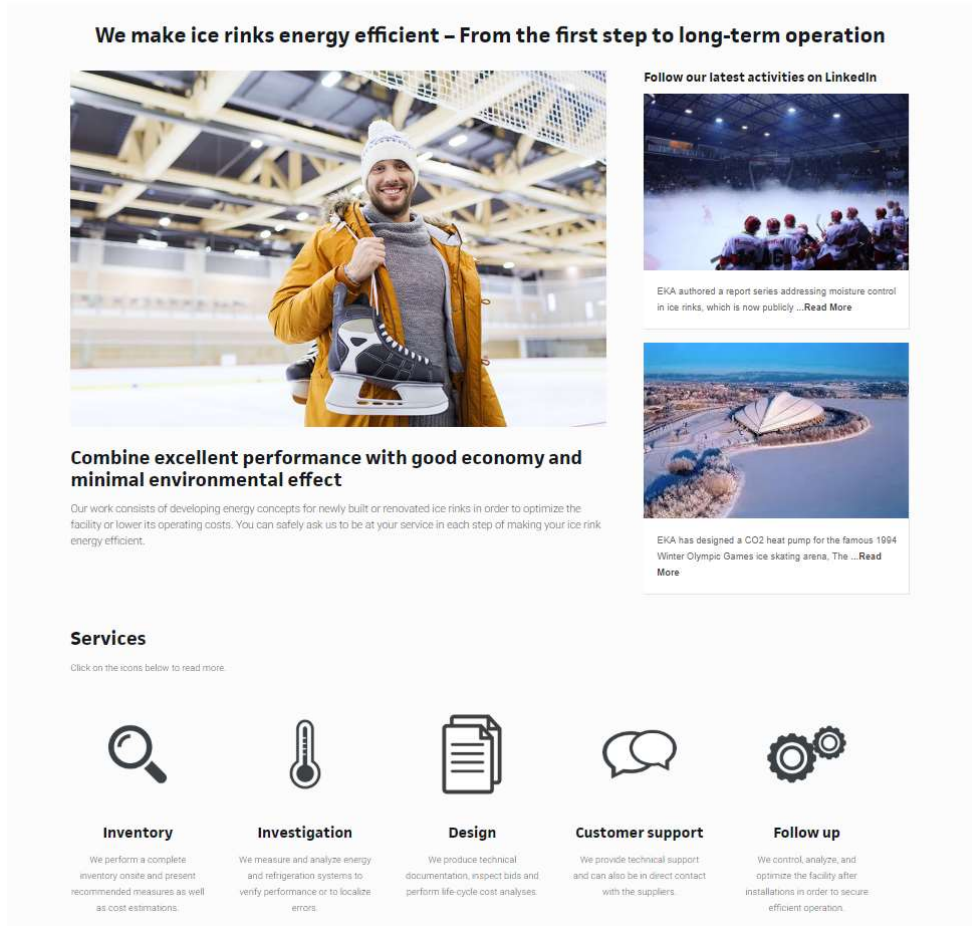


# **Jäähallin kosteudenhallinta – Moisture control in ice rinks**

**Cajus Grönqvist**  
**EKA - Energi & Kylanalys**  
**Rakennusfysiikka 2019**



**We make ice rinks energy efficient – From the first step to long-term operation**

**Combine excellent performance with good economy and minimal environmental effect**

Our work consists of developing energy concepts for newly built or renovated ice rinks in order to optimize the facility or lower its operating costs. You can safely ask us to be at your service in each step of making your ice rink energy efficient.

**Services**

Click on the icons below to read more.

- Inventory**  
We perform a complete inventory onsite and present recommended measures as well as cost estimations.
- Investigation**  
We measure and analyze energy and refrigeration systems to verify performance or to localize errors.
- Design**  
We produce technical documentation, inspect bids and perform life-cycle cost analyses.
- Customer support**  
We provide technical support and can also be in direct contact with the suppliers.
- Follow up**  
We control, analyze, and optimize the facility after installations in order to secure efficient operation.

**Follow our latest activities on LinkedIn**

EKA authored a report series addressing moisture control in ice rinks, which is now publicly [Read More](#)

EKA has designed a CO2 heat pump for the famous 1994 Winter Olympic Games ice skating arena. The [Read More](#)

**EKA on puolueeton jäähalliasiantuntija ja suunnittelija**

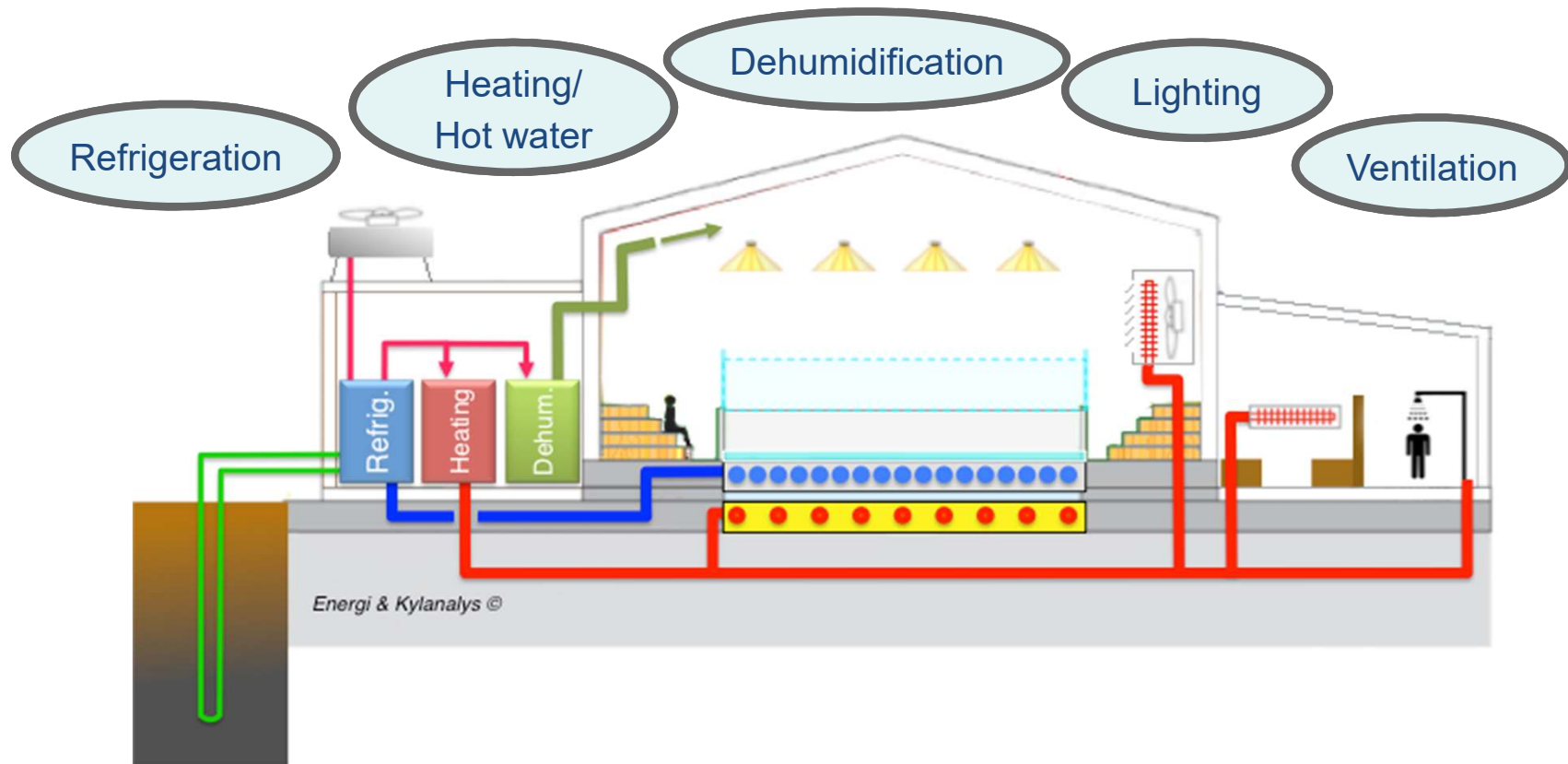
**www.ekanalys.se**



**We make ice rinks energy efficient! From the first step to long-term operation.**

**in** Follow Energi & Kylanalys on LinkedIn to find out more about our latest projects and research!

# EKA's Focus: The Big 5 Energy Systems



## References

Here you can view the facilities that we have worked with. You can filter or search in our work categories and technology scopes. You can also specify your search by filtering among our clients, cities where have been active, and year of project in order to find a specific facility.

### Category

- Technology and energy inventory (45)
- Design (33)
- Investigation (14)

### Scope












- Air handling (15)
- Boards (8)
- Heat export (9)
- Heat pump (1)
- Heat recovery (29)
- Lighting (5)
- Refrigeration (31)
- Rink floor (14)
- Sec. refrigerant (32)

### Client

### City

### Year



	<b>Vikingskipet</b> Client: HOA Hamar Olympiske Anlegg City: Hamar Year: 2018
	<b>Glysisvallen</b> Client: Glysisvallen AB City: Hudiksvall Year: 2018
	<b>Storhamar ishall</b> Client: HOA Hamar Olympiske Anlegg City: Hamar Year: 2018
	<b>NERIS reports – Moisture control in ice rinks</b> Client: KTH Royal Institute of Technology City: Stockholm Year: 2018
	<b>Ben Boeke Arena</b> Client: Municipality of Anchorage City: Anchorage Year: 2018
	<b>UAA Arena</b> Client: UAA City: Anchorage Year: 2016
	<b>Hedesunda IP</b> Client: Gavlefastigheter City: Hedesunda Year: 2018
	<b>Malungs ishall</b> Client: Malung-Salens kommun City: Malung Year: 2018
	<b>Storegårdshallen</b> Client: Eksjö kommunfastigheter City: Eksjö Year: 2018
	<b>Tibro ishall</b> Client: Tibro kommun City: Tibro Year: 2018
	<b>Åkersberga ungdomshall</b>

## Pirkkalan Jäähalli

- Tarveselvitys 2018
- Hankesuunnitelma 2019



# EKA is Expert Consultant in Beijing Winter Olympics 2022





BY JÖRGEN ROGSTAM, MEMBER ASHRAE; SIMON BOLTEAU; CAJUS GRÖNQVIST

Ice rinks use a considerable amount of energy, and Sweden boasts more than 350 indoor rinks for ice hockey alone. An average Swedish ice rink uses about 1 million kWh of electricity and heat combined each year,<sup>1</sup> about 40% of which is from the refrigeration system. To reduce energy use, one municipality replaced its ice rink's old indirect refrigeration system with a direct 100% CO<sub>2</sub> system that is combined with a heat pump function. This article reviews the technology and how it reduced the ice rink's energy use by 50% to 60%.

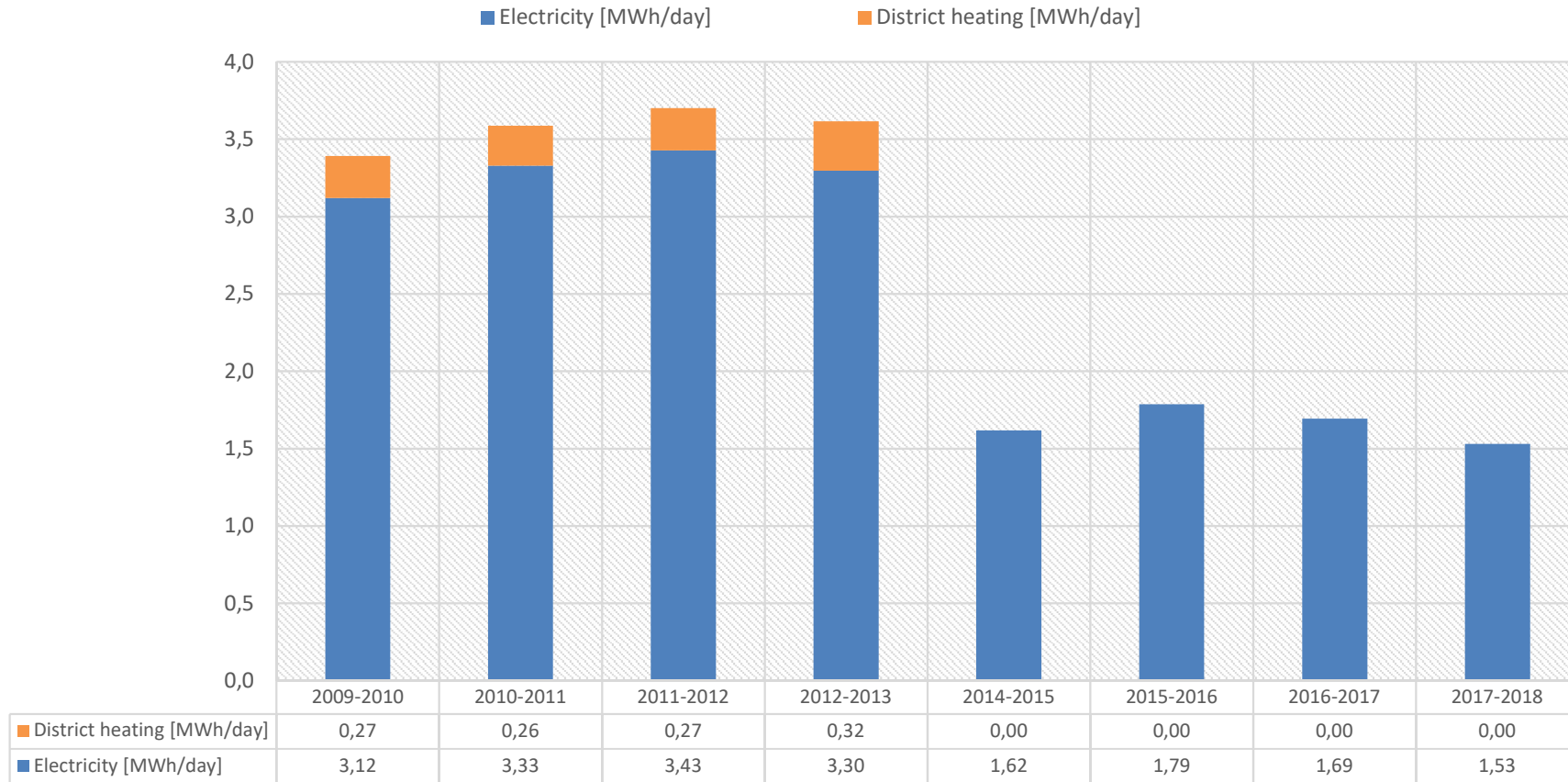
Updated F-Gas Regulation Requires New Solutions

Using CO<sub>2</sub> Systems in Ice Rinks



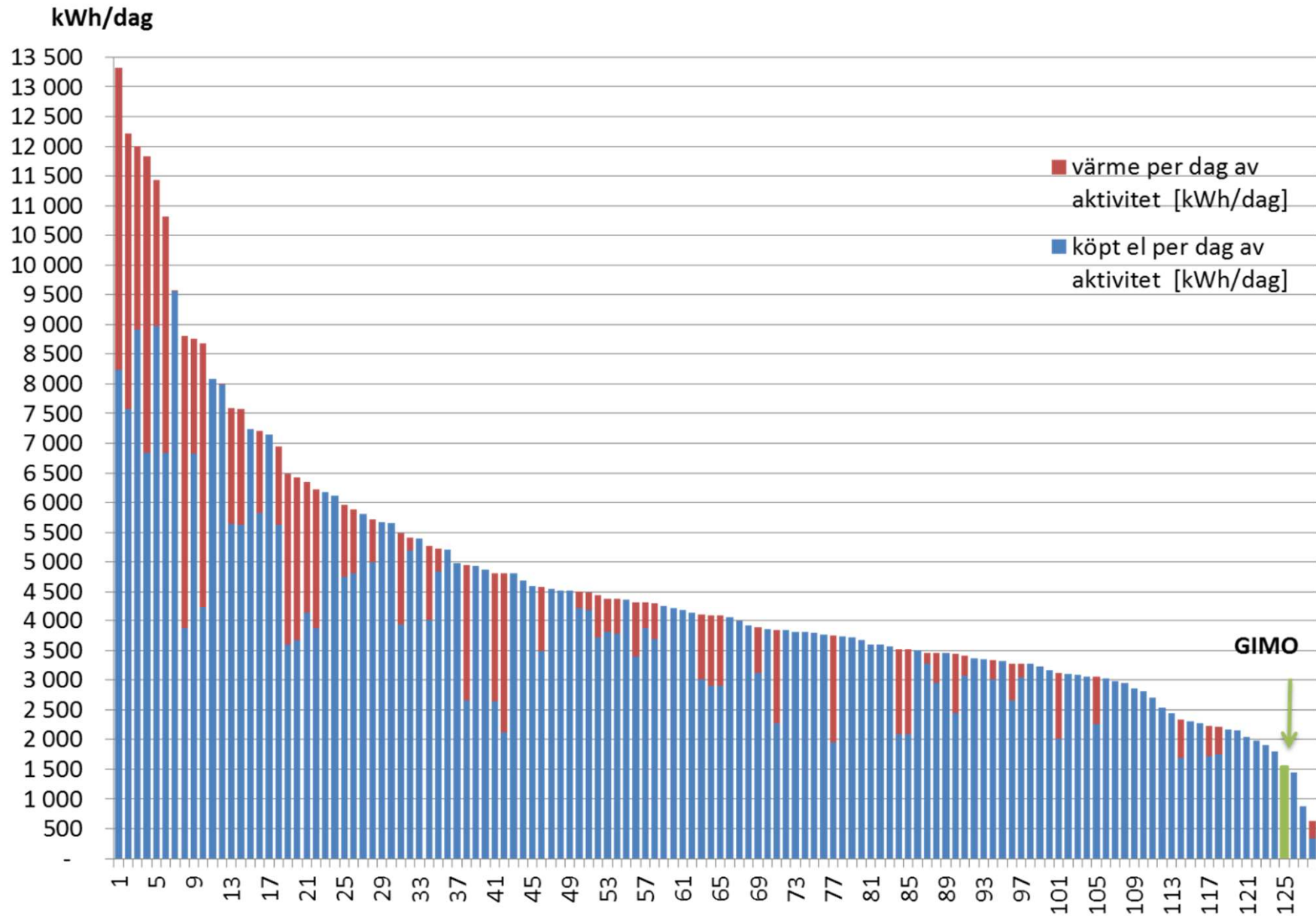
# Gimo ice rink – Before/After

Energy consumption per day of activity - Facility A



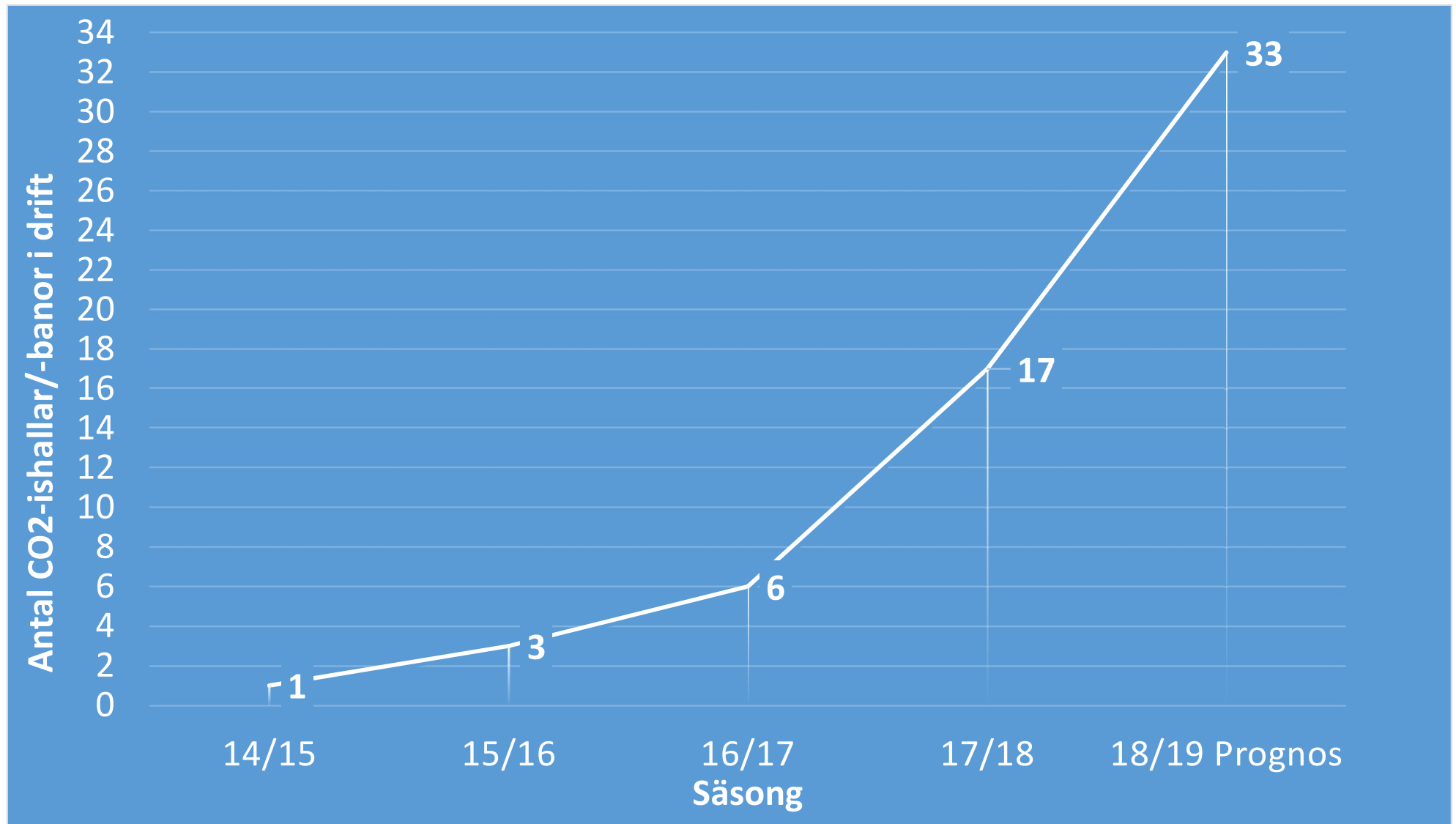
- Previously: 950 MWh per year
- Today: 450 MWh MWh per year (50+ % reduction)

# Comparison of Gimo and other Swedish ice rinks





## No of CO2 ice rinks in Sweden 2018/2019

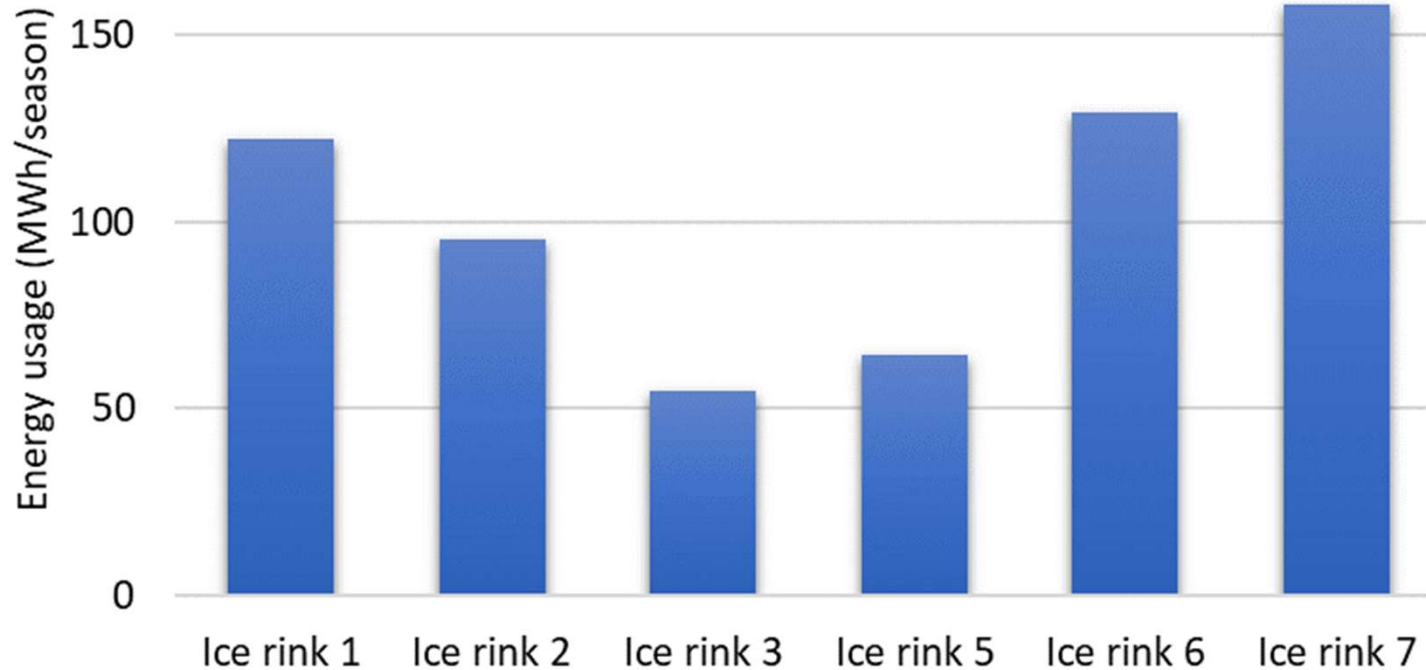


Equivalent to ca 10% of the ice rinks in Sweden



# JÄÄHALLIN KOSTEUDENHALLINTA

TUTKIMUSPROJEKTI YHTEISTYÖSSÄ TUHKOLMAN TEKNILLISEN KORKEAKOULUN  
(KTH) JA RUOTSIN JÄÄKIEKKOLIITON KANSSA



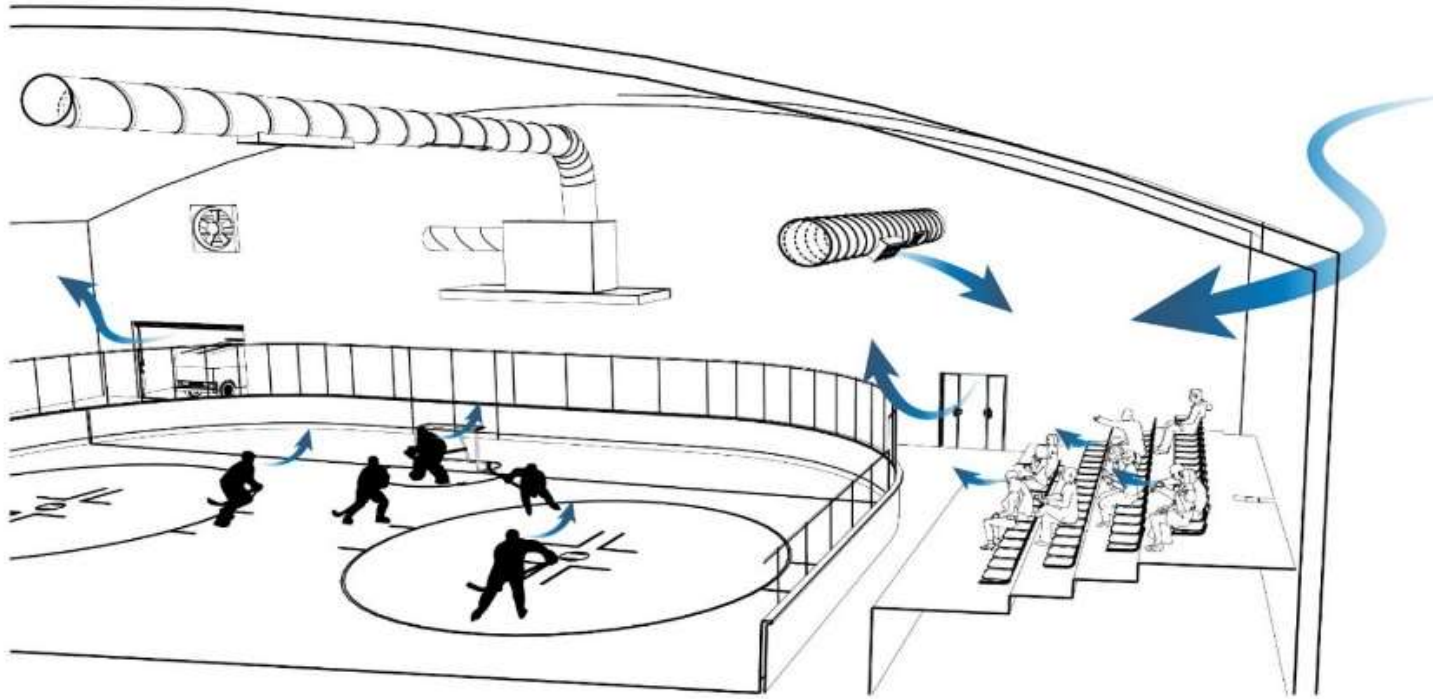
- All typical Nordic ice rinks:
  - Indoor temperature: 5-10°C during season
  - spectator capacity: ca 500 people

1. Kosteuskuorman minimointi
2. Kestävä ilmankuivausjärjestelmä
3. Kestävä käyttöstrategia



## Kosteuskuorman minimointi

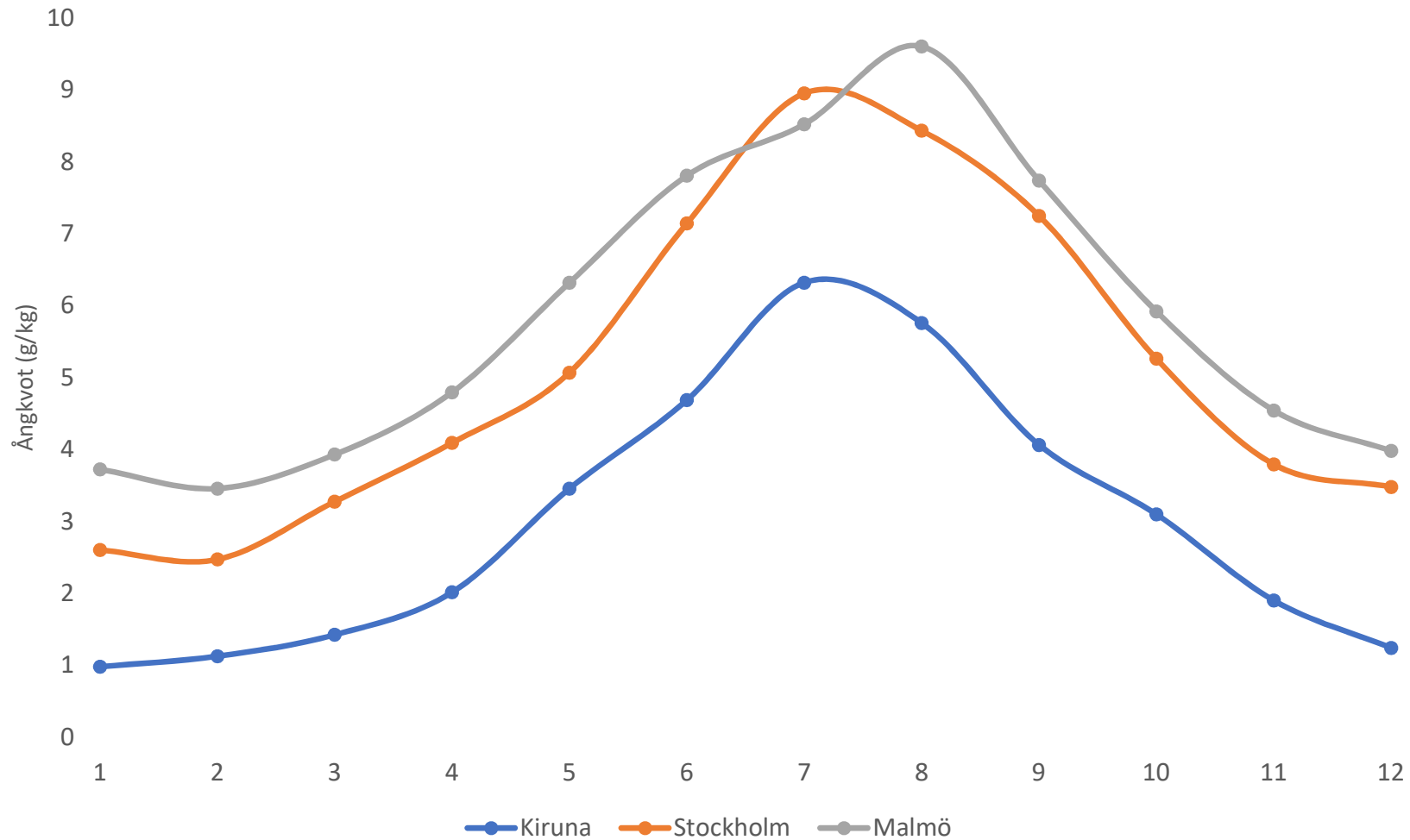
# Kosteuslähteet



- Ulkoilman konvektio suurin kosteuslähde!  
– **Ilmatiiviys!**

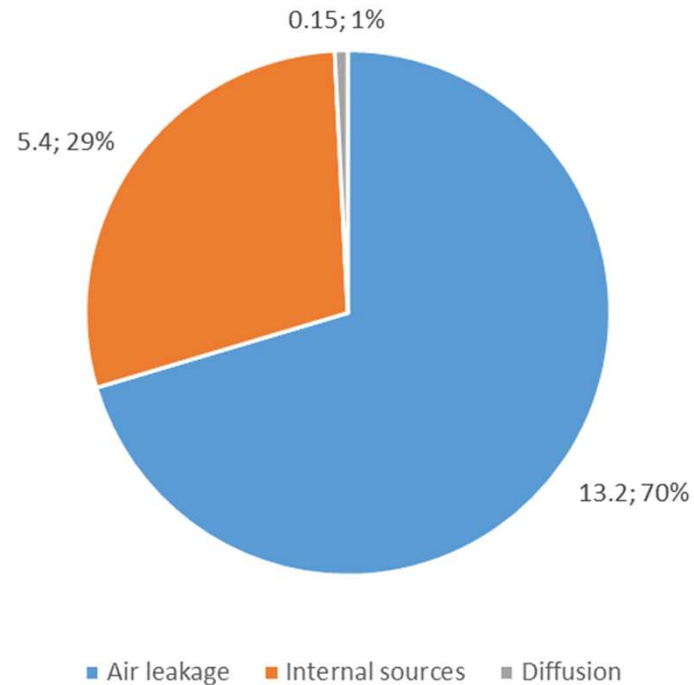
## Kosteuskuorman minimointi

# Ulkoilman kosteusmäärä



## Kosteuskuorman minimointi

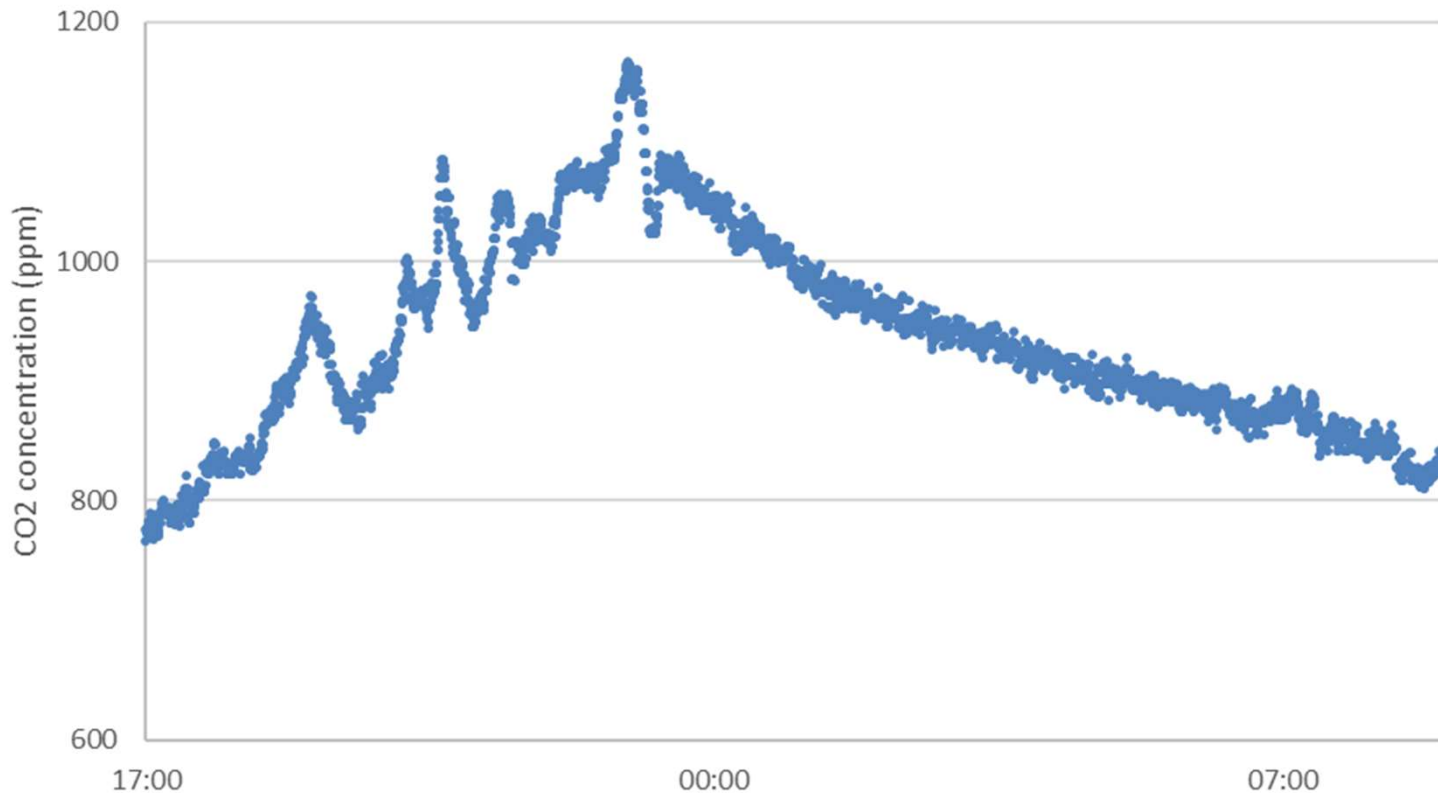
# Kosteuskuorma (kg/h) ottelun aikana



- Sisäiset kuormat ca 0 kg/h kun halli tyhjä
- Diffuusiolla melkein olematon vaikutus
  - Kosteusvaurioita mahdollisia kuitenkin
    - **Ilmansulku! Tuulikaappeja!**
    - **Höyrynsulku**

# Kosteuskuorman minimointi

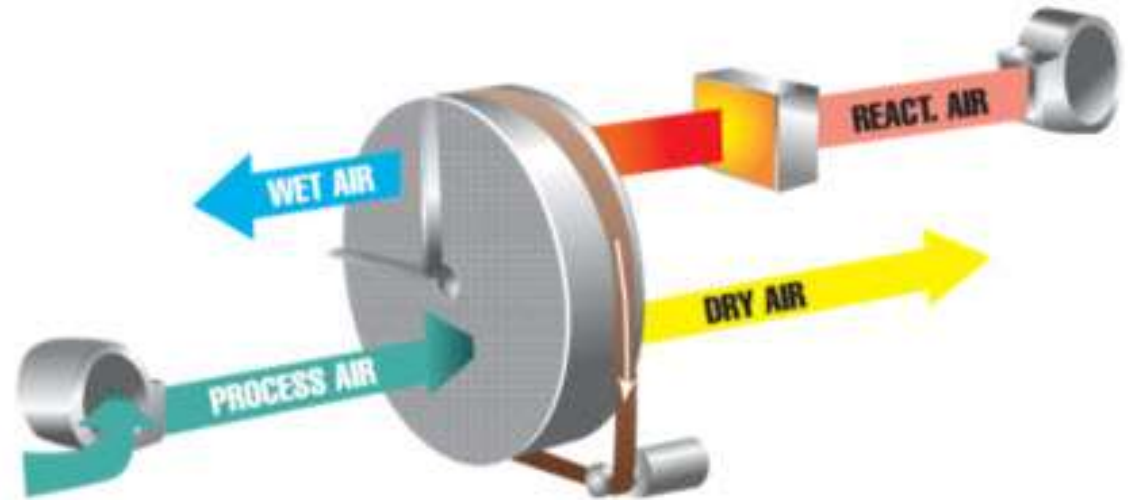
## Ulkoilman vuoto jäähalliin



- CO2-mittauksilla lasketaan ilmavuodon (kosteuskuorman) määrää
  - Tyypillisesti noin 5-15 % hallin tilavuudesta per tunti
  - Raitisilmaa IV-koneen kautta harvoin tarpeen!
- **Kiertoilmatila!**

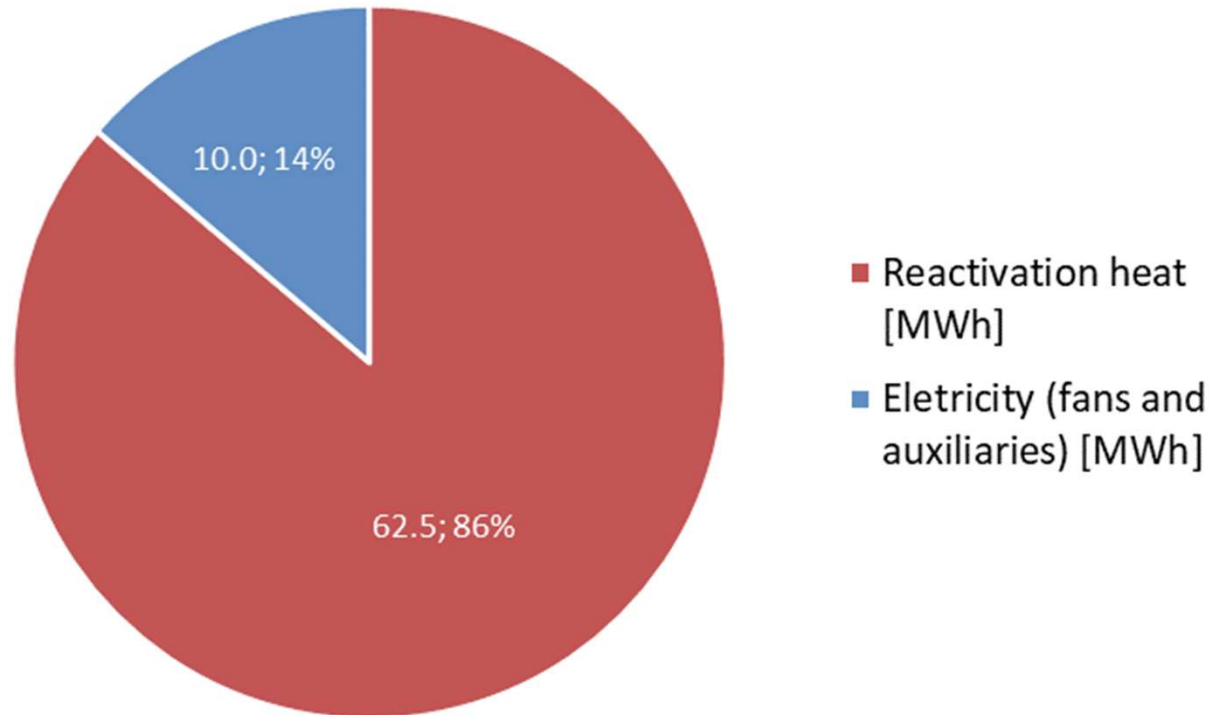


## Kestävä ilmankuivausjärjestelmä Sorptiokuivain + Lauhdelämpö



- Sorptiokuivaimen lämmönlähteenä usein ollut sähkö...
- Nyt: Sorptiokuivaimen lämmönlähteenä jäähdytysjärjestelmän lauhdelämpö!
  - Lämpötilan oltava noin 60-70 astetta
  - CO<sub>2</sub>-järjestelmän "ilmainen" lauhdelämpö pystyy tähän
- **Merkittävä säästöpotentiaali!**

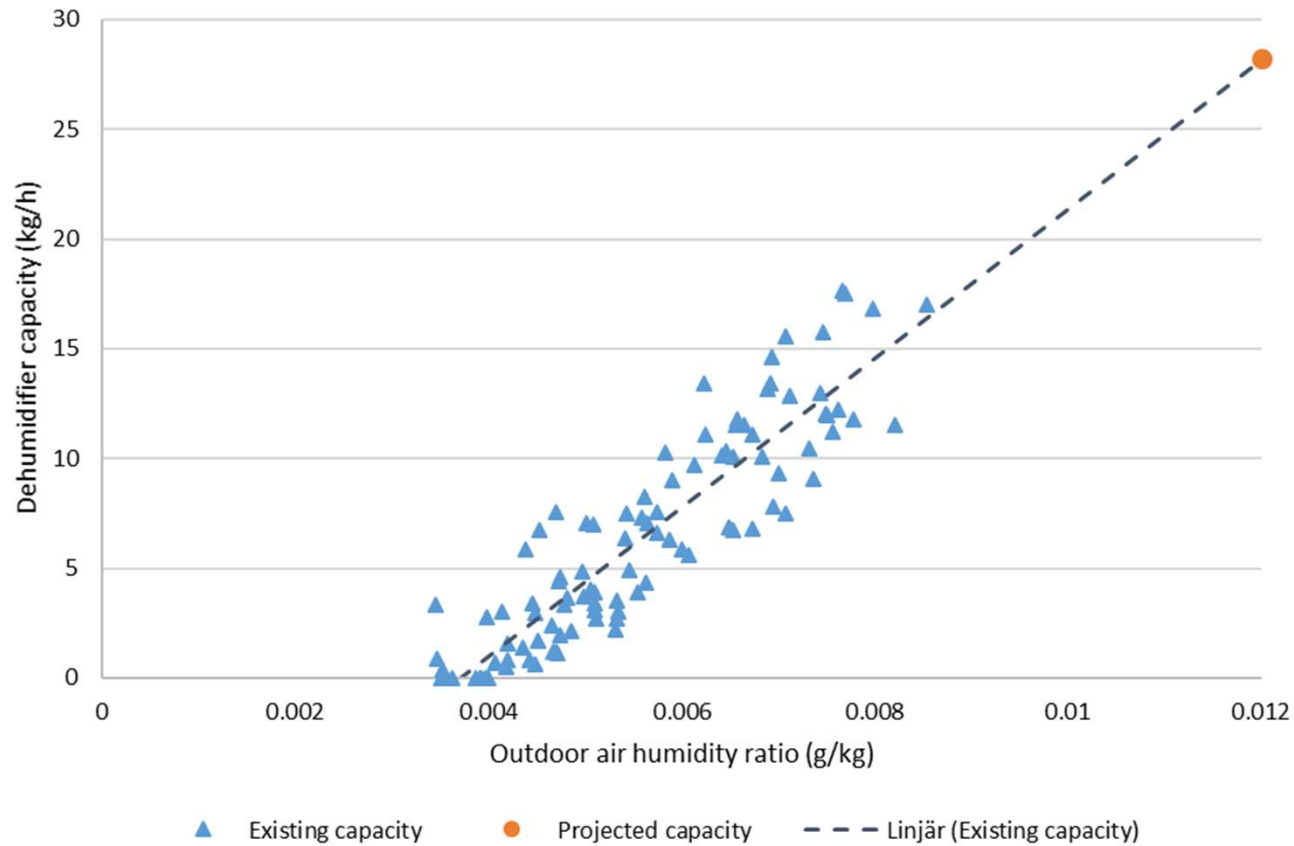
## Kestävä ilmankuivausjärjestelmä Sorptiokuivain + CO<sub>2</sub>-Lauhdelämpö



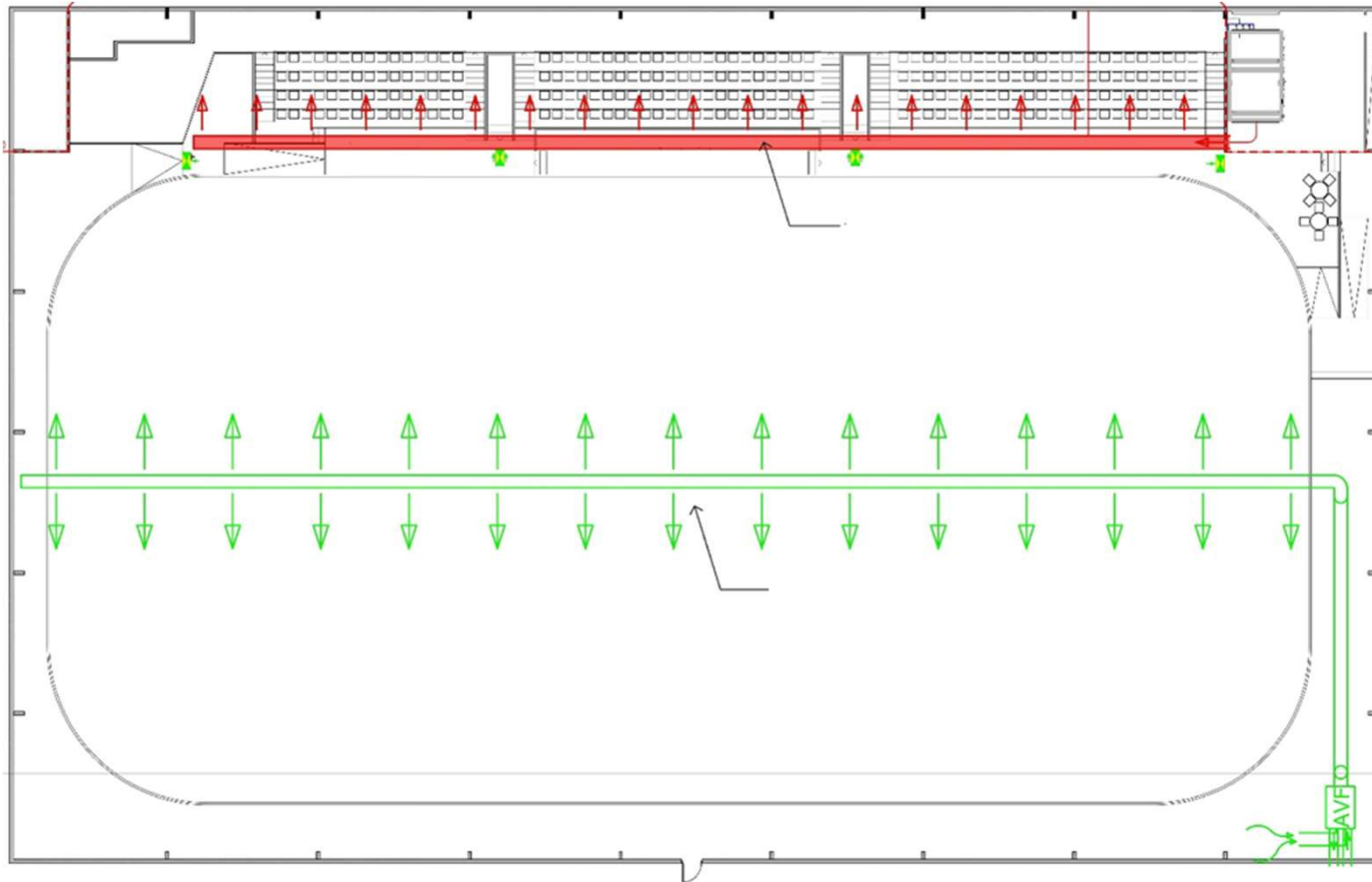
- Mittaukset osoittavat 85% säästöä ostoenergian käytössä!

# Kestävä ilmankuivausjärjestelmä

## Kuivauskapasiteettitarve



- 20 kg/h is good enough capacity for typical Nordic ice rink

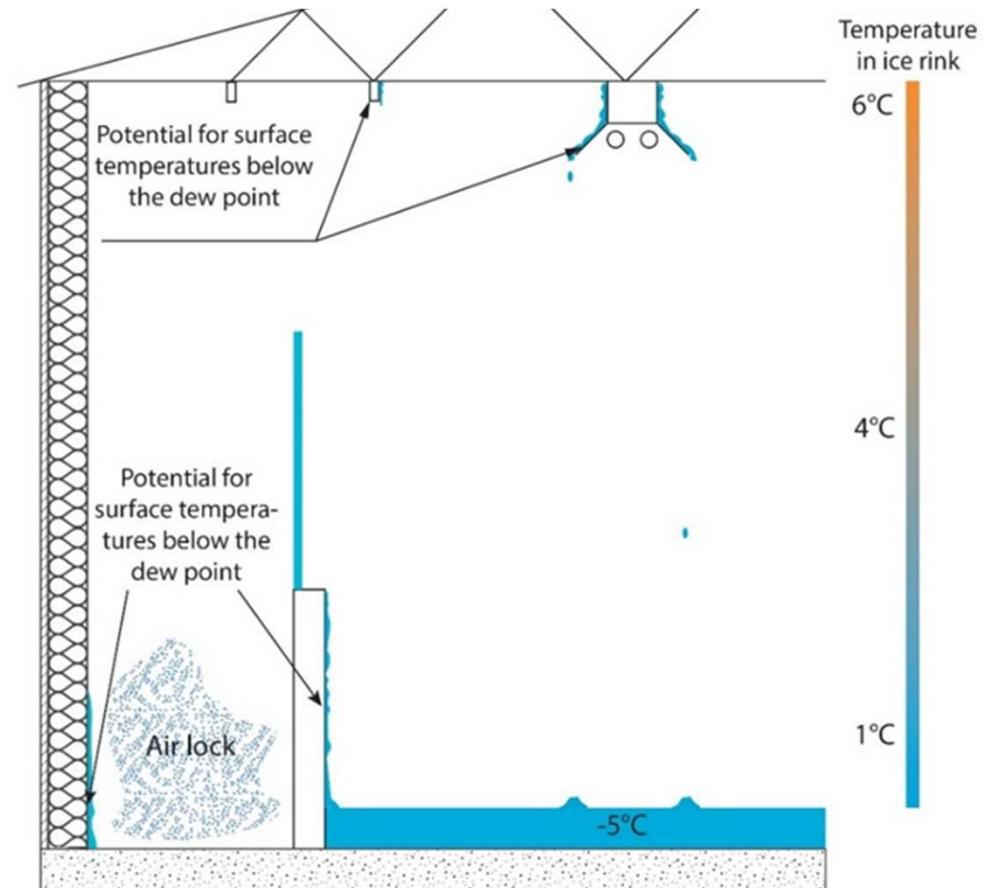


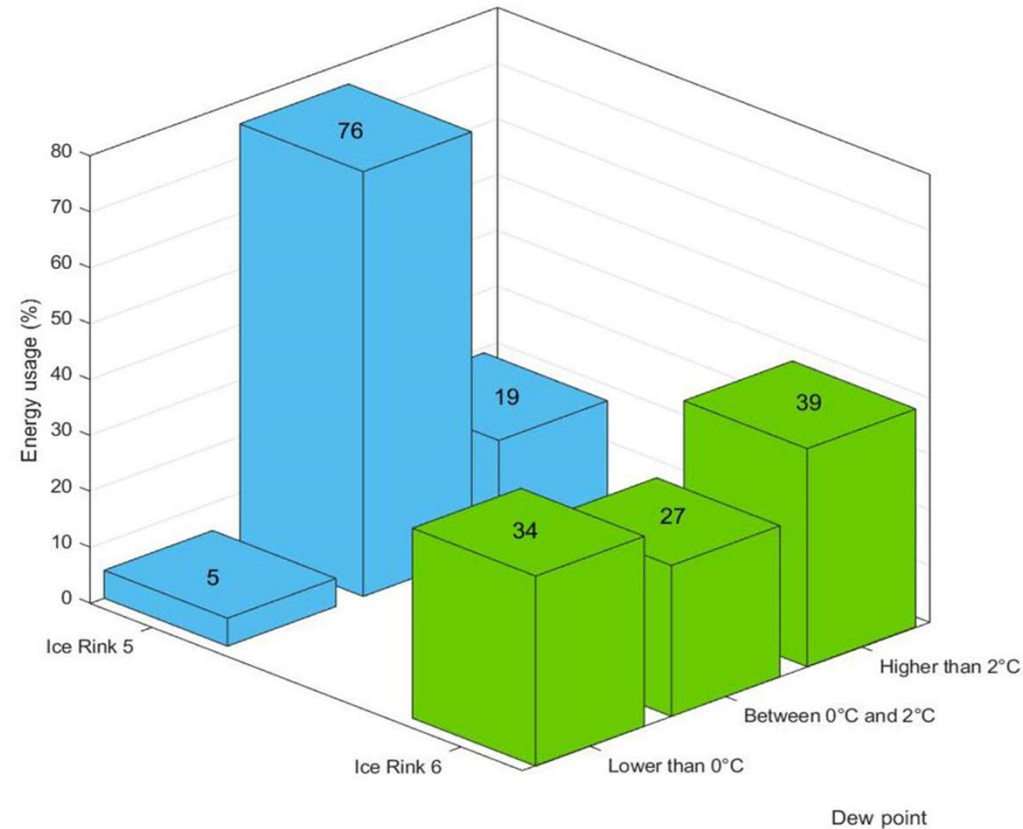
- Ventilation and dehumidification separate!
- Warm air towards the audience
- Dry air above the ice



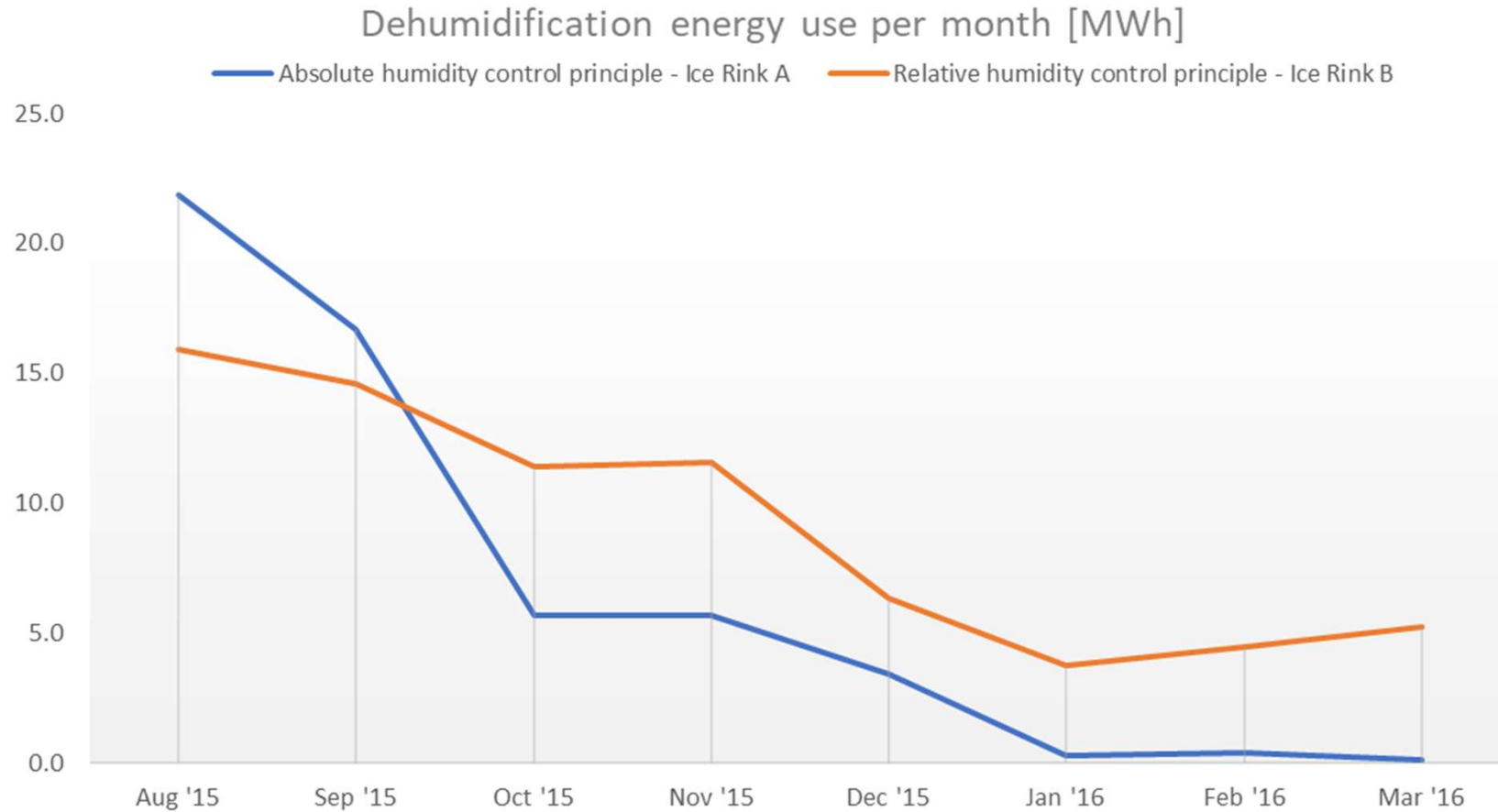
## Kestävä käyttöstrategia Kastepiste

- Sisäilman lämpötila voi vaihdella 5-10°C kauden aikana
- Pintalämpötilat ei yhtä paljon  
— RH-käyttöstrategia



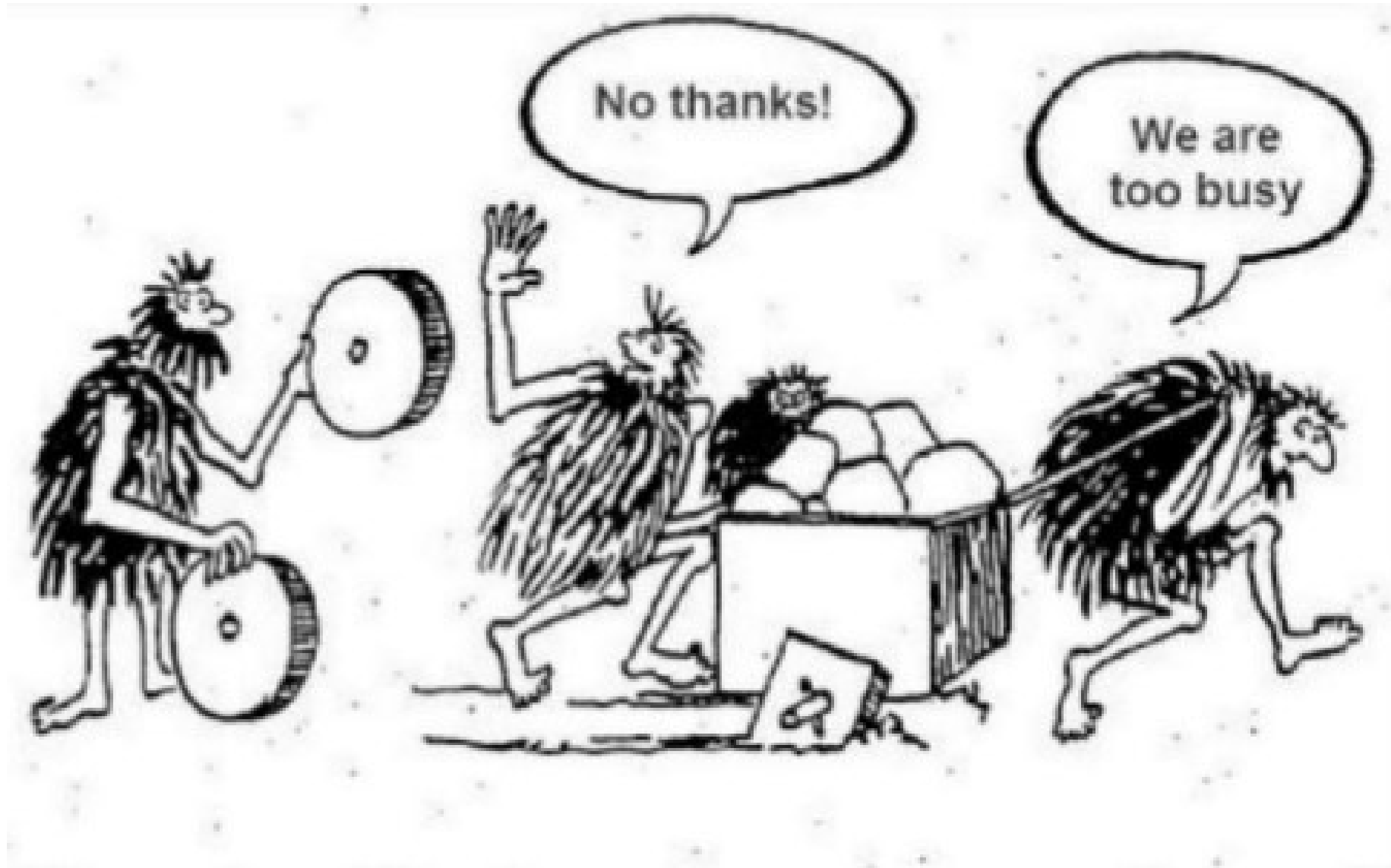


- Kastepiste-strategia tyypillisessä jäähallissa
  - Sisäilmalla yleensä 0°C – 2°C kastepiste
    - 0°C alapuolella “ylikuivaminen”-riski
    - 2°C yläpuolella kondenssiriski



- 54 MWh for dew point / absolute humidity control vs 73 MWh for relative humidity control

# To implement new technology.....!!







***Kiitos!***

*Cajus Grönqvist*



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[www.ekanalyt.se](http://www.ekanalyt.se)



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