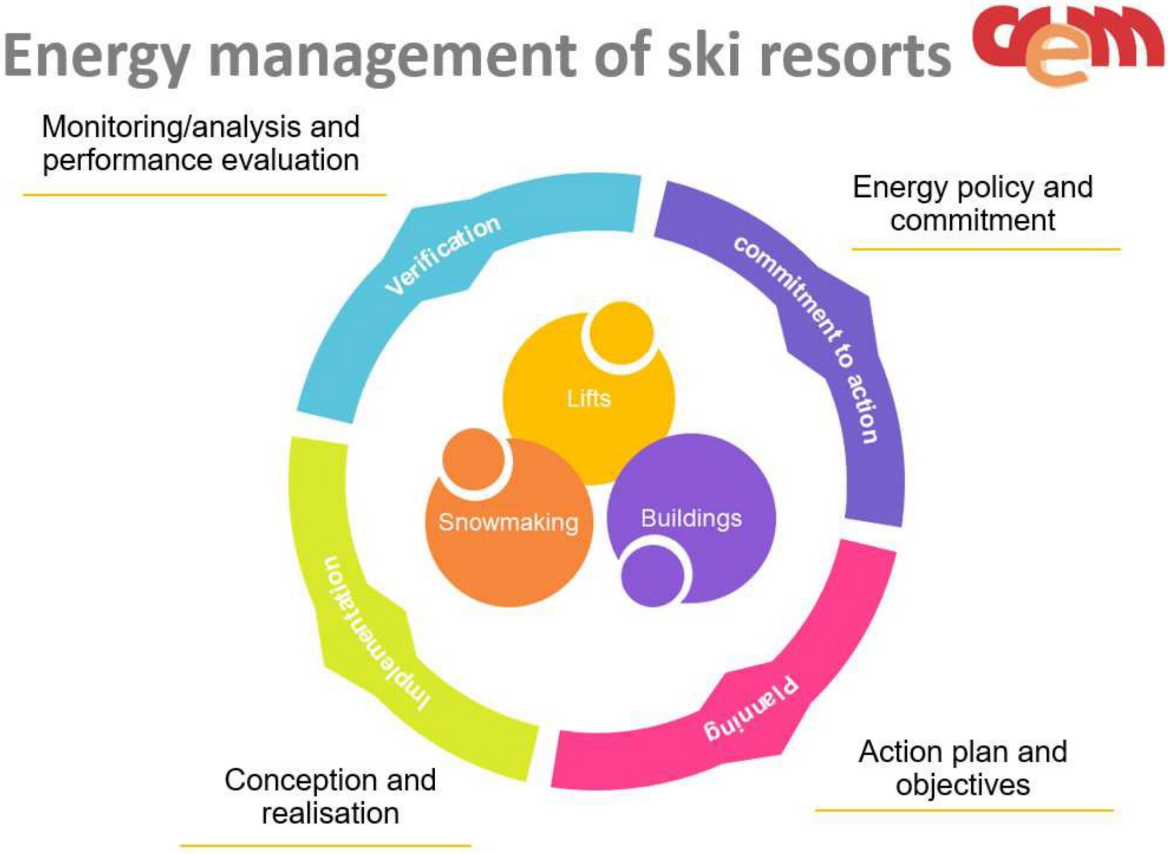


Figure 1 : Energy management of ski lifts

Levers for energy efficiency

There are several levers of action for lift companies to increase their energy efficiency.

A study on the "Energy management of ski lifts", published by Swiss Ski Liftsgives a first overview of the actions that can be taken by them.

On this basis and after an initial analysis, 7 major themes appear as important consumption items as shown in the figure below.

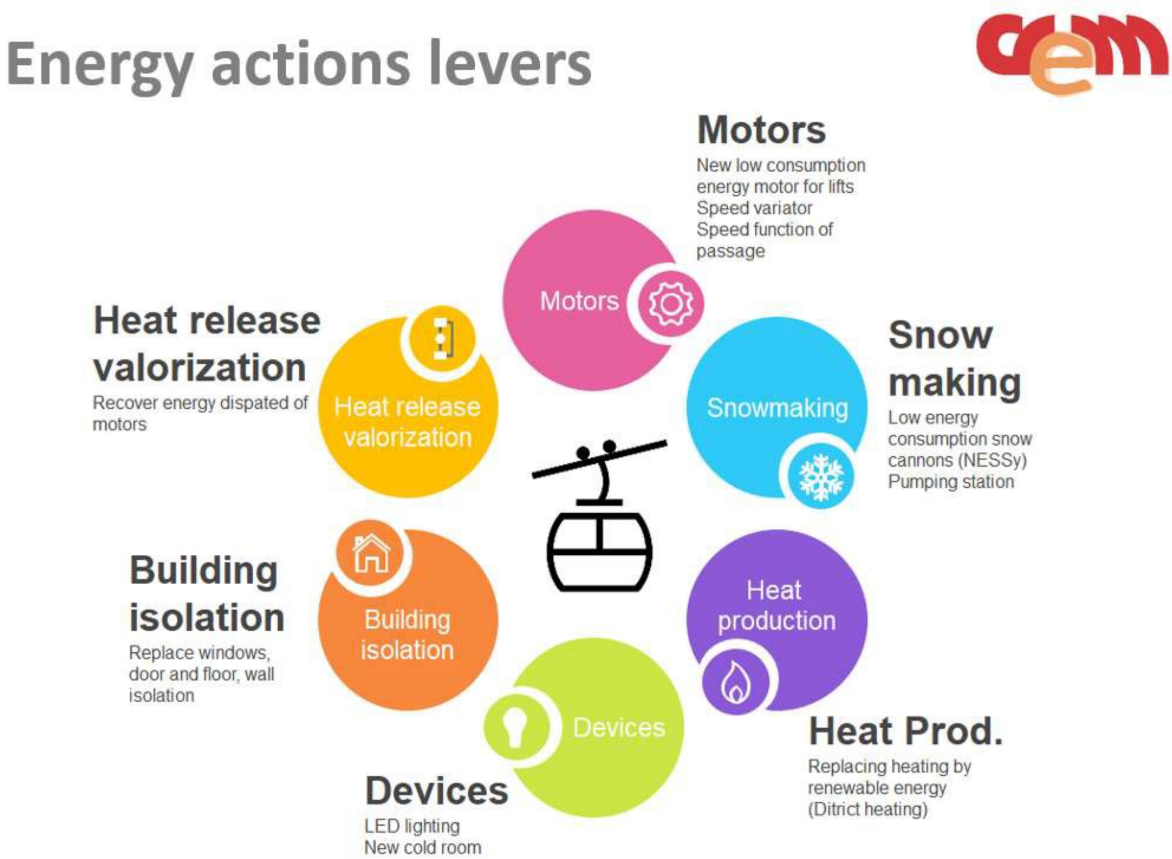


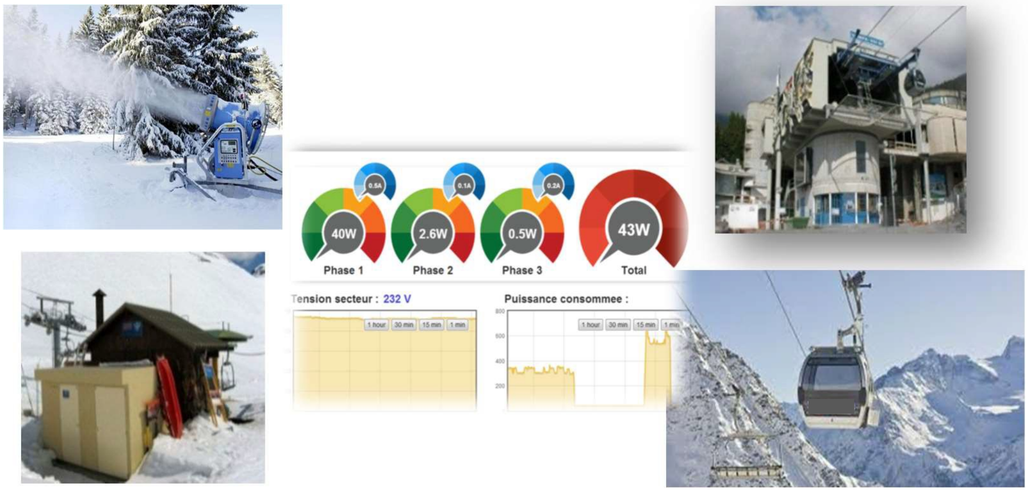
Figure 2 : Themes for energy efficiency for ski lifts companies

The management and reduction of electrical power peaks is also an important area for improvement that helps reduce energy bills. Nevertheless, this issue is linked to the contracts signed between the mechanical company and the energy supplier and should therefore be dealt with on a case-by-case basis during an energy audit, for example. It is not dealt with in this report.

The possible levers of action for the main themes of the ski lifts can be summarized as follows (to translate).

Figure 3 : Actions énergétiques par thématique d'amélioration des performances remontées mécaniques

2.2. Towards more competitive ski lifts companies by more performing energy efficiency



Context

Ski lift companies play a significant role in the tourist economy of the Alpine Space. Thanks to them, both locals and tourists have access to mountain sports: numerous ski areas in winter but also hiking and mountain bike trails in summer.

In order to ensure maximum attractiveness and to provide customers with the best possible services, these companies have set up various infrastructures: ski lifts, artificial snowmaking in the ski area, huts or buildings for welcoming tourists or staff (e.g. restaurants). However, all these infrastructures consume energy, mainly electricity. These consumptions represent costs ranging from a few hundred thousand francs per year to more than a million for the most important resorts.

The lift companies in the Lower Valais therefore represent an interesting lever for the implementation of the energy transition. Pioneering and exemplary actions to optimise the energy efficiency of the ski lifts in this region would enable the development of know-how that can be used by ski areas.

Consumption items

A register of the main consumption items for the four types of consumers existing in a ski lift area, i.e. sheds, buildings, snow cannons and ski lift drives, was drawn up. It allows a quick identification of the stations that a ski lift station should be interested in. This register is presented below.

Altitude sheds

Heating

The quality of a building's thermal envelope is responsible for its heating requirements. Characterizing it on the materials that make it up, their thickness and thermal performance makes it possible to evaluate the level of insulation it provides.

Secondly, there is the heating system of the shed, which has a more or less good energy efficiency. As a general rule, sheds have electric convectors with an efficiency close to 100%.

The third point is the regulation of the heating system. Depending on the type of heating system, the heating could run 24 hours a day, 7 days a week, generating an aberrant consumption considering the surface area and the use of the shed. Moreover, depending on the size of the ski area, it can happen that sheds stay on all summer long.

The fourth aspect concerns user behaviour. It is common for the user to leave the door open if the sun is shining, or because he is outside to assist the skiers in the area. Without a door-opening sensor, the heating will continue to run while the door is wide open. Knowing that the thermostats operate on a measurement of the ambient temperature (and not the received solar radiation), the heating will run as long as the temperature is below the set point (17 to 20°C).

Finally, the last point, which is difficult to control, is the presence of an auxiliary heating connected directly to the outlet, installed by the person working in the shed. This position is difficult to control. Only a monitoring of the entire shed (temperature, consumption, etc.) would make it possible to identify this type of heating.

Buildings

Heating

The quality of a building's thermal envelope is also the cause of its heating needs. Characterizing it on the materials that make it up, their thickness and thermal performance makes it possible to evaluate the level of insulation that it provides.

Secondly, the heating system of the building must be broken down into three points: heat production, distribution/emission and regulation.

- The heat production corresponds to the system that ensures the generation of heat for heating. It can be a boiler (oil, electric, gas), a heat pump, electric convectors, etc...

- The heat distribution/emission corresponds to the hydraulic network that allows hot water to be conveyed from the heating plant to the heat emitters. The latter are the devices that release heat such as radiators, underfloor heating systems or air heaters (mainly in garages or technical halls).

- The third point is the regulation of the heating system. Depending on the type of heating system, the heating could run 24 hours a day, 7 days a week, generating an aberrant consumption in view of the surface area and the use of the building.

The fourth point concerns the behaviour of the user. The user can control the management of the opening of windows or the heating temperature of the room in which he works, which can lead to a drift in heating consumption.

Domestic hot water production

The energy consumption resulting from the production of domestic hot water is linked, apart from the need for hot water, to two elements.

Firstly, the temperature level at which the water is heated. The higher this is, the more it consumes. For example, water heated to 65°C will consume more than water heated to 55°C, for example. However, below a certain threshold there is a risk of developing legionella.

Secondly, poor quality thermal insulation of the storage tank can lead to heat losses that cause the temperature of the water in the tank to drop. The water must then be reheated to keep it at the set temperature. This consumes energy.

Finally, the way in which hot water is produced. For example, if it is generated by an electric resistance, the consumption will be much higher than if it is produced by a thermodynamic water heater. That is to say, a heat pump for domestic hot water. The performance of this type of system depends on the temperature of the cold source used by the thermodynamic water heater.

Network equipment

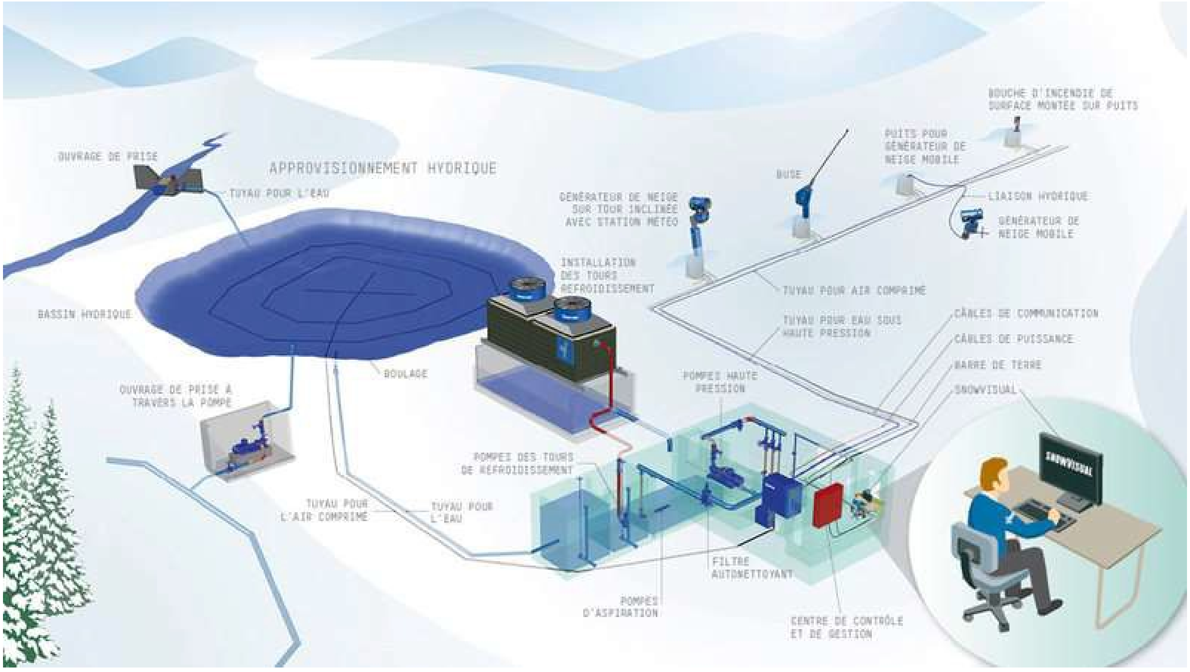
Different fluids have to be transported in a building. They can be hot water moved from the heat generation to the emitters, hot air blown into the rooms of the building, or air extracted from the rooms. To move these fluids the building will consume electrical energy. Whether for water or air transport, pumps or fans can be constant speed, multi-speed or variable speed. The last case is the most energy efficient because the consumption is more adapted to the needs of the room to be heated.

Other electrical equipment

Finally, the lighting of the building also represents a consumption item. This depends on the type of luminaire (incandescent, fluorescent, LED, etc.) and the lighting control (manual, timer, presence detector).

Snow canons

Artificial snow production accounts for around 10% of the energy consumption of ski lifts. It requires water, air, energy and favourable climatic conditions. In the latter case, the water stored in basins is conveyed to the cannons. At the outlet of the cannons, it is mixed with air under a certain pressure, which produces artificial snow. The water is conveyed to the cannons either by gravity (the basin is located at a higher altitude than the cannons) or by pumping. In the latter case, the pumping station is an energy consumption station. The second main consumption station is the system for pressurizing the air for the creation of snow from each of the cannons.



Source : http://www.demaclenko.com/

Pumping stations

The pumps in pumping stations can reach several hundred kilowatts for the largest ones, with annual operating hours ranging from about 200 to 700 hours. Depending on the age and energy performance of the pumps used, significant energy savings can be achieved by replacing them with more efficient models.

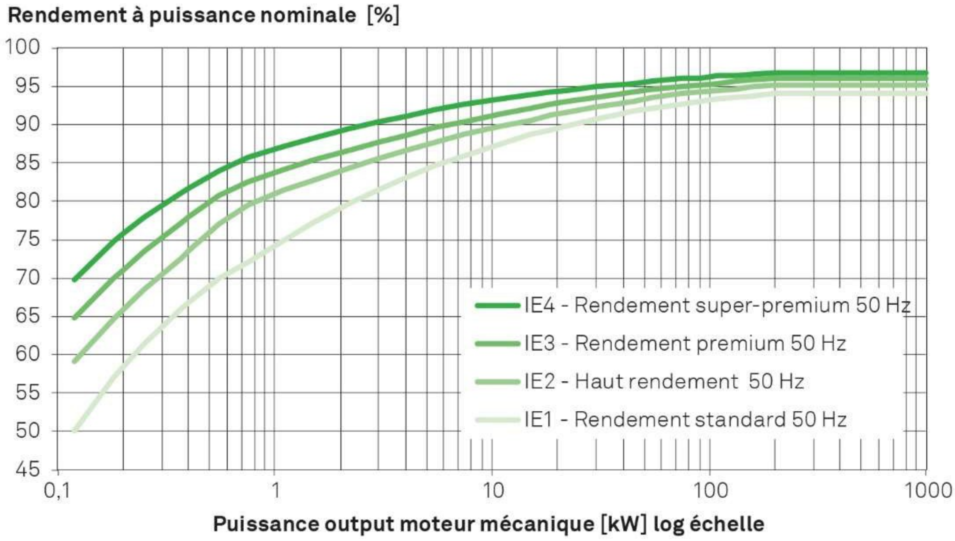
Air compressors

Compression of the air that will be mixed with water for the snowmaking can be produced in two ways. Either it is directly integrated into the snow cannons or it is centralized and fed via a pressurized air network from a central production facility to the individual cannons. Depending on the case, either we will have several small decentralized powers (from some 2kW to 30kW), or a large centralized compression power. The performance of the compressors used is largely related to the efficiency of the compression system.

Ski lifts

Mechanical drive motors

The actions that can be taken on the lift motors are mainly their replacement by more efficient drive motors. Generally speaking, DC motors have optimum efficiencies of around 60%. To date, almost all DC motorshave been replaced by newer motors. The diagram below shows the evolution of efficiency at rated power for asynchronous motors as a function of their efficiency (IE) - (source: topmotors.ch) :



For example, replacing DC motors with Ward Leonard drives with asynchronous motors equipped with frequency converters would be a very interesting solution from an energy point of view. This would allow an installation to go from an efficiency of 60% (DC motor) to an efficiency close to 95% for motors with powers greater than 100kW (corresponding to ski lift powers).

Thus, it is possible to save almost 30% of energy on the electrical consumption of DC motors by IE4 energy class asynchronous motors.

Antifreeze auxiliary heaters

The presence of the power electronics cabinet and the mechanical lift equipment requires temperature conditions between 10°C and 35°C to avoid damage. For this reason, a safety heating system is mandatory in the mechanical drive rooms to prevent the temperature in the room from falling below 10°C. The number of operating hours of this heater generally does not exceed 50 hours. Similarly, a ventilation system prevents the room from rising too high in temperature. To do this, a window in the room opens automatically to let the calories out of the room.

This heat, which is released by a lift system (gearbox + power cabinet), can be recovered, in particular by means of a heat pump. CREM has developed this type of concept for a company in the Lower Valais and the coefficient of performance obtained/measured is of the order of 6 (note: the average annual COP value for a heat pump in the plain is 3). Particular attention to the dimensioning of the equipment, the installation of the heat pump cold source and the regulation settings are fundamental to obtain maximum performance and profitability of this type of installation.

Toolbox

The tool is structured around various modules providing information on the energy consuming stations, the annual consumption per station, evaluating the means and measures that make it possible to increase the energy efficiency of each of the stations and characterizing return on investment times.

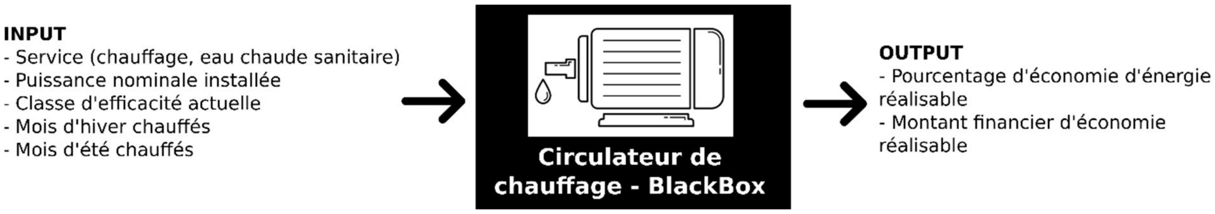
Buildings

Replacement of heating circulators

Replacing old electric circulators is an energy-saving operation for various reasons. The first is related to the poor energy efficiency of the old circulators. The second is the frequent over-dimensioning of the latter compared to the real needs of hydraulic networks.

The module developed takes into account only the gain in energy efficiency. In order to define the possible gains with correct sizing, an expert in the field of HVAC should be consulted.

The diagram below summarizes the inputs and outputs of the module.

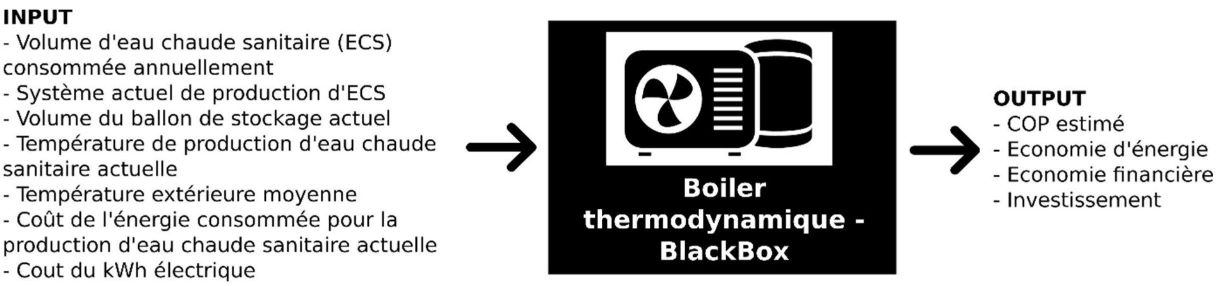


Replacement of an existing DHW production by a thermodynamic boiler

High-rise buildings are often powered solely by electricity. For this reason, they often use electric boilers to produce domestic hot water. This type of production can be replaced by thermodynamic water heaters, which are more energy efficient if the outdoor climatic conditions are favourable.

This system consists of a heat pump producing only domestic hot water. The performance of this system is therefore a function of the outside temperature or more generally of the cold source used.

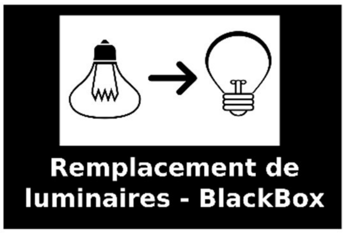
A module allows the user to assess the relevance of installing such a system to replace an electric boiler for example.



Replacement of existing bulbs with new technologies

Today, the replacement of old, high-consumption light bulbs is widespread. For this reason, a module has been developed to estimate the energy-saving potential of replacing a large number of light bulbs at the same time.

INPUT
- Puissance installée d'ampoules incandescentes
- Puissance installée d'ampoules hallogènes
- Puissance installée d'ampoules à économie d'énergie
- Puissance installée d'ampoules LED
- Choix de la technologie de remplacement (économie d'énergie ou LED)



OUTPUT
- Pourcentage d'économie d'énergie

Altitude sheds

Smart control of ski lift sheds

Ski lift sheds are large consumers of heat for two main reasons. Firstly because they are poorly insulated. Second, it is common for their users to be outside the shed in order to monitor the safety of skiers with the door wide open. The heating then runs at 100% with no real efficiency. Finally, the heating systems of the cabins are not always turned off during unoccupied periods (at night, between seasons, in the summer).

To solve this problem, the remote control platform called Simetis is the result of the ObserV project carried out by Simnet SA, CREM, HES-SO VS and TheArk on behalf of a ski lift company in the Lower Valais, and allows remote control of ski lift sheds.

This control system includes heating management with temperature reductions at night, an internet display of the status of the heating systems in each cabin, the possibility of switching the heating equipment on and off remotely from the platform, or even an automatic cut-off of the heating if the door remains open for more than a certain time, etc.

This system has a profitability of less than 5 years based on measurements.

Ski lifts

Mechanical drive motors (motor replacement)

Mechanical drive motors are high energy consumers. There are energy efficiency classes that allow them to be categorized from the most energy-consuming to the least energy-consuming. The most energy-intensive are DC motors. Today they have almost all been replaced. For those that are still installed, replacing them with IE3 efficiency motors (required by the standard) would result in significant energy savings. However, by going a step further by installing IE4 energy class motors, it would be possible to save a little more kWh.

To analyse the energy and financial stakes of this type of improvement, a calculation module has been developed and integrated into the tool.

INPUT
- Technologie de moteur actuel
- Puissance mécanique installée du moteur
- Année de mise en service du moteur
- Nombre d'heure de fonctionnement annuel du moteur
- Coût du kWh électrique

OUTPUT
- Investissement pour un moteur de classe d'efficacité IE3
- Investissement pour un moteur de classe d'efficacité IE4
- Investissement convertisseur de fréquence
- Investissement Moteur IE3 + Convertisseur
- Investissement Moteur IE4 + Convertisseur
- Economie d'énergie avec un moteur IE3
- Economie d'énergie avec un moteur IE4

Evaluation of the heat recovery potential of the lift installation

Finally, the operation of mechanical drive motors dissipates a great deal of heat, particularly in connection with power electronics. This heat can be recovered and valorized through heat pumps for example. This technological coupling has several advantages.

First of all, it makes it possible to heat all or part of buildings at high altitude that house a drive motor with renewable energy, despite the constraints linked to altitude and the lack of road access in winter.

Secondly, this coupling allows the use of heat pumps at high altitudes, despite a low outside temperature during heating demands.

Finally, this technological coupling makes it possible to achieve very low return times, in particular because of the low operating costs linked to the very attractive performance of heat pumps that make use of this type of waste heat.

For all these reasons, a module dedicated to the analysis of the heat recovery potential of mechanical drive motors has been developed.