

# Toolkit Snow Production

How to minimise resource use in snow production

Deliverable 4.3

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# (1) Snow Production

Challenging sustainable snow management

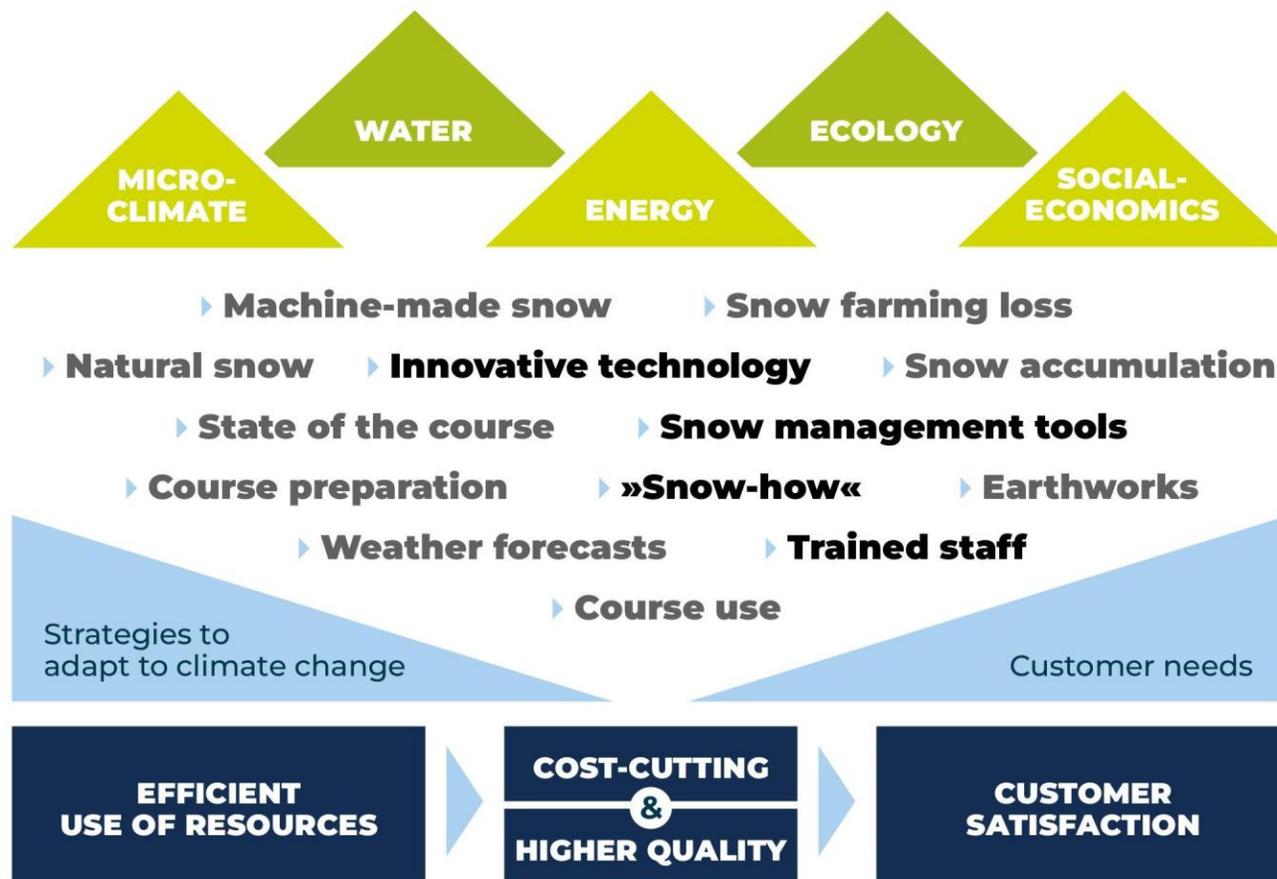


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# (1) Sustainable snow management



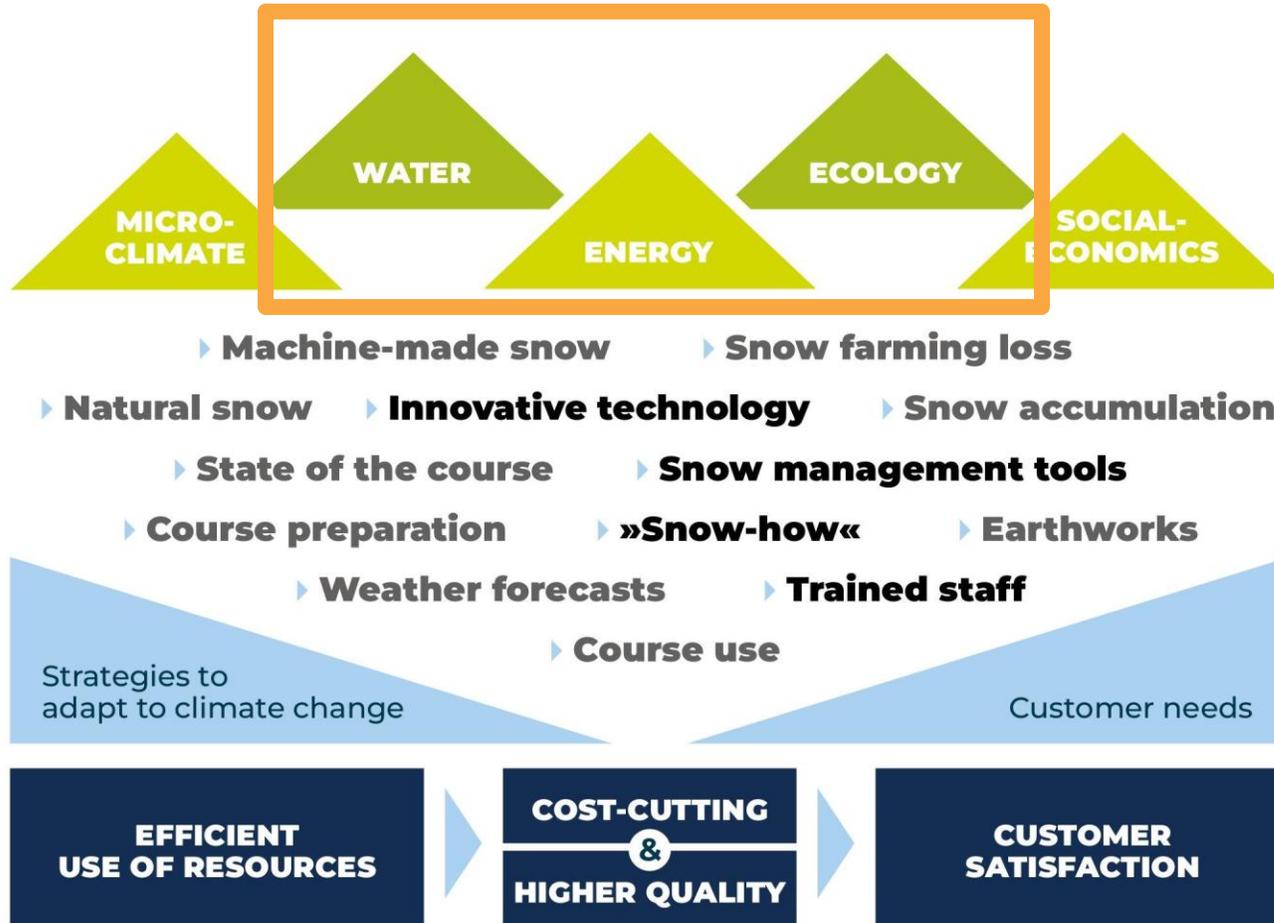
...to **reliably provide snow**...

...within a given set of climatological, hydrological, ecological, and social-economical constraints...

...to run snow sport infrastructures in an **ecologically and economically sustainable** manner.

...to reduce **costs** while improving the **quality of snow** sports facilities.

# (1) Sustainable snow management - Snow Production



**SNOW...**

**Snow Production**  
reliable high-quality snow,  
today, and in a warmer  
future

# (2) Snow Production

Reliable high-quality snow, today, and in a warmer future



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# (2) Snow Production

...key to **reliable** high-quality snow, today, and in a warmer future

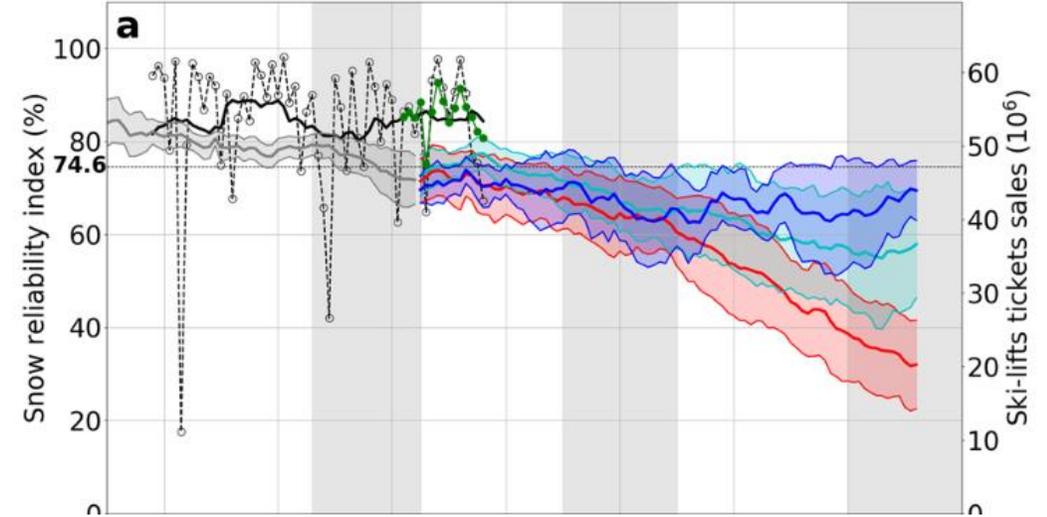
## Why do we need it?

Natural snow reliability will further reduce

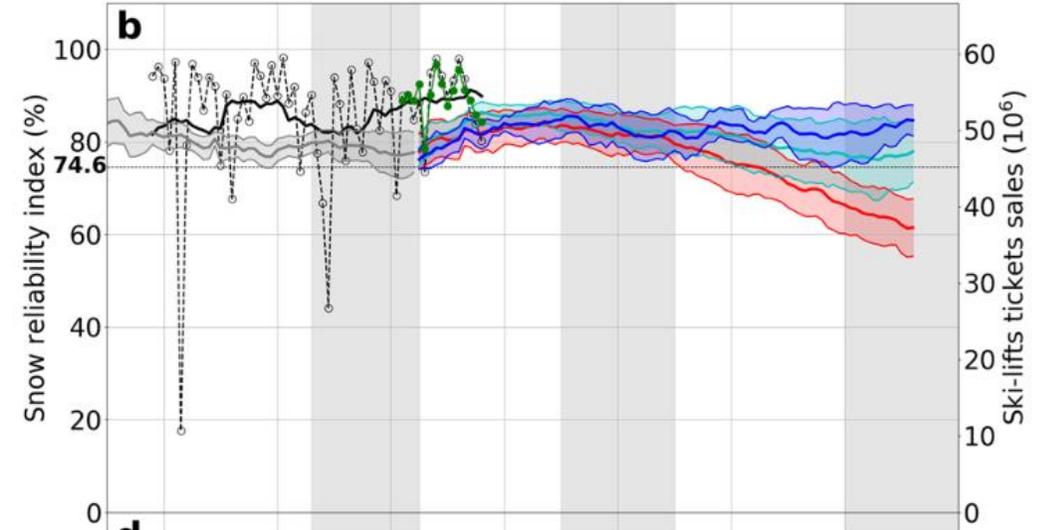
## How long will it work?

Technical snow reliability can compensate lacking natural snow in many regions but leads to increasing water demand

NATURAL SNOW & GROOMING



WITH SNOWMAKING



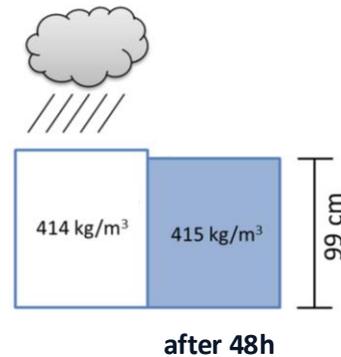
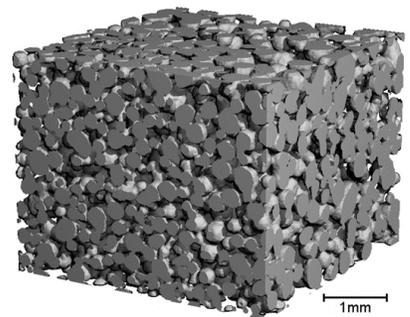
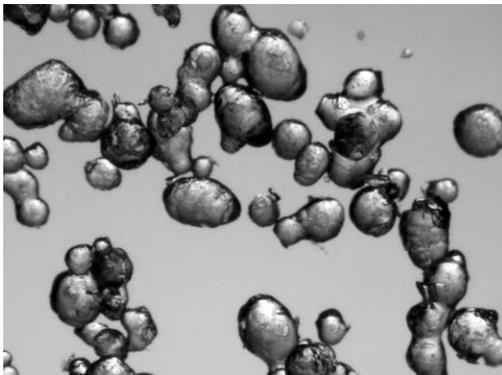
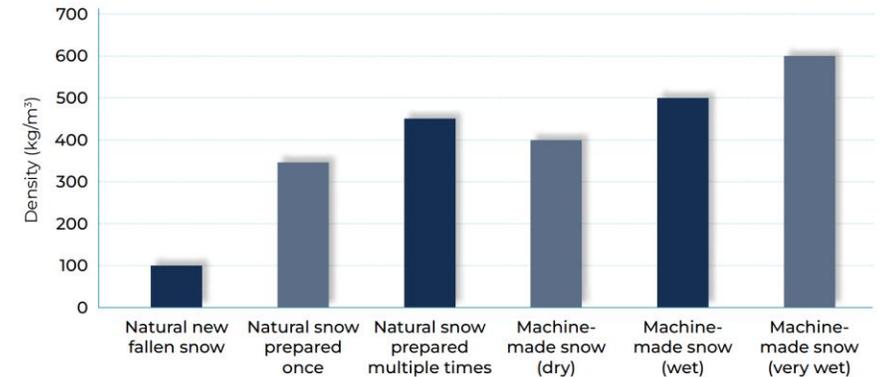
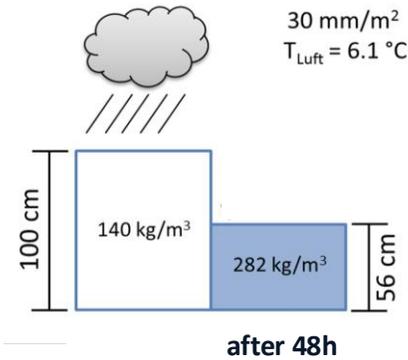
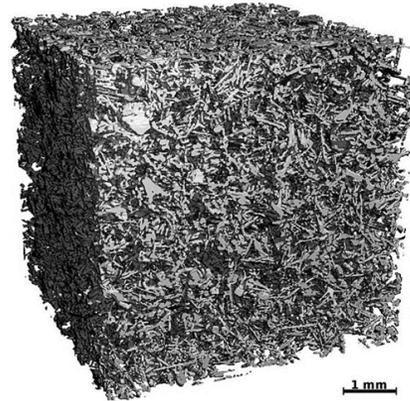
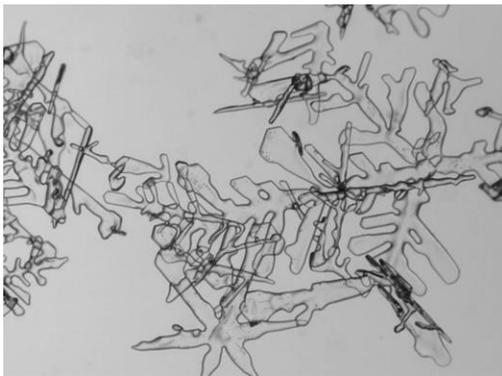
Spandre et al. (2019). Climate controls on snow reliability in French Alps ski resorts



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## (2) Snow Production – snow properties

...key to reliable **high-quality snow**, today, and in a warmer future



**Higher density**  
 → more resistant and long-lasting  
 → less grooming work

Find more information in the freely available e-book:

[https://www.dora.lib4ri.ch/wsl/islandora/object/wsl%3A17135/datastream/PDF/Wolfspurger-2018-Pistenpr%C3%A4paration\\_und\\_Pistenpflege\\_Das\\_Handbuch-%28published\\_version%29.pdf](https://www.dora.lib4ri.ch/wsl/islandora/object/wsl%3A17135/datastream/PDF/Wolfspurger-2018-Pistenpr%C3%A4paration_und_Pistenpflege_Das_Handbuch-%28published_version%29.pdf)

# (3) Snow Production

Lances, guns, and factories



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## (3) Snow Production – lances & guns

**Weather-dependent snow production  
– should preferably be used to minimize energy consumption**



Abb. 1.32: Schneilanze NESSy, Bächler Top Track AG (CH). Davos (CH).



Abb. 1.33: Propellermaschine T40, TechnoAlpin (IT). Davos (CH).

## (3) Snow Production – factories

### Weather-independent and hybrid snow production

- Should only be used as a complementary or back up since it uses 10-30 times more energy per m<sup>3</sup> compared to weather dependent snow production



Abb. 1.38: Techno Alpin SF 220.  
(TechnoAlpin AG, Snowfactory models and general infos, 2015).

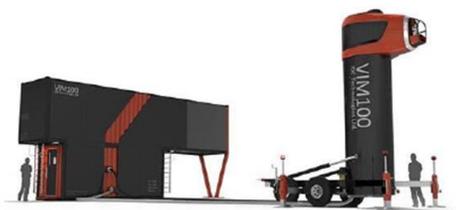
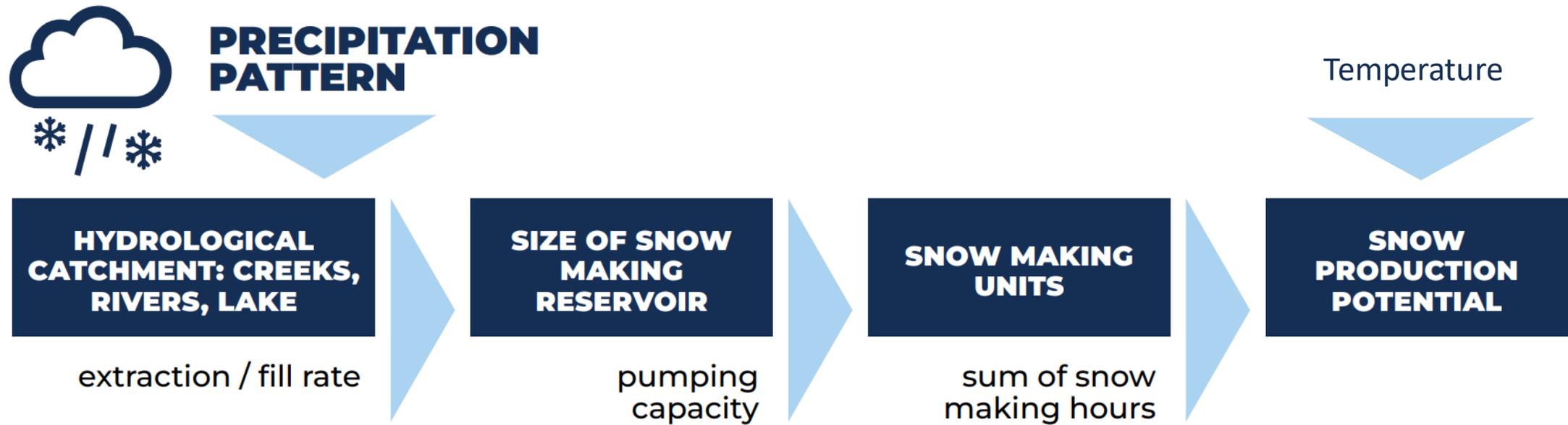


Abb. 1.39: IDE Vacuum Ice Machine.  
(IDE Technologies Ltd., VIM 100 All Weather Snowmaker, 2014).



# (3) Snow Production – water availability & demand



# (4) Snow Production

Efficiency, productivity, and quality

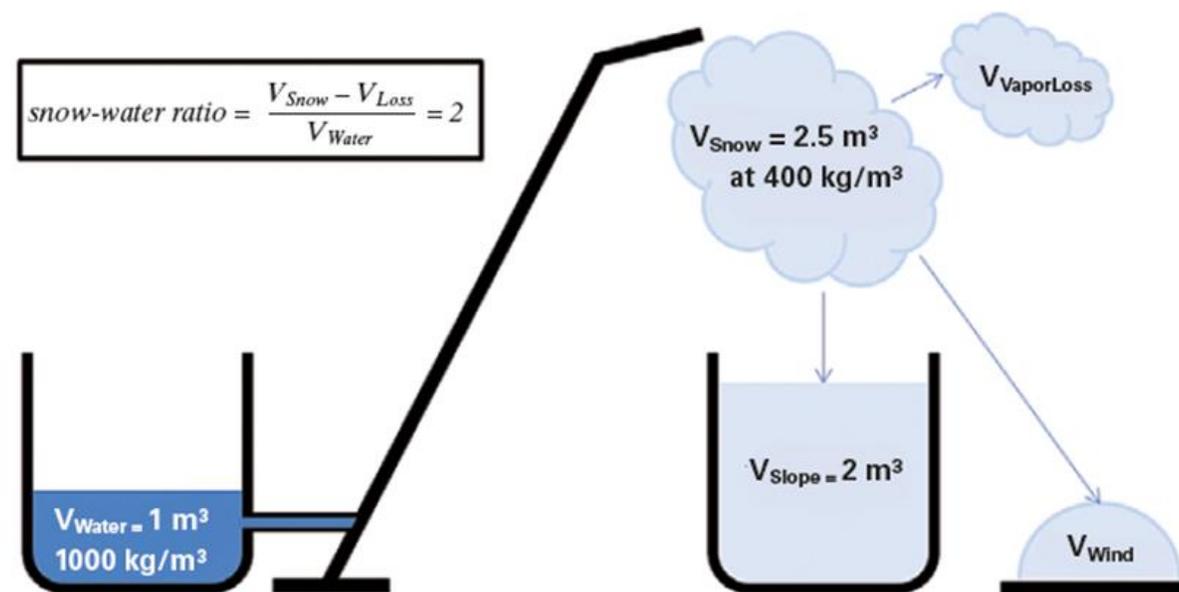
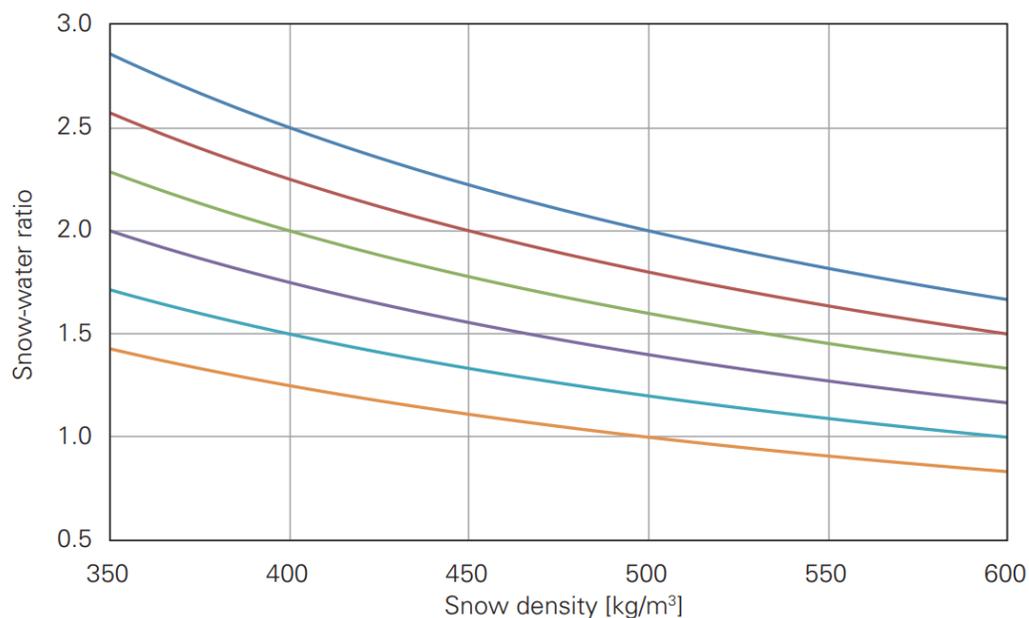


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# (4) Snow Production – Productivity

Maximise productivity by minimising losses – produce at colder temperatures and low wind speeds

$$productivity = \frac{volume\ of\ snow - loss\ [m^3]}{time\ [h]}$$



Loss

— 0 %	— 20 %	— 40 %
— 10 %	— 30 %	— 50 %

## (4) Snow Production – Energy efficiency

Maximising energy efficiency (aiming 1-2kWh/m<sup>3</sup> snow)

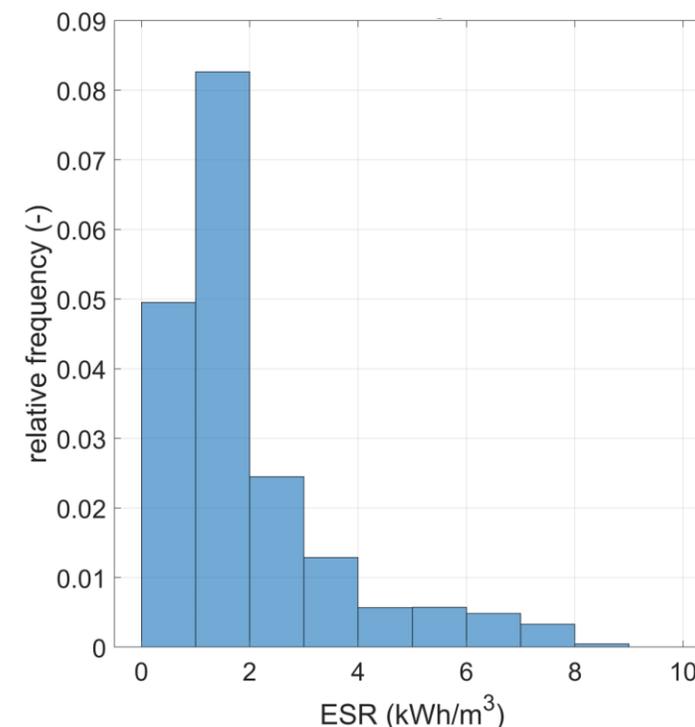
- produce snow in colder temperatures, preferable lances and high elevated water reservoirs to minimizing pumping

$$\text{energy-snow ratio} = \frac{\text{energy [kWh]}}{\text{volume of snow – loss [m}^3\text{]}}$$

SIEPPUR venues 22/23:

ESR = 1.6...5.2 kWh/m<sup>3</sup>

Martell storage production 2024

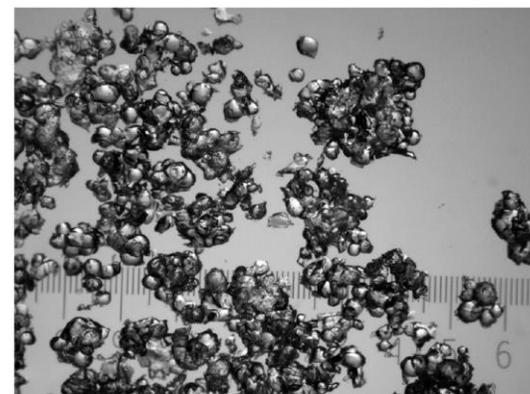
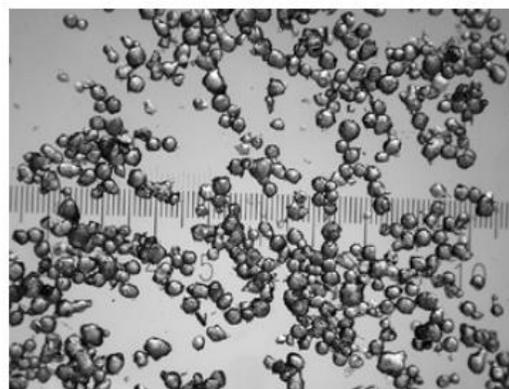
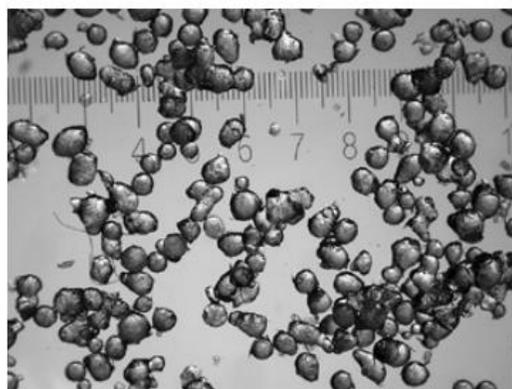


## (4) Snow Production – Snow quality

Aim to produce snow with high quality (dry) to improve track quality

(a) dry snow → grippy surface → freeze as much water as possible

(a) small grains → faster strengthening → atomization by water nozzles



## (4) Snow Production - overview

Tab. 1.5: Comparison of the properties of various snowmakers.

<b>Technology</b> (version) (refrigerant)	<b>Manufacturer</b> <b>type</b>	<b>Productivity</b> <sup>26</sup>	<b>Snow</b> <b>quality</b>	<b>Energy efficiency</b> <b>ESR</b> (incl. pumping capacity)
Snow lance with nozzle technology; WBT = -3 to -16°C	Bächler SnoTek	3.6 to 51 m <sup>3</sup> /h 550–400 kg/m <sup>3</sup>	low– very good	1.3 to 0.5 kWh/m <sup>3</sup>
Fan gun with nozzle technology; WBT = -3 to -16°C	DemacLenko Titan 2.0	3.6 to 89 m <sup>3</sup> /h 550–400 kg/m <sup>3</sup>	low– very good	8.4 to 1.4 kWh/m <sup>3</sup>
Refrigeration (ammonia)	TechnoAlpin <sup>27</sup> SF220	9.2 m <sup>3</sup> /h at 450 kg/m <sup>3</sup>	low	25 kWh/m <sup>3</sup> (36 kWh/m <sup>3</sup> )
Refrigeration (ammonia)	SnowGen <sup>28</sup>	8.3 m <sup>3</sup> /h	low	31 kWh/m <sup>3</sup> (40 kWh/m <sup>3</sup> )
Refrigeration (water)	IDM <sup>28</sup> VIM 100GO	35.8 m <sup>3</sup> /h at 650 kg/m <sup>3</sup>	low	30 kWh/m <sup>3</sup> (40 kWh/m <sup>3</sup> )

# (5) Snow Production

Numbers from IBU venues



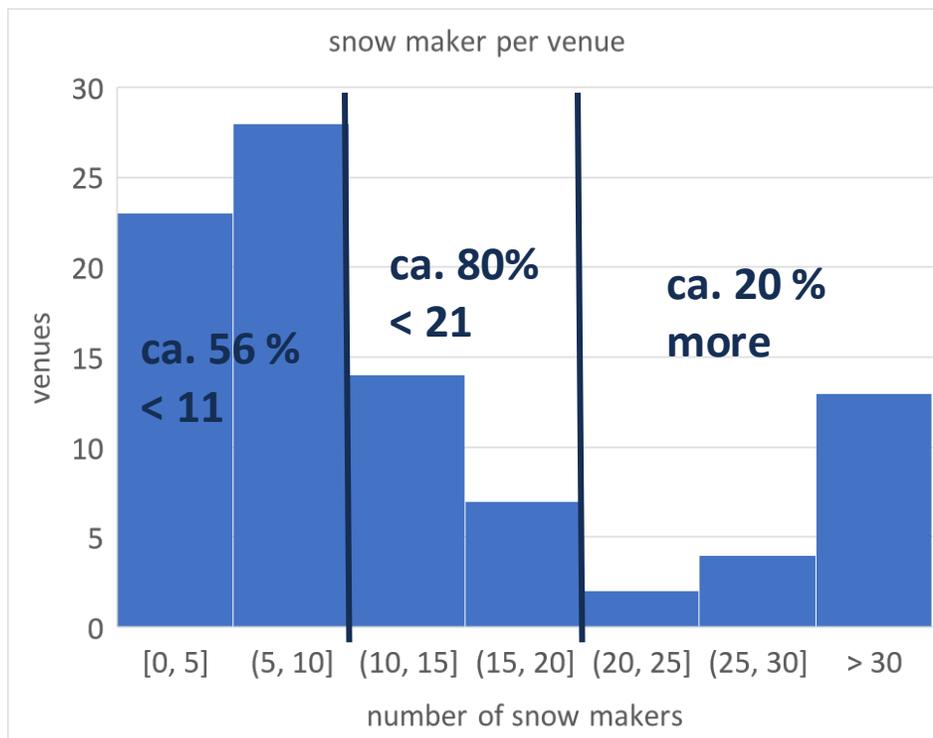
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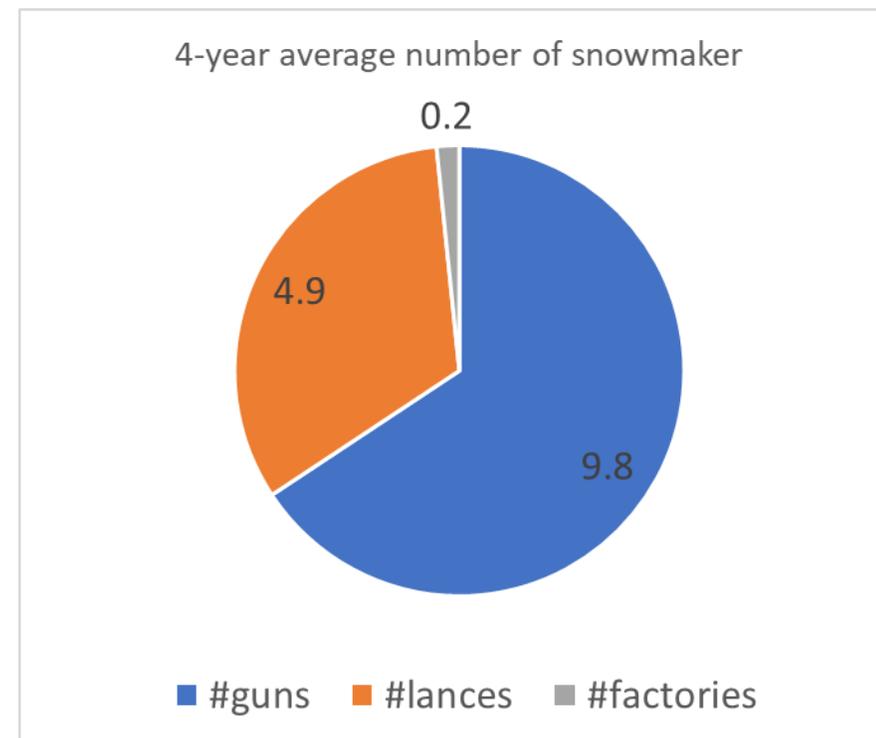
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# (5) Snow Production – units at IBU venues

25 % 0-5  
 31 % 5-10  
 15 % 10-15  
 8 % 15-20

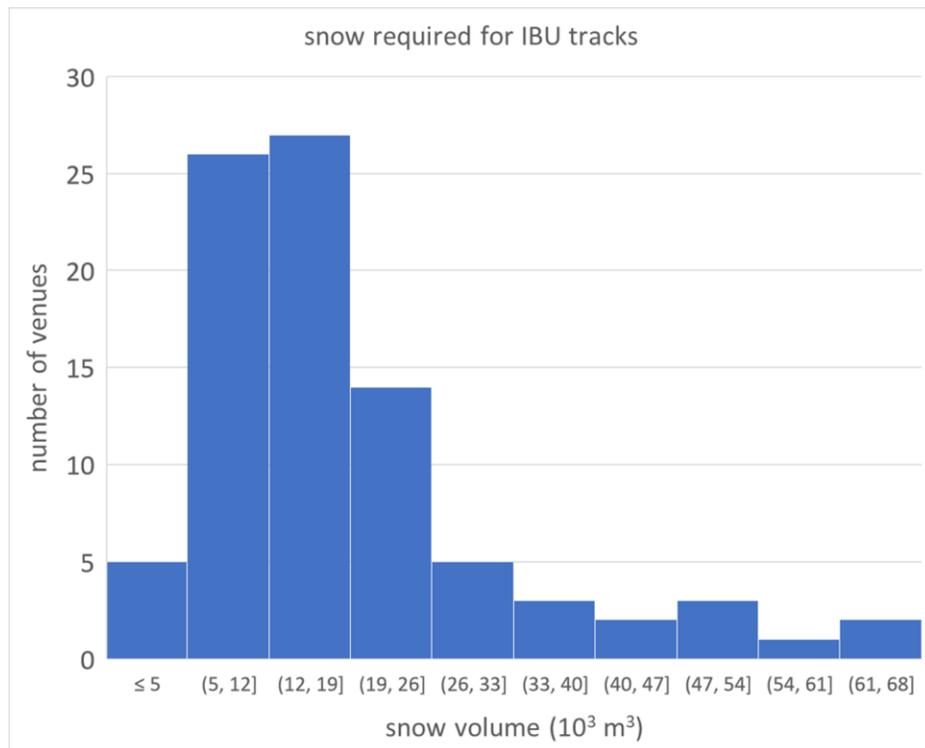


15 units per venue on average



# (5) Snow Production – snow produced at venues

- trend towards less snow
- ca. 2.6k m<sup>3</sup> reduction per year



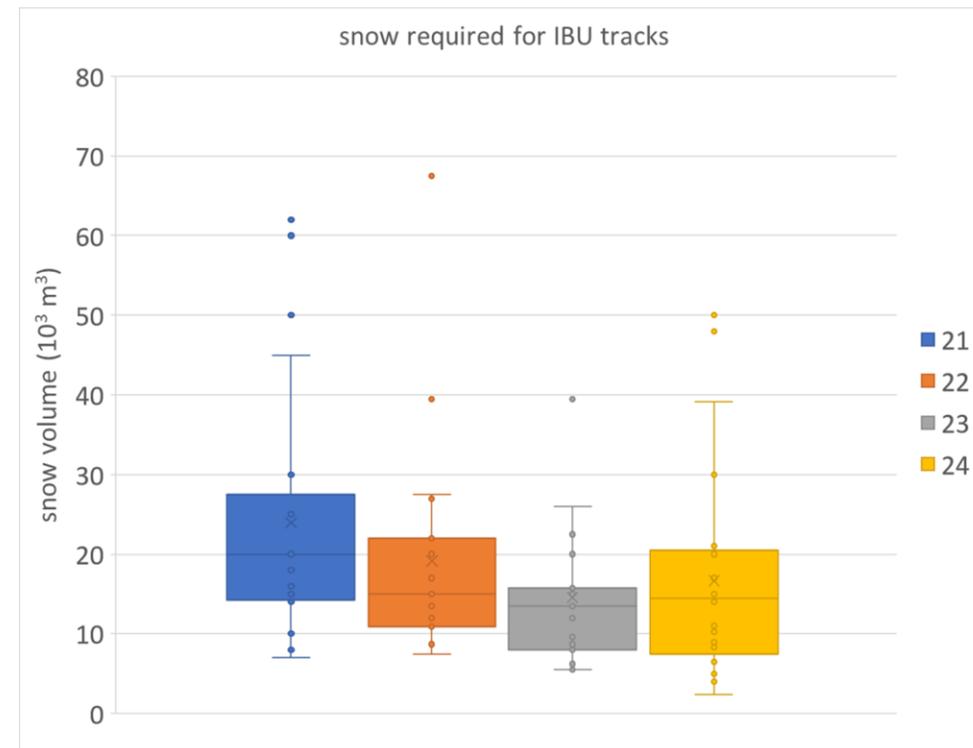
6 % < 5k m<sup>3</sup>

30 % 5-12k m<sup>3</sup>

30 % 12-19k m<sup>3</sup>

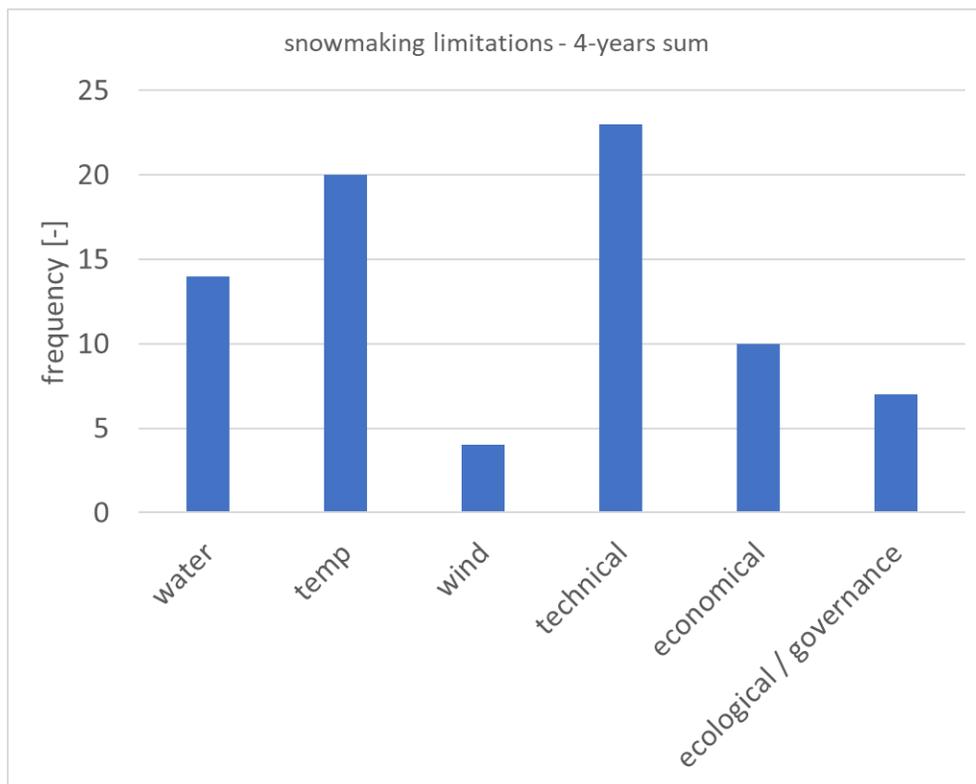
14 % 19-26k m<sup>3</sup>

20% >26k m<sup>3</sup>

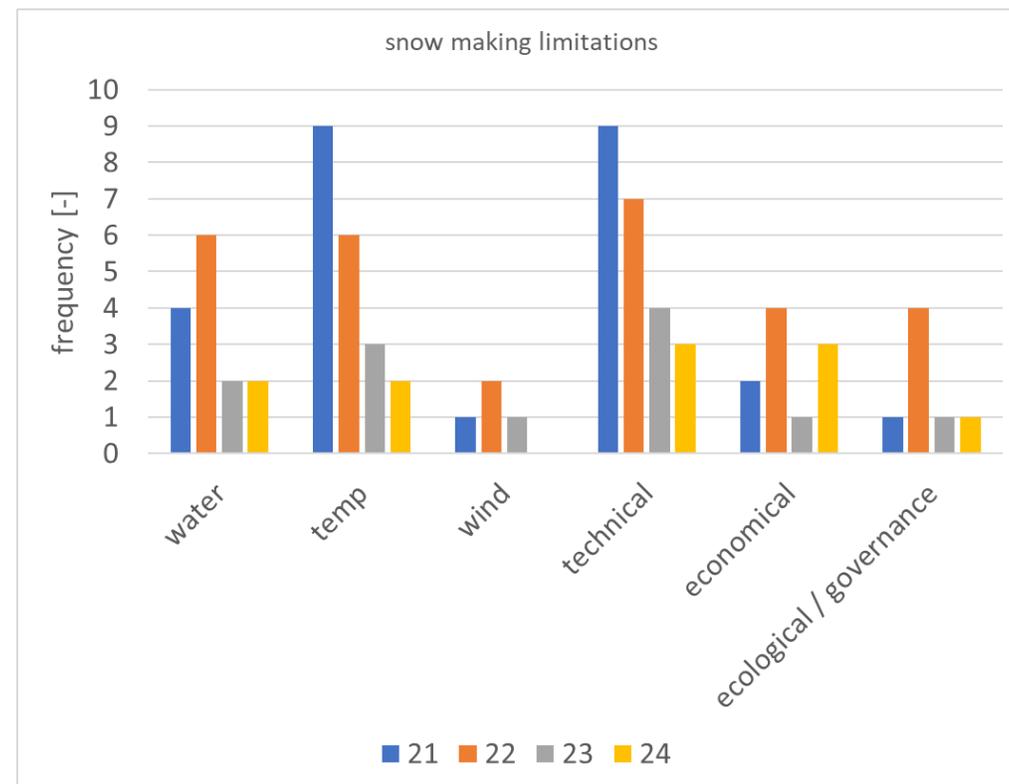


# (5) Snow Production – limitations

Technical limitations & warm temperatures most frequent



Most limitations were reduced



## (5) Snow Production – volumes

	number of fan guns	Number of lances	Snow factories	Snow production on course	Snow production snow storage (m3)	Total snow production (calculated) (m3)
Average	9	8	0	20522	14269	34791
Min	2	0	0	0	0	8000
Max	28	84	2	136680	67720	136680
Median	7	1	0	20000	7500	34500

# (6) Snow Production

Examples of good practices



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# Reduce noise in snow production

**Challenge:** To reduce acoustic emissions during snow production which can be problematic for animals and humans and, in some cases, limit snow production activity.

**Solution:** Using lances or more silent snow cannon models or sound shelter may reduce the noise.

**Limitation:** Lower productivity, esthetic issues with lances, or increased cost.



*Sound shelter for snow production. Inside is isolated and covered with perforated metal plates. (Oskarshamn, Sweden)*

# Snow making hydro power

**Challenge:** To maximise water use efficiency

**Solution:** Using snow making water supply infrastructure to run a small hydro power plant

**Limitation:** Larger investment



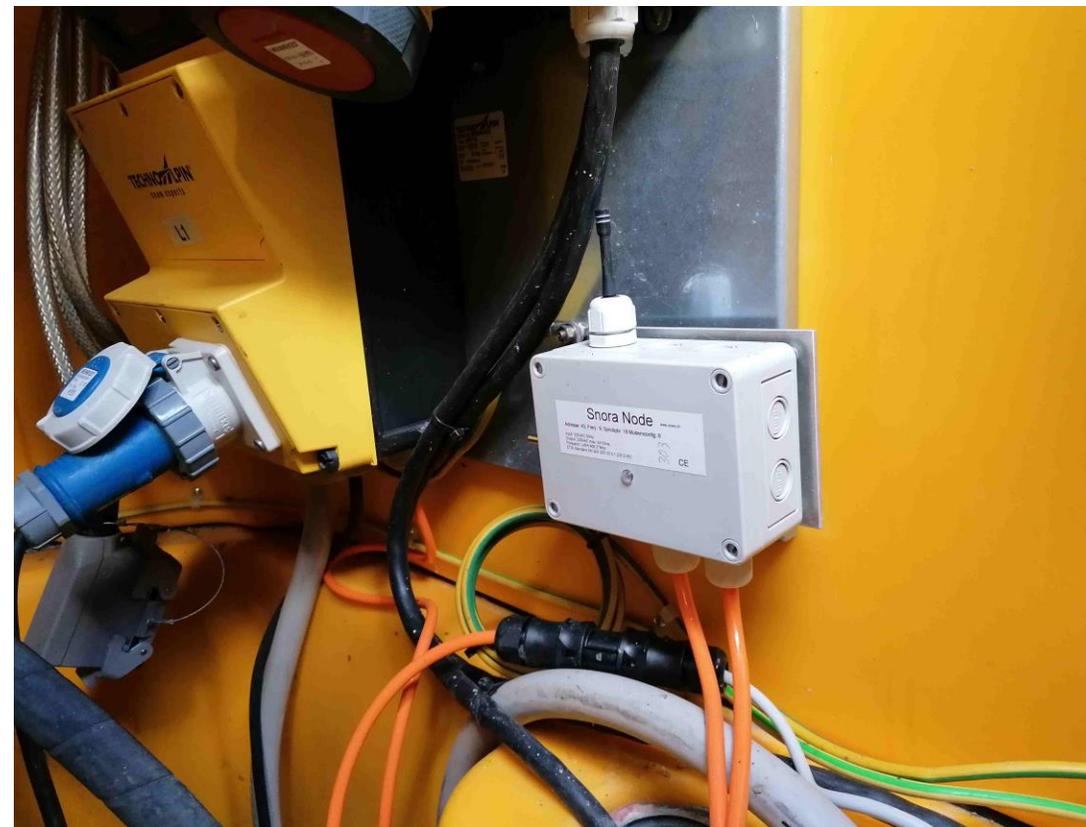
Davos, Switzerland

# Snora

**Challenge:** To increase the energy efficiency of snow making.

**Solution:** The Snora 'networked control' system is designed for the energy-efficient operation of electric heaters in shafts which provide the snow makers with water, electricity and pressurized air. To prevent unnecessary heating of the shafts, Snora controls the shaft heating.

**Limitation:** Investment costs



# Zero Energy Snow Lance

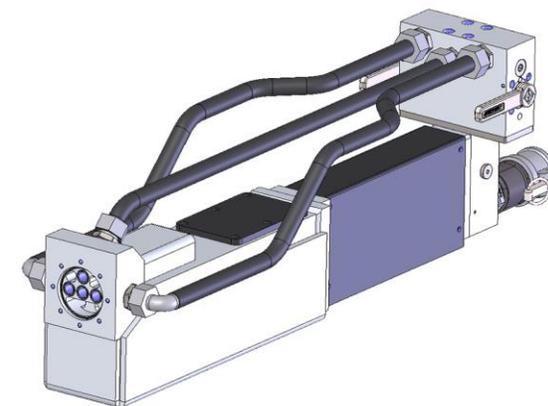
**Challenge:** To reduce energy consumption of technical snow making.

**Solution:** The NESSy Zero E snow lance (Bächler Top Track AG, CH) requires no electricity and no infrastructure due to the use of pressurized air. This snow making system requires high water pressure, which should be provided though a reservoir lake located at a higher altitude.

**Limitation:** Lower productivity



Obersaxen, Switzerland



# Natural cooling tower: ponds & cascades

**Challenge:** To cool water for snow making to increase productivity and quality.

**Solution:** Making multiple smaller ponds with cascades in between will increase the surface area of the water exposed to the cold air and hence cooling faster. Adding a metal fence below the cascade breaks up the water into smaller droplets which increases the cooling.



Osbrlie, Slovakia

# Cooling towers

**Challenge:** To cool the water for snow making to increase productivity and quality.

**Solution:** Cooling towers pumping water through a mesh network of metal with the purpose of increasing the surface area of the water and exposing it to cold air, hence cooling the water before snow production, which increases productivity and quality.

**Limitation:** Extra risk of freezing in the tower causing operations to stop



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