SNOW FOR THE FUTURE

Final workshop 26.10.22, Granåsen

Project period: 2019-2022

Agenda

The Norwegian research project

Snow for the Future

arrange a final Workshop

October 26th 2022 at Granåsen Stadium,

(Helse og Arenabygg: meeting room Panorama 1/2)

Learn more about temperature independent snowmaking, snowmaking from surplus heat, energy efficient and integrated energy solutions for snowmaking and sustainable venue development. Meet experts from R&D, university, skiing federations, organizers and site developers.

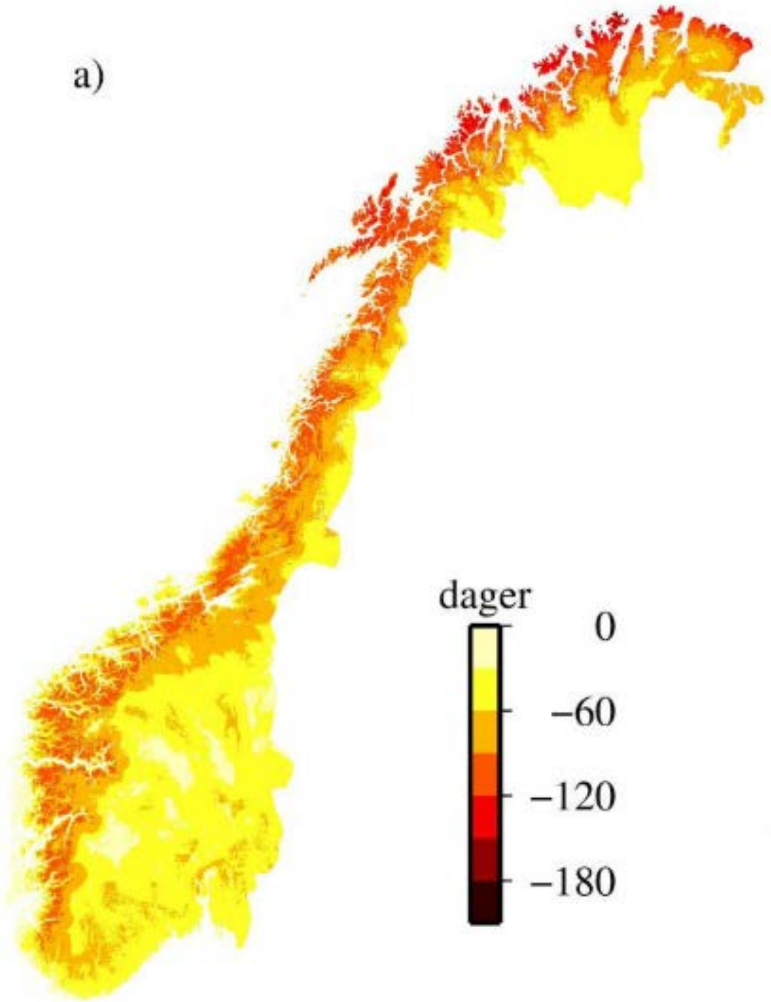
Program

09:00-	**Coffee and mingling**
09:15-09:30	Snow for the Future project, Project leader Ole Marius Moen, SINTEF
09:30-09:50	FIS Nordic World Ski Championships Trondheim 2025, Kristin Mürer Stemland
09:50-10:05	Plate ice/flake ice technologies, Håkon Selvnes, SINTEF
10:05-10:15	Snowproduction- different solutions, Trygve M. Eikevik, NTNU
10:15-10:35	Heat driven snow production with ejector technology, Ailo Aasen, SINTEF
10:35-10:50	**Coffee break**
10:50-11:10	Granåsen VM 2025– snow solutions- case analysis, Ole Marius Moen, SINTEF
11:10-11:35	Energy concept Granåsen Idrettsby, Frida Sæther and Sigurd Sannan, SINTEF
11:35-12:20	**Lunch**
12:20-12:40	Skiing facilities in Norway- the skiing federation perspective, Marit Gjerland, NSF
12:40-13:00	Snow production and storage in Granåsen venue, Heidi Arnesen, Trondheim Kommune
13:00-14:00	Visiting tour at Granåsen stadium - the venue for the FIS Nordic World Ski Championships in 2025
14:00-15:00	What now? Discussions and inputs. Introduction by Ingrid C. Claussen, SINTEF and Marit Gjerland NSF

Dream winter conditions

Climate change

- The number of days with snow cover is reduced due to climate change
- Winter sports locations are challenged
  - Events are sometimes cancelled due to poor snow conditions
- Traditional snowmaking systems do not work in plus temperatures



Predicted changes in the number of days with snow cover in the period 1971-2000 to 2071-2100

Hundrevis av ski øydelagde: – Plassen som m
å drepe alle toppski

LANGRENN.COM

Forside | Pluss + | Nyhetskategorier | Resultater | Smøretips | Terminlister

Logg inn - Pluss

Kjøp Langrenn Pluss (+) | Annonsering og profilering | Tips oss | Kontakt oss | Arkiv

Nye annonser
Artikkeltopp
* Red Bull Nordenskiöldsloppet

Begivenheter

Ski Tour
Fra Sverige til Norge
* Hjemmeside
* Program
* TV-tider
* Norges tropp
* Pengepremier
* Bonussekunder
* Smøretips
* Startlister
* Resultater

VM Skiskyting
* Hjemmeside
* Program
* TV-tider
* Norges tropp
* Startlister
* Resultater
* Medaljeoversikt

NC Senior
* Resultater

NC Junior
* Smøretips
* Resultater

Trysil Skimaraton
* Smøretips
* Resultater

Furusjøen Rundt-rennet
* Smøretips
* Resultater

Langrenn på TV
* Sendetider

Skiskyting på TV
* Sendetider

Oppkjørte skispor
* Løyper i Norge
* Løyper i Sverige

WEB-kameraer
* Klikk for å se alle

NYESTE RESULTATER

Ski Tour | VM Anterselva | BKK Bulkenrennet | Ogndalsrennet | Teamstafett Overhalla | NM Skiorientering | ØTS-rennet | Marka Rundt | Madshus Skimaraton | KLIKK FOR ALLE RESULTATER

SKI TOUR: Tirsdag: Sprint: Finale: Kvinner-Menn | Prolog: Kvinner-Menn | Totalt 2 av 6 etp: Kvinner-Menn | Søn: 10/15 km: Kvinner-Menn | Lør: 10/15 km: Kvinner-Menn

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Smøretips: Ski Tour

Lite snø i verdenscupløypene i Falun 2020. Foto: Modica/NordicFocus.

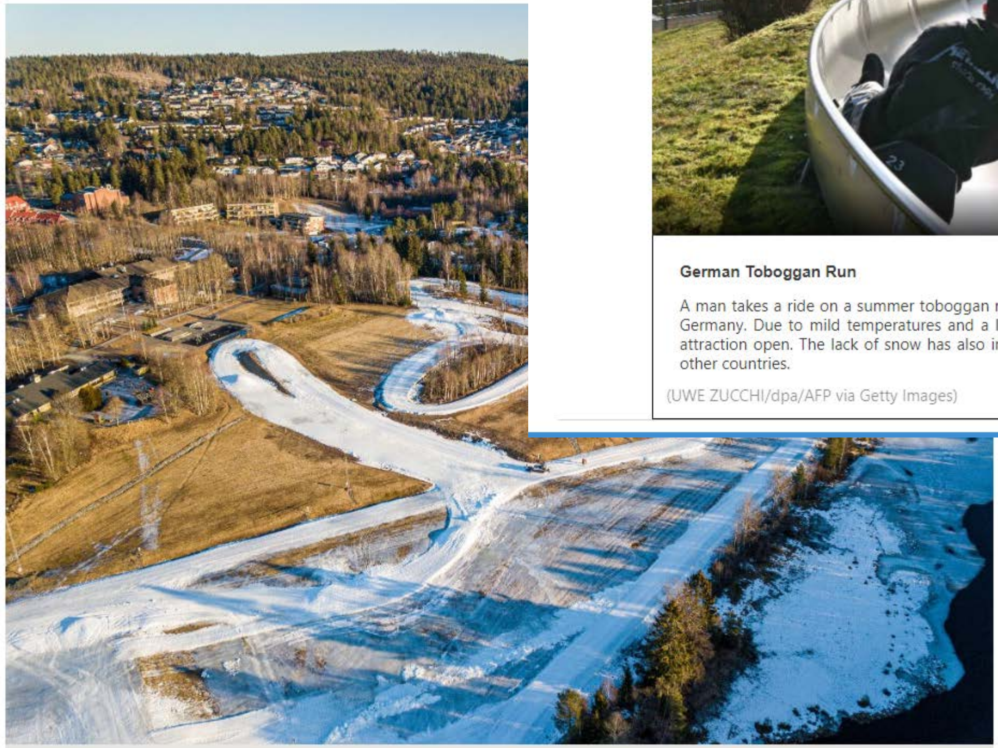
FLYTTER DRAMMEN WORLD CUP: – For øyeblikket har vi ikke snø nede i byen

Oberhof er ... lir øydelagde ... kostba ... ei ... der ... d og ... en ... fredag.

TIDKREVJANDE: Det norske støtteapparatet må bruke mykje tid og ressursar på å slipe ned mange skipar. 30 par har blitt sendt til Noreg og like mange blir slipt på Fischer-fabrikken.

FOTO: HANS HENRIK BÅRTVEDT / NRK

Det blir endringe programmet på



NM-STADION: Det blir ski-NM her på Konnerud skistadion, men det blir justeringer på programmet. Foto: Rune Folkedal

Av Jostein Nilsen — 23. januar 2020, kl. 10:35

På grunn av mildværet har juryen for ski-NM på Konnerud bestemt at det blir flere endringer i konkurranseprogrammet.

DEL **DRAMMEN:** Det gjelder hvilken stilart

NEWS

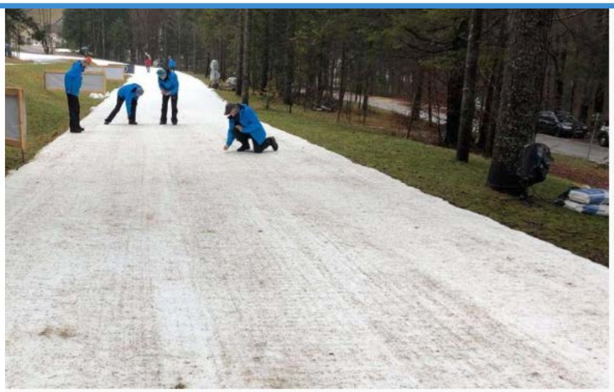
'No Snow': Climate Change is Challenging Ski Resorts Across the Globe

By Jan Wesner Childs · 5 days ago · weather.com

German Toboggan Run

A man takes a ride on a summer toboggan run on Jan. 16, 2020, in the winter sports resort of Willingen in western Germany. Due to mild temperatures and a lack of snow, the operator of the summer toboggan run has kept the attraction open. The lack of snow has also impacted ski resorts and other winter sports in France, Switzerland and other countries.

(UWE ZUCCHI/dpa/AFP via Getty Images)



printløypene i Planica fredag. Arrangøren i Planica gjør det de kan for at helgen konkurranser går som

Traditional snow production and its temperature limitations

Temperature (°C) \ Relative humidity (%)	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
-9	-11,9	-11,7	-11,6	-11,4	-11,2	-11,1	-10,9	-10,7	-10,6	-10,4	-10,3	-10,1	-9,9	-9,8	-9,6	-9,5	-9,3	-9,2	-9,0
-8	-11,1	-10,9	-10,7	-10,6	-10,4	-10,2	-10,0	-9,9	-9,7	-9,5	-9,3	-9,2	-9,0	-8,8	-8,7	-8,5	-8,3	-8,2	-8,0
-7	-10,3	-10,1	-9,9	-9,7	-9,6	-9,4	-9,2	-9,0	-8,8	-8,6	-8,4	-8,3	-8,1	-7,9	-7,7	-7,5	-7,4	-7,2	-7,0
-6	-9,5	-9,3	-9,1	-8,9	-8,7	-8,5	-8,3	-8,1	-7,9	-7,7	-7,5	-7,3	-7,1	-7,0	-6,8	-6,6	-6,4	-6,2	-6,0
-5	-8,8	-8,6	-8,3	-8,1	-7,9	-7,7	-7,5	-7,3	-7,1	-6,8	-6,6	-6,4	-6,2	-6,0	-5,8	-5,6	-5,4	-5,2	-5,0
-4	-8,0	-7,8	-7,6	-7,3	-7,1	-6,9	-6,6	-6,4	-6,2	-6,0	-5,7	-5,5	-5,3	-5,1	-4,9	-4,6	-4,4	-4,2	-4,0
-3	-7,3	-7,0	-6,8	-6,5	-6,3	-6,0	-5,8	-5,6	-5,3	-5,1	-4,8	-4,6	-4,4	-4,1	-3,9	-3,7	-3,5	-3,2	-3,0
-2	-6,5	-6,3	-6,0	-5,7	-5,5	-5,2	-5,0	-4,7	-4,5	-4,2	-4,0	-3,7	-3,5	-3,2	-3,0	-2,7	-2,5	-2,2	-2,0
-1	-5,8	-5,5	-5,3	-5,0	-4,7	-4,4	-4,1	-3,9	-3,6	-3,3	-3,1	-2,8	-2,5	-2,3	-2,0	-1,8	-1,5	-1,3	-1,0
0	-5,1	-4,8	-4,5	-4,2	-3,9	-3,6	-3,3	-3,0	-2,7	-2,5	-2,2	-1,9	-1,6	-1,3	-1,1	-0,8	-0,5	-0,3	0,0
1	-4,4	-4,1	-3,8	-3,5	-3,1	-2,8	-2,5	-2,2	-1,9	-1,6	-1,3	-1,0	-0,7	-0,5	-0,2	0,1	0,4	0,7	1,0
2	-3,7	-3,4	-3,1	-2,7	-2,4	-2,1	-1,7	-1,4	-1,1	-0,8	-0,5	-0,2	0,1	0,4	0,8	1,1	1,4	1,7	2,0
3	-3,1	-2,7	-2,3	-2,0	-1,7	-1,3	-1,0	-0,6	-0,3	0,0	0,4	0,7	1,0	1,4	1,7	2,0	2,4	2,7	3,0
4	-2,4	-2,0	-1,6	-1,3	-0,9	-0,6	-0,2	0,2	0,5	0,9	1,2	1,6	2,0	2,3	2,6	3,0	3,3	3,7	4,0

Good snow quality Poor snow quality No snowmaking

(Eikevik 2017).

European energy crisis

- European energy crisis – spiking electricity prices in Southern Norway
- Electricity consumption in Norway expected to grow significantly over the next years due to increased electrification
- Cost challenges for clubs and winter sports facilities
- Intensified the political debate on sustainable use of electricity in Norway
- Increased focus on:
  - Energy efficiency
  - Utilization of waste heat

Seks av 10 skianlegg kan ikke drives som normalt

Norges Skiforbunds klubbundersøkelse om strøm indikerer at kun fire av 10 skianlegg vil drives som normalt.

Source: skiforbundet.no

Source: nrk.no

Vision of Snow for the Future

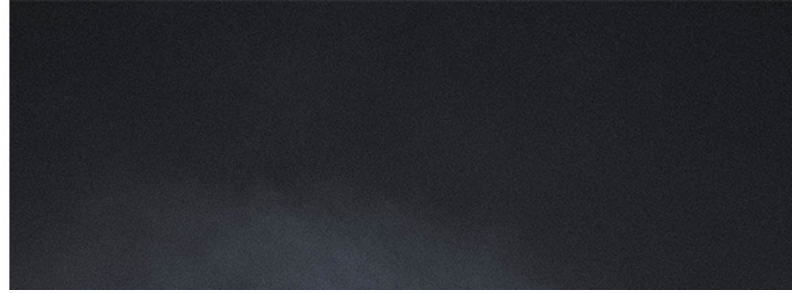
The vision of Snow for the future (phase 2) is to contribute to snow secure winter sports areas close to where people live

- Maintain the tradition for skiing and winter sports activities
  - Continue to recruit younger generations to organized sports
  - Contribute to improving the public health
  - Increase the number of skiing days in local communities
- Value creation
  - Improve the predictability of organizing winter sport events and competitions
  - For technology manufacturers

Snow for the future - phase 2 (2019-2022)

- New solutions for snow production at the ski resorts
- Production of snow independently of temperature
- Contribute to energy-efficient and climate-friendly solutions

1. Development of snow technologies
   - Temperature independent snow production
   - Snow production from surplus heat
2. Integrated snow systems
   - Planning tool – snow model
   - Integration towards heat consumers
3. Centre of snow competency



NTNU

NORGES SKISKYTTER FORBUND

NORGES SKIFORBUND

Kulturdepartementet

Klima- og miljødepartementet

TRONDHEIM KOMMUNE

SINTEF

PTG
THE VALUE OF PERFECT TEMPERATURE

FIS

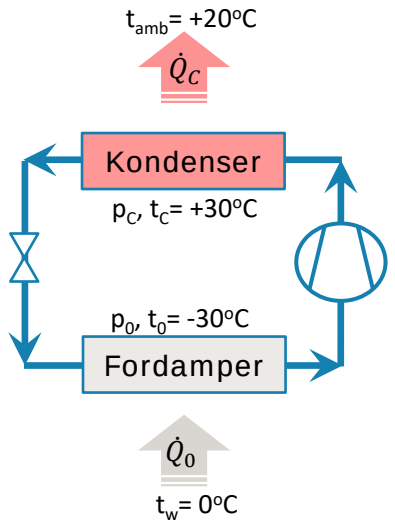
Temperature Independent snow production (TIS)

- Existing technology with several suppliers
- Guarantee season opening, and ensure snow during mild winters

- Disadvantages:
  - Energy demanding: 20-40 kWh/m^3 vs. 0.5-1 kWh (traditional)
  - Low production capacitiy
  - High investment costs

- Research focus in Snow for the future:
  - Modeling the production process
  - Improve efficiency in components and systems
  - Focus on climate friendly working fluids
  - Utilization of surplus heat – integrated heat production
    - No examples in Norway

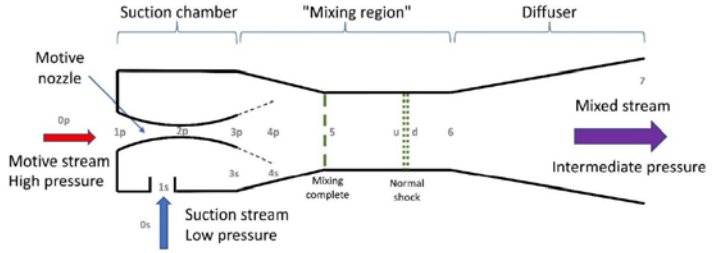
Snøfafactory SF220
Sjusjøen



TIS technology research in Snow for the Future

Highlights:

- Detailed Modeling of components and processes to reduce of energy consumption
- System design and optimization
- Evaluation of different production technologies
- Concepts for utilization of surplus heat integrated heat production



Ejector cross section

Plate / flake ice technology

✓Modeling of plate freezing mechanisms
✓Modelling of CO2 flake ice machine
✓Energy analysis of plate ice and flake ice machines – comparison
✓Optimization of defrosting system for plate ice freezing machine

Ejectortechnology for slurry / plate / flake:

✓ Development of ejector modeling tools
✓ Investigation of critical mass flow for CO2 og H2O through nozzle restrictions.
✓ Snow production through expansion and flash freezing of CO2
✓ Steam driven ejector systems for slurry / vacuum ice production

Indoor snow production systems

✓ Indoor refrigerations systems for snow production (collaboarition with SNØ (Oslo))

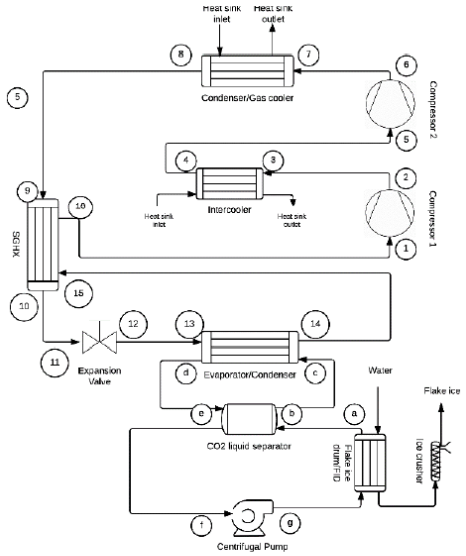
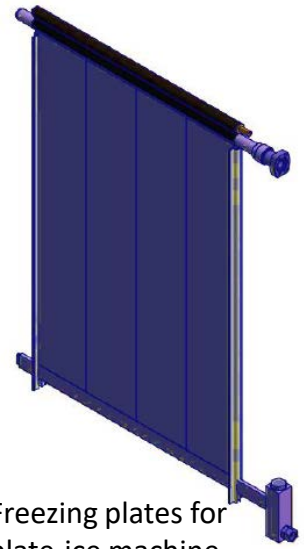
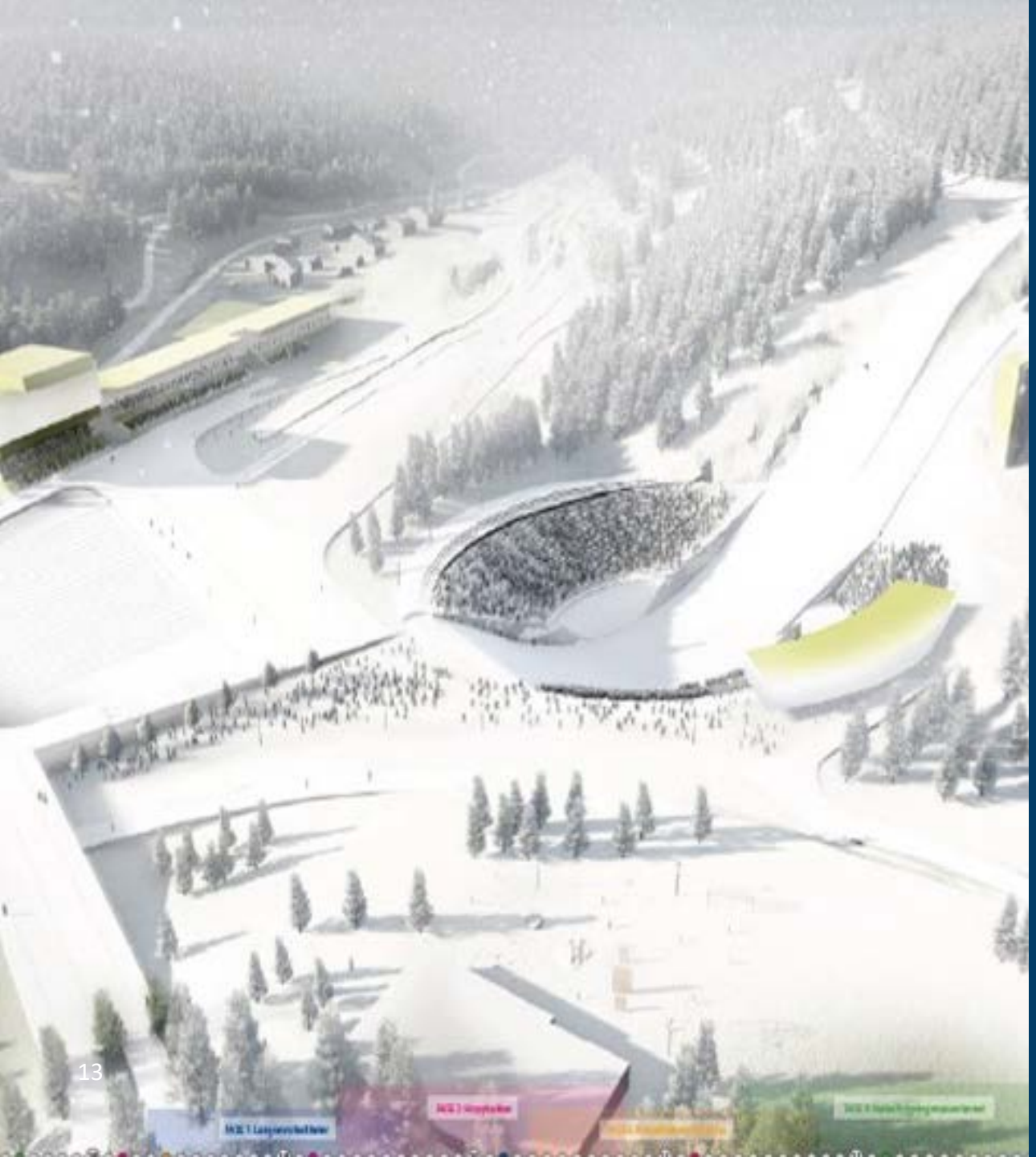


Figure 2 Flake ice maker with CO_2 refrigeration system. Two stage



Freezing plates for plate-ice machine



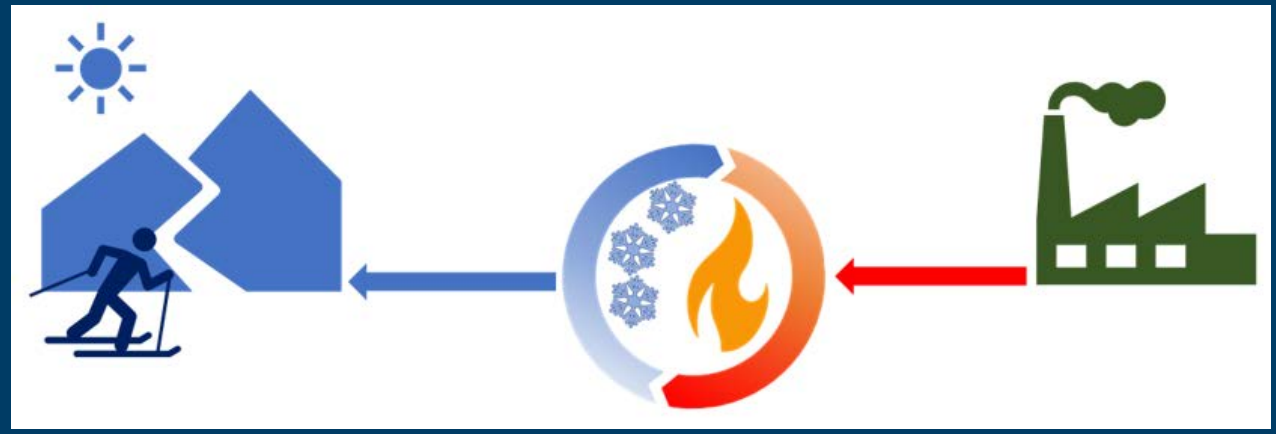
Smart planning

- For destinations and venues
- Evaluate different solutions to fulfull the snow demand for seasons and events
- Adapted model for each venue
- Minimise energy consumption, cost and emissions

SINTEF

Heat driven snow production

- Temperature-independent snow production is very energy demanding
- Heat can be used to produce snow
- Large surplus of "free" heat in Norway and Europe



Is it possible to utilize heat sources near ski facilities for snow production?

Potential heat sources

Results from mapping study in Norway – heat sources cross mapped with ski locations:

District heating:

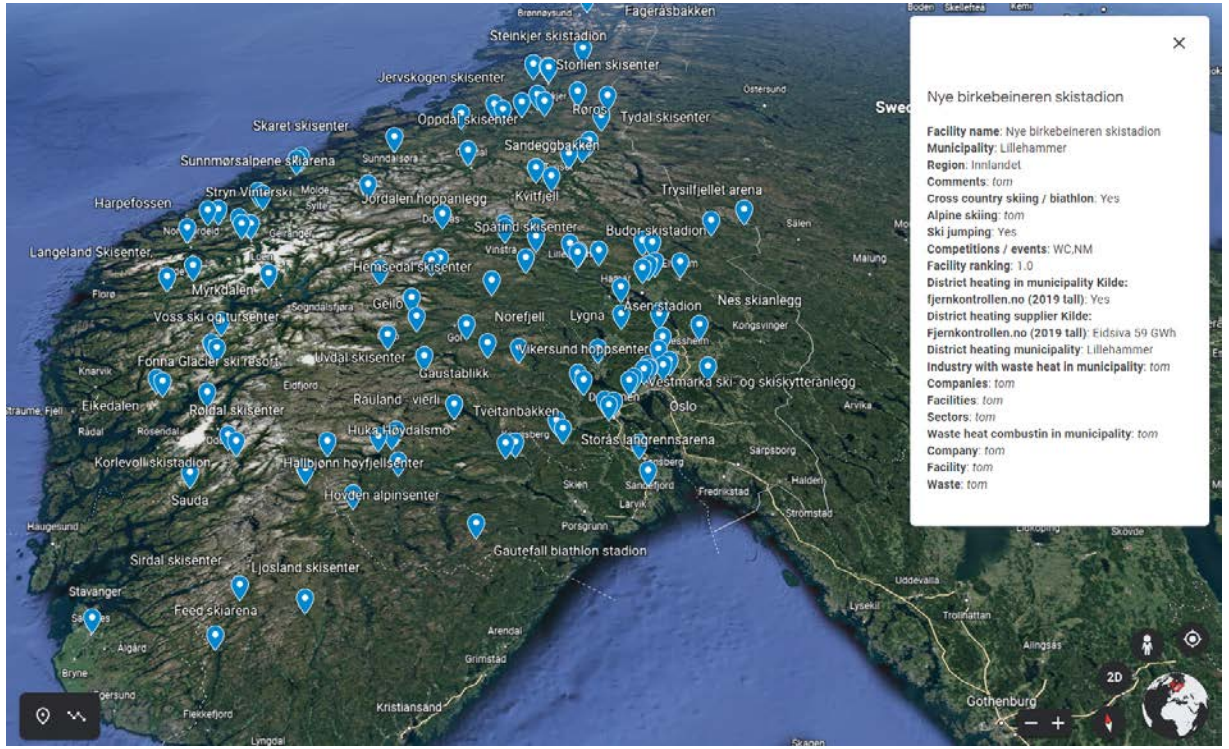
- Over 100 municipalities, 7 TWh potential
- Waste combustion facilites often have large amount of surplus heat during summer time

Heat from Industry:

- Potential: 10 TWh, more than 100 potential industry facilities
- high temperatures – good for efficiency

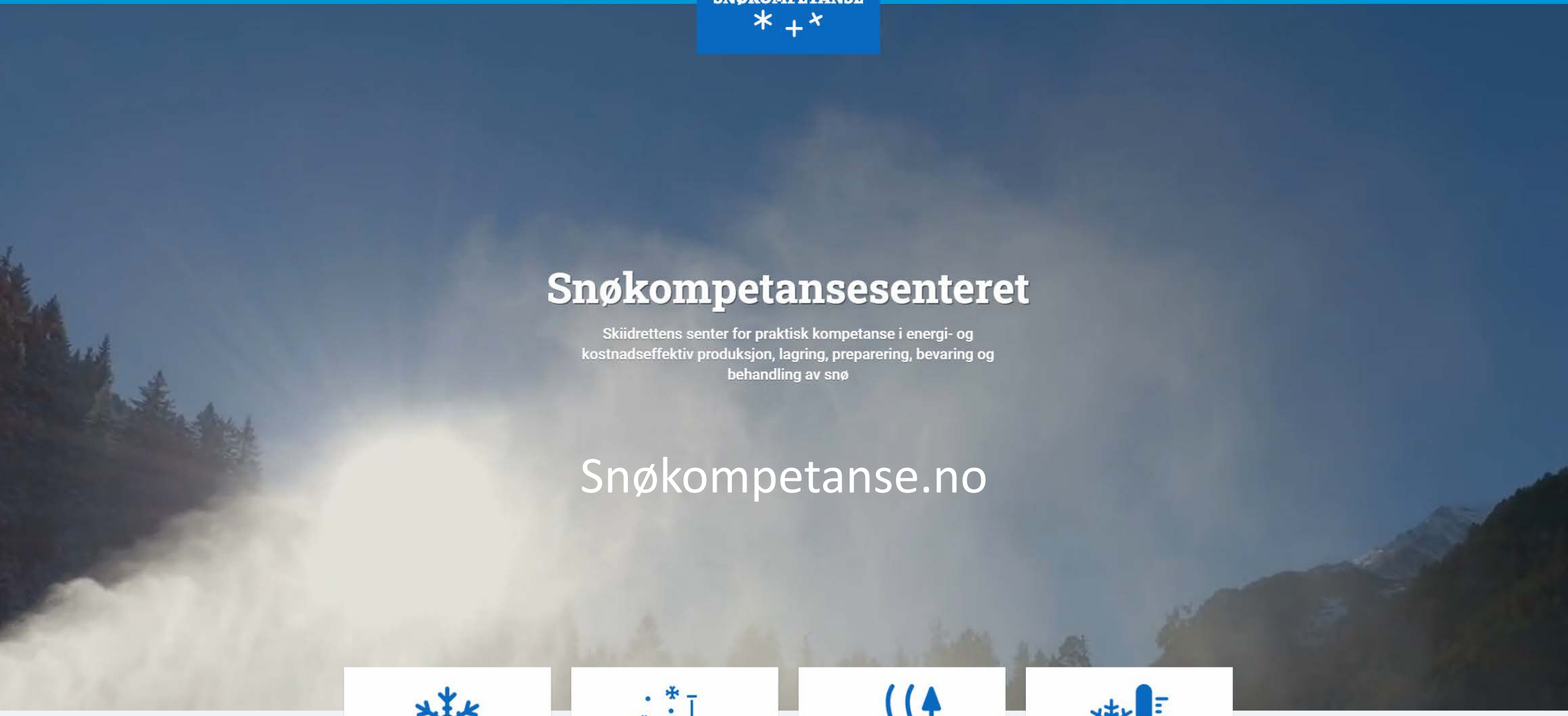
Technology mapping and development:

- Needs to be located near the heat sources
- Heat source should be 80-90°C or higher
- Lower efficiciency than electricity based TIS – cost of heat needs to be 1/3 of electricity price or lower
- Production technologies not at the same commercial level
- Sorption based technology and ejector technologies look promising



Centre of snow competency

- Lack of established knowledge nettworks for snow production
- Knowledge gap between small and large ski facilities
- Small facilities need an information channel



Snøkompetansesenteret

Skiidrettens senter for praktisk kompetanse i energi- og kostnadseffektiv produksjon, lagring, preparering, bevaring og behandling av snø

Snøkompetanse.no

PRODUKSJON AV SNØ

LAGRING AV SNØ

PREPARERING AV SNØ

BEVARING AV SNØ

Topics on snøkompetanse.no

- Information regarding the practical considerations on these topics
- access to new research, publications, snow seminars, news and more

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Centre for practical SNOW COMPETENCY

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Teknologi for et bedre samfunn