EcoArtiSnow

"Snow generation with reduced energy consumption and noise emission, more consistent quality and extended operating temperature ranges"

EcoArtiSnow
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www.ecoartisnow.eu

Final Report - Publishable Summary

EcoArtiSnow was a project placed within the 7th Framework funding scheme of the European Union, in the programme "Research for the benefit of the SME". A consortium consisting of 5 international SME from the Alpine region, that are active in the business of winter tourism and technical snowmaking, and two interdisciplinary research companies launched this project. The mutual goal was to develop reliable snowmaking equipment that is more energy efficient, more silent and thus more economic and environmentally friendly. This was aimed to be achieved by creating a basis of scientific knowledge, deducted from extensive testing routines and simulation programs.

In the first phase of the project this goal first was approached with literature and market research in the respective fields of thermo- and fluid dynamics, spray technology, blower and fan design and technology, noise generation/canceling and fluid conditioning, as well as on climate behaviour, snow quality and measuring techniques and equipment. This knowledge was enhanced by efforts in gathering technical data as well as operating data and process conditions for the state of the art snowmaking machinery at different operating points.

Second an extensive program of measurements and CFD simulations was carried out, that was to be connected to the existing process data of the snowmaking machinery and to build a scientific basis for the process. The created database and the findings from literature research are of significant help in understanding the snowmaking process. Beyond the creation of a better understanding it was possible to describe, design and physically build solutions that could be proven to enable more efficient snowmaking. These have partly been tested in laboratory setups and, more important, also under real conditions during the winter seasons of 2012/2013 and 2013/2014.

Through the described work the project lead to a significantly improved scientific understanding and enabled an optimized process design, especially with respect to acoustics, thermodynamics, spray processes and fluid dynamics. Through this the project resulted in new technologies that could be realised in form of an improved fan/stator/blower combination, an optimised nucleator and water nozzle design and a new nozzle ring design to support the improved nozzle set in an optimal way.

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As final result a prototype of an optimised and more efficient snow gun, applying the mentioned technological results, was developed and constructed. Further, new findings for the description of snow quality and the influence of process settings were made, especially in combination with the newly developed modules. During the last testing phase in the 2013/2014 winter season the integrated prototype was evaluated positively and the new system could be proven to operate with 15% lower energy consumption and 25% lower noise emission.

The enhanced database that was retrieved from testing is believed to yield all the information that will be needed after the EcoArtiSnow project, in order to make the prototype ready for market. Further knowledge that was created, e.g. concerning passive cooling methods and efficient spray homogenisation, can be used by the consortium to achieve further development progress after the project.

In performing the project work, the communication and transfer of information was assured by regular project meetings, including the whole consortium, but also smaller work groups. Additional telephone conferences were held and frequent email communication was maintained throughout the project.

The described results of the EcoArtiSnow project will lead to a more eco-friendly operation of snowmaking plants, but also to clearly improved economics. This will encourage a more widespread use of the technology and will contribute to safeguard the economies in areas that are depending on winter tourism. Beyond this the developments will help improving the reputation and recognition of technical snowmaking.

Project context and the main objectives

Mountainous regions are often strongly dependent on tourism, particularly on winter tourism. Technical snow is of vital importance in operating ski resorts that are facing rising temperatures due to the climate change. Operating costs and environmental aspects considerably gain importance and threaten feasibility of snowmaking.

This project presented a multi-barrier approach to establish a scientific basis in technical snowmaking, which was prior dominated by incremental experimental developments. Bringing a scientific understanding to the process development we anticipated and realized major improvements, especially in fluid dynamics and noise-control. Current state of the art snowmaking technology is already sophisticated, but still yields a major potential for improvement. High energy demands and therefore operating costs hinder the widespread use of the technology, as well as the high noise emissions that are restricted by law.

The aim of the project therefore was the development of a new snowmaking system that offers an improved performance, allowing production of quality snow with reduced energy consumption at higher temperatures and with low noise emission. This will enable the widespread and financially viable use of snowmaking technology in ski resorts. Operators profit from low operational costs and an earlier season start. The lowered noise emission enables use near residences or wildlife sanctuaries.

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Tourism industry is a major branch in Europe, which together with all its linked businesses in 2010 accounted for 10% of Europe's GDP and 12% of the total employments. It annually generates €266 billion. The tourism market is steadily growing at about 4%, the high demand on winter tourism is lasting and climate change is threatening. This demands an increased use of snowmaking equipment in areas that depend on winter tourism as most important or even single branch of commercial enterprises. In developing the new snowmaking equipment we aimed to generate improved technologies in the area of fluid dynamics, passive cooling and noise-control that can be of interest not only for snowmaking, but also for industrial applications beyond this project.

Main project objectives:

1. To develop a structured and unbiased scientific model/basis for the description of the artificial snow generation process
2. To develop a new nucleation system that will consume less energy when compared with state of the art technology.
3. To improve the snow making process by a better conditioning of the fluids used and better atomization.
4. To optimise the process at the outlet of the machine and enable a homogeneous mixture of snow nuclei, water and air.
5. To reduce the noise emissions of snow making machines significantly

Main S & T results/foregrounds

The EcoArtiSnow project delivered a number of scientific results that could successfully be merged into an extensive database, allowing a better and more complete understanding of the snowmaking process. They assure an optimised development of nucleator, nozzle and fan prototypes, as well as an improved evaluation of new designs.

Further, five main technological results were achieved that could successfully be integrated into the positively evaluated EcoArtiSnow prototype. The single technological results are described below:

1. New nucleator and water nozzle design

One of the project goals was the development of a new nucleation and nozzle system that consumes less specific energy by consuming less compressed air and/or producing more snow while keeping the snow quality. This goal is achieved by a new nozzle design that was obtained from a CFD based development. To lay a basis for this development a droplet size analysis was conducted in the first reporting period of the project and a comprehensive CFD model was set up. The CFD-based development of new designs followed during the second reporting period. The new nozzle design in general could be proven to produce higher quality snow when maintaining water throughput. Thus a higher water throughput at maintained snow quality is possible and makes the snow generator more efficient and more attractive. Besides the application on the Titan machine, Demaclenko and CBN plan to market the new nozzle system with all fan gun models and also for the lance snowmaking

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systems. The possibility of selling the new nozzle/nucleator system as spare parts for older snow generator models will be evaluated, since those machines are often used for 10 years and more. Further the single nozzles could also be marketed for older machines and even for not entirely known purposes in other application fields.

2. Silent blower system with improved geometry

According to the tasks assigned to the work package no. 5, a new design of the snow generator's blower was created that reduces the sound emission during operation, by cancelling out or reducing the inefficiencies of the system that could be detected by measurements and CFD simulations during the first phase of the project. A thoroughly designed combination of all blower components was realised, with minimised gaps and tip clearance. The beneficiaries anticipate being able to apply the design on new snow generator models and market them as more silent and especially efficient machines. Beyond the design could be licensed as especially efficient model to manufacturers that build blowers for other fields of application. Further the entrance into other markets with blower units constructed by Demaclenko is in general possible.

3. Overall snow generator design and layout

Further the whole snow generator design and layout that was developed during the project – in order to implement the sub-developments in the best suited and most efficient way – represents exploitable and protectable IP that will be applied and marketed by the beneficiaries in selling a new and attractive snow generator model. Further it will be possible for the beneficiaries to extend the design/layout of the EcoArtiSnow prototype to other models of snowmaking machines and to also market these models. Beyond it is generally possible to adapt the snow generator design to dust binding machines, which work on a similar basis.

4. Intensified mixing and heat transfer in nucleation

In the last year of the project a new method to enhance mixing and heat transfer in nucleation was developed and tested in the lab. The pressurised water for the nucleation nozzle is saturated with air in the feed line. When the saturated pressurised water is exposed to atmospheric pressure at the nozzle discharge, the air in the water will immediately form bubbles that produce shear forces and cold, provoked by the pressure drop. The expected effect is a better nucleation process that is enhanced by the creation of a high number of small particles and an intensified cooling. Even though the development was not finalized within the project this technology seems to be promising for a further post-project development and exploitation.

5. Method for passive cooling of water and compressed air

As it is given in the description of WP2 the application of a passive cooling system for the feed water and compressed air was investigated. A newly developed design is intended to enable the beneficiaries to build passive cooling devices based on PCM materials and Heatpipes, which allow the control of fluid temperature and prevent the water from freezing. The modules can be designed to

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work autarkic, without the need for electrical energy. First designs and laboratory tests could be realised during the project, optimisation and integration into different snow generator models have to follow after the project. A respective cooling module is anticipated to make snow generators more efficient and therefore more attractive to consumers. The possibility to market such systems as part of new efficient snow generators will be evaluated, as well as the possible use as additional spare part for older machines. The application in other market areas, independent from snowmaking, could in general be possible.

Potential impact and main dissemination activities

The alpine winter tourism during the last two decades became more and more threatened by climate change, rising temperatures and less reliable snow precipitation. Nevertheless, skiing and other activities related to winter sport tourism are still very popular and related businesses provide a mayor income in alpine regions. In some areas this sector even is the only commercial branch providing employment.

As a result, ski resorts are applying snow making machinery and large supply systems that provide water, compressed air and electrical energy. These systems, beyond representing noticeable interferences with the prevailing eco-systems, demand considerable amounts of energy to produce the valuable snow. This results in high investment and operational costs, provoking higher ski-pass prices, and in raised emissions of CO_2. As such the application of the state of the art technology is presumed to enhance the climate change which effects it is supposed to overcome.

With the EcoArtiSnow project and the development of significantly more energy efficient and silent machinery, the sustainable applicability of technical snowmaking as well as its reputation is strongly supported. With the results that were generated, Ski resorts can operate snowmaking plants at lower costs, more eco-friendly and at a significantly more pleasant noise level. This will help ski-resorts to survive economic problems that are caused by high operational costs, and further will enable the installation of snow generators where high restrictions regarding to noise emissions have to be regarded. This secures the jobs of many people in businesses that are depending on winter sports tourism throughout Europe and especially in alpine regions. The ecologically positive impact of the EcoArtiSnow developments could be proven in a streamlined LCA (Life Cycle Assessment) that analysed the impact on global warming by the standard and the prototype system. The result was that the relative contribution to global warming is produced to 93% and more by operation of the machinery, and that the EcoArtiSnow prototype reduces this impact by 17% during a 10 year lifetime.

In parallel to the technical work during the project that was required to achieve the described results, dissemination activities were scheduled in order to promote the developments within the snowmaking community. During the project and also during the years before, Demaclenko has established a quite active dissemination strategy. The company is regularly present with their most recent technologies on all major international trade shows that relate with the snowmaking business. Beyond this Demaclenko frequently appears in branch specific magazines like the “Mountain Manager” or the “ISR (Internationale Seilbahn Rundschau)” and furthermore publishes their own magazine “Snow World”.

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This own magazine and the appearances in specialist journals serve as effective channel to communicate the latest Demaclenko developments and the most relevant international projects, as well as to give relevant insights into the snowmaking business.

Beyond these methods for a wider publication, Demaclenko uses direct customer dissemination strategies, e.g. by sending prototype machines to loyal customers or inviting customers to the company in Selva di Val Gardena. This direct customer contact is based on confidence and is especially suited to communicate the newest developments that may not yet be completely ready for market. All the described channels were used during the EcoArtiSnow project to promote the achieved results, and will further on be applied intensively.

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