Jäähallitekniikan kansainvälinen kehitys

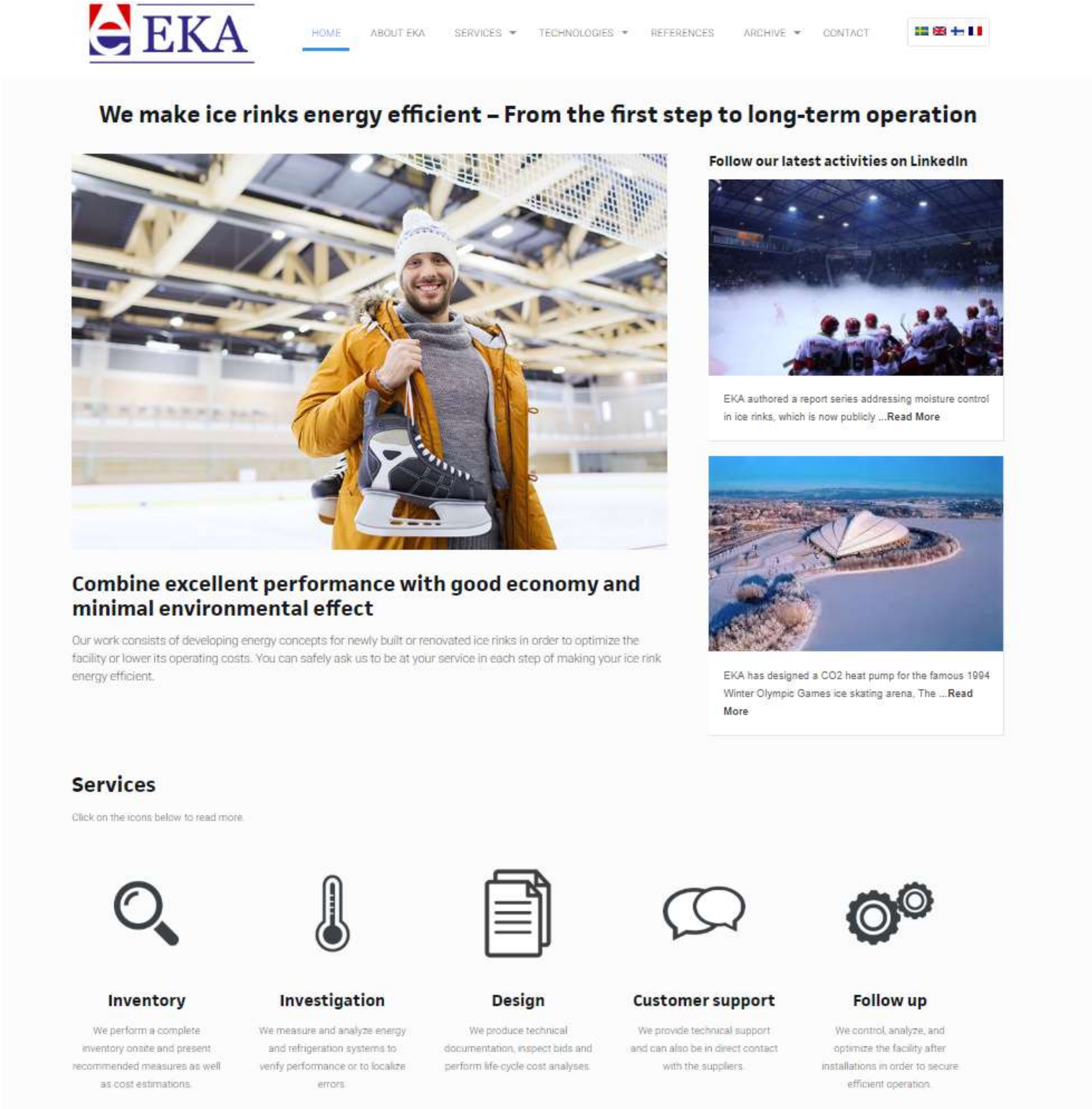
Cajus Grönqvist
EKA - Energi & Kylanalys

Jäähallipäivät 2019

Agenda

- EKA:n esittely
- Jäähallitekniikan perusteet
- Suurimmat kehitykset
  - Yksi kone = Energiakeskus
  - Vanhaan rataputkistoon ammoniakkivettä
  - Kustannustehokas ilmankuivatus
  - Hyvän kilpailutusmateriaalin merkitys
- Referenssiesimerkkejä

EKA – Presentation



EKA on puolueeton jäähalliasiantuntija

www.ekanalys.se

EKA – References

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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

Any

City

Any

Year

Any

Vikingskipet
Client: HOA Hamar Olympiske Anlegg City: Hamar Year: 2018

Glysisvallen
Client: Glysisvallen AB City: Hudiksvall Year: 2018

Storhamar ishall
Client: HOA Hamar Olympiske Anlegg City: Hamar Year: 2018

NERIS reports – Moisture control in ice rinks
Client: KTH Royal Institute of Technology City: Stockholm Year: 2018

Ben Boeke Arena
Client: Municipality of Anchorage City: Anchorage Year: 2018

UAA Arena
Client: UAA City: Anchorage Year: 2016

Hedesunda IP
Client: Gavlefastigheter City: Hedesunda Year: 2018

Malungs ishall
Client: Malung-Sälens kommun City: Malung Year: 2018

Storegårdshallen
Client: Eksjö kommunfastigheter City: Eksjö Year: 2018

Tibro ishall
Client: Tibro kommun City: Tibro Year: 2018

Åkersberga ungdomshall

Pirkkalan Jäähalli

- Tarveselvitys 2018
- Hankesuunnitelma 2019

ASHRAE Journal 08/2017

TECHNICAL FEATURE

INTERIOR VIEW OF THE RENOVATED GIMO ICE RINK.

Cooling and Heating Ice Rinks With CO_2

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,[1] 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_2 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_2 Systems in Ice Rinks

R744.COM 12/2016

Will ice rinks go CO_2 in future?

EUROPE | AMERICA | INDUSTRIAL REFRIGERATION

By Charlotte McLaughlin, Dec 20, 2016, 14:00 GMT+2 · 6 minute reading

Ammonia has long been the refrigerant of choice for ice rink installers. But it is facing growing competition from another natural refrigerant – CO_2.

Ice rink in Enköping, Sweden

Ammonia is facing increased competiton in the market for ice rinks from another natural refrigerant – CO_2., Some who work in the industry like Jörgen Rogstam, managing director of Swedish refrigeration engineering consultants Energi & Kylanalys (EKA), have even declared "ice rinks will go CO_2 in the future".

Thanks to their impressive energy efficiency, ammonia systems dominate Sweden's ice rinks. 85% of them use the natural refrigerant, with the remainder using R404A and R134a or other hydrofluorocarbon (HFC) refrigerants. With HFCs currently being phased down under the EU's F-Gas Regulation, manufacturers of CO_2 technology are targeting the ice rink sector too.

Yet for CO_2, "commercialisation has been a problem," according to Rogstam. While ammonia has a long history of

PARTNERS

> "Today the number of CO_2 ice rinks is growing rapidly. There are now 25-30 CO_2 ice rinks in the world."
> - Jörgen Rogstam, Managing Director, EKA

share on:

R744.COM 06/2017

CO_2-ammonia ice rink installed in Sweden

EUROPE | INDUSTRIAL REFRIGERATION | ENGINEERING & CONTRACTING

By Charlotte McLaughlin, **Jun 29, 2017, 15:13 GMT+2 • 1 minute reading**

The system, designed by Swedish firm EKA (Energi & Kylanalys), specialists in the field of ice arenas, replaced the previous ammonia-based system.

The T3 Center – an ice hockey arena that hosts Swedish 2nd division team Björklöven in Umeå, northern Sweden – has retrofitted its ammonia refrigeration system with a CO_2-ammonium hydroxide system.

The existing ammonia system was retrofitted with "ammonium hydroxide [as the secondary refrigerant, which] offers half the pump energy compared with brine so the energy saving is considerable," according to Jörgen Rogstam, managing director at ice arena specialists EKA (Energi & Kylanalys).

The new retrofitted installation designed by EKA has the "ammonium hydroxide pump circulated in the rink floors, since it is an indirect system solution, with CO_2 [acting as] the primary refrigerant," Rogstam said.

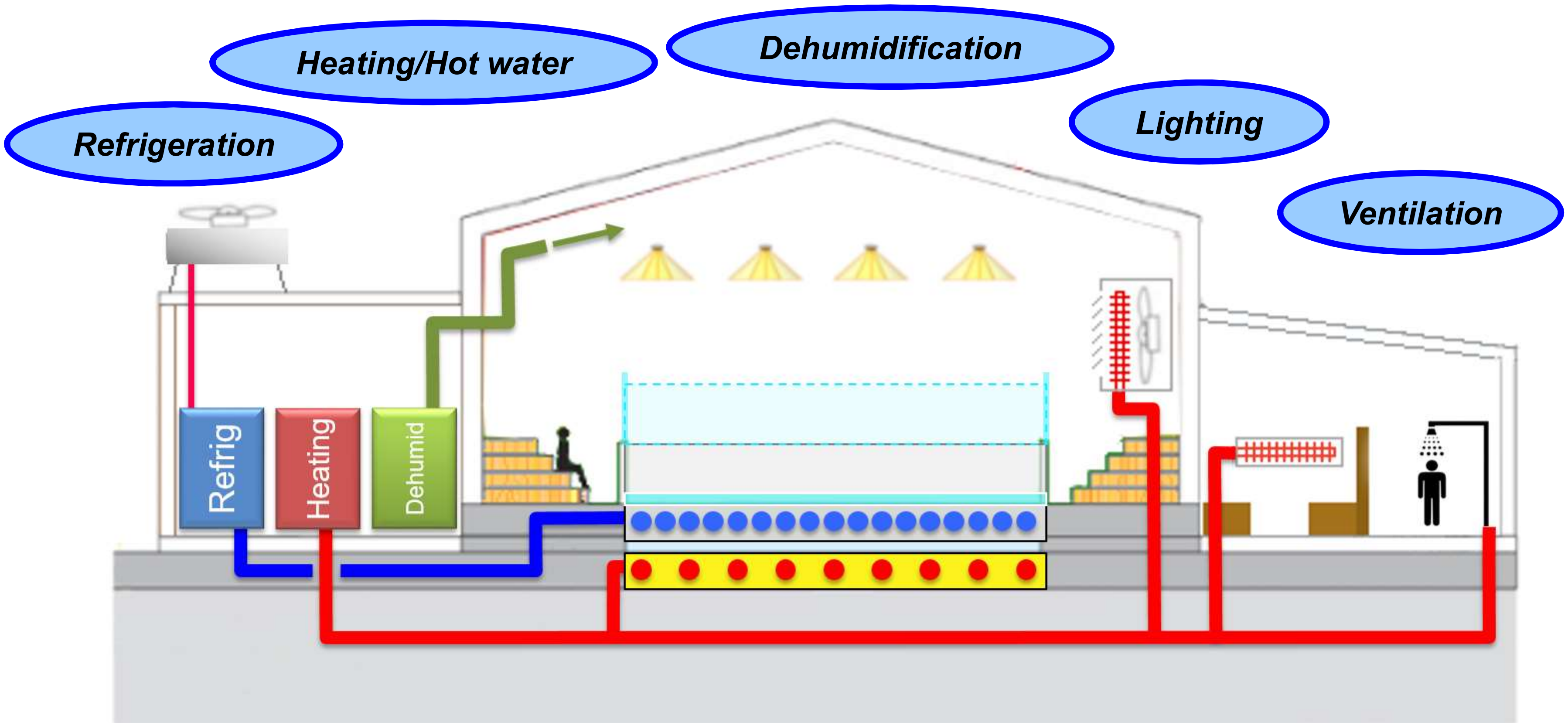
PARTNERS

> "It is becoming clear to the business that this makes the real difference on the energy bill. In the past people were way too focused on the refrigeration performance (COP) but today the perspective is extended."
> – Jörgen Rogstam, EKA

share on:

JÄÄHALLITEKNIIKAN PERUSTEET

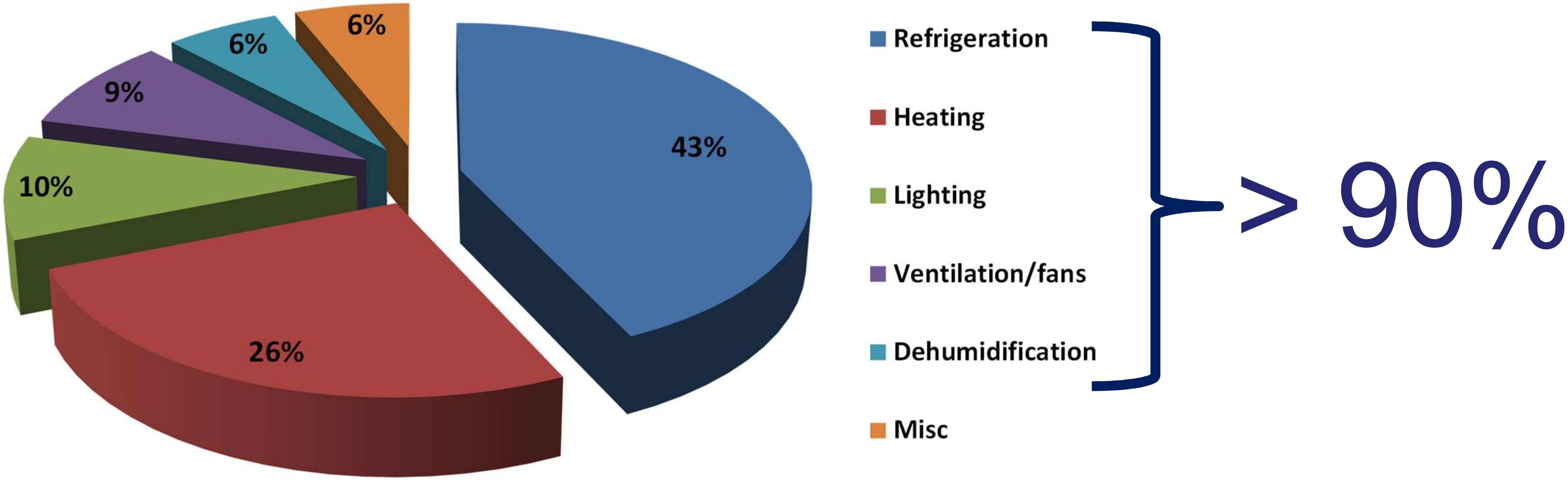
The Big 5 Energy Systems



The energy systems interact with each other

- Energy management system!
- Energy metering on all Big 5 for control and follow up!

Energy consumption of an ice rink



An average Nordic ice rink consumes 1 000 MWh per year

- With modern ice rink technology this could be cut by half

EKA

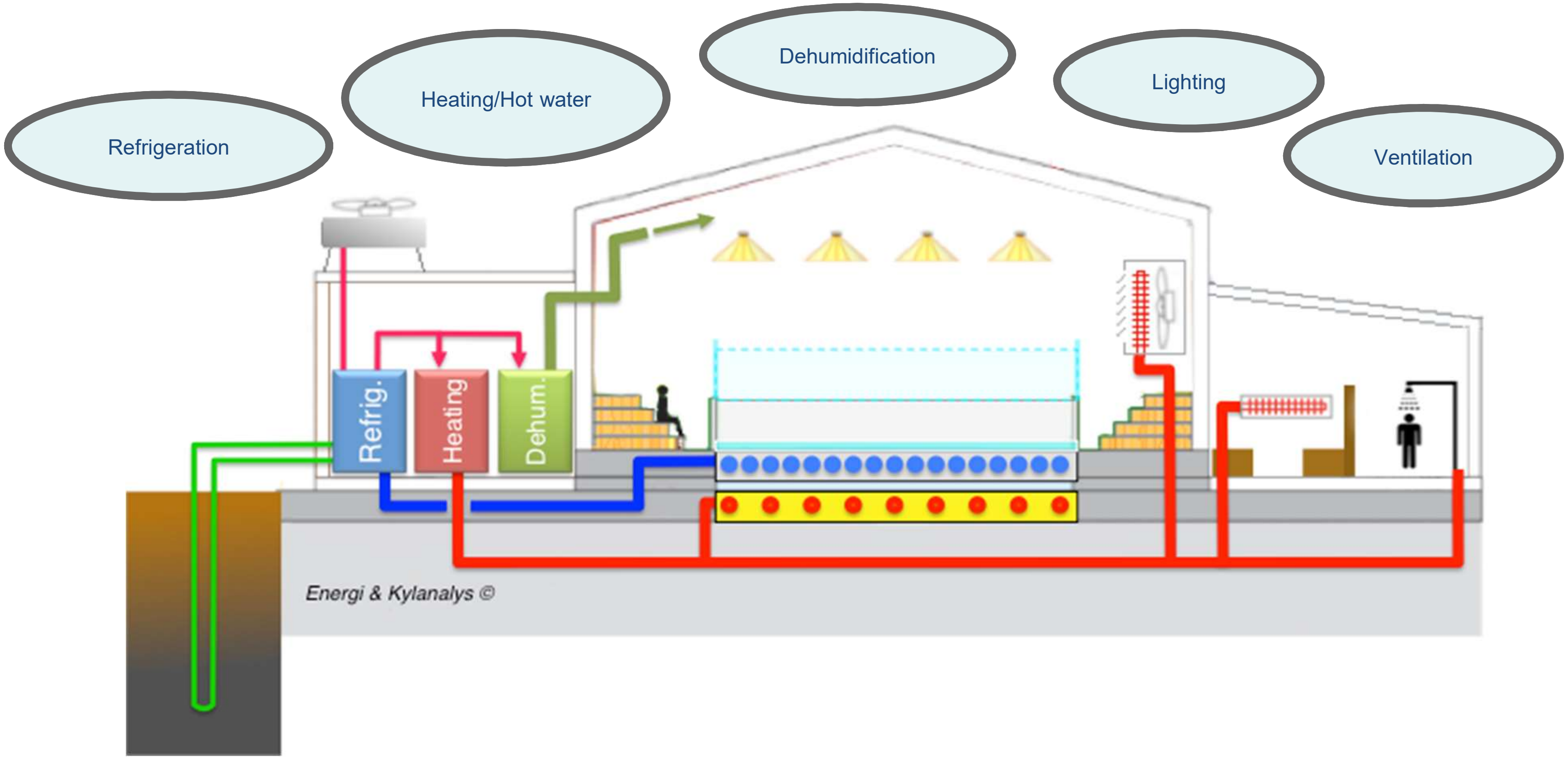
KANSAINVÄLINEN KEHITYS 1

YKSI KONE = ENERGIAKESKUS

Environmental aspects

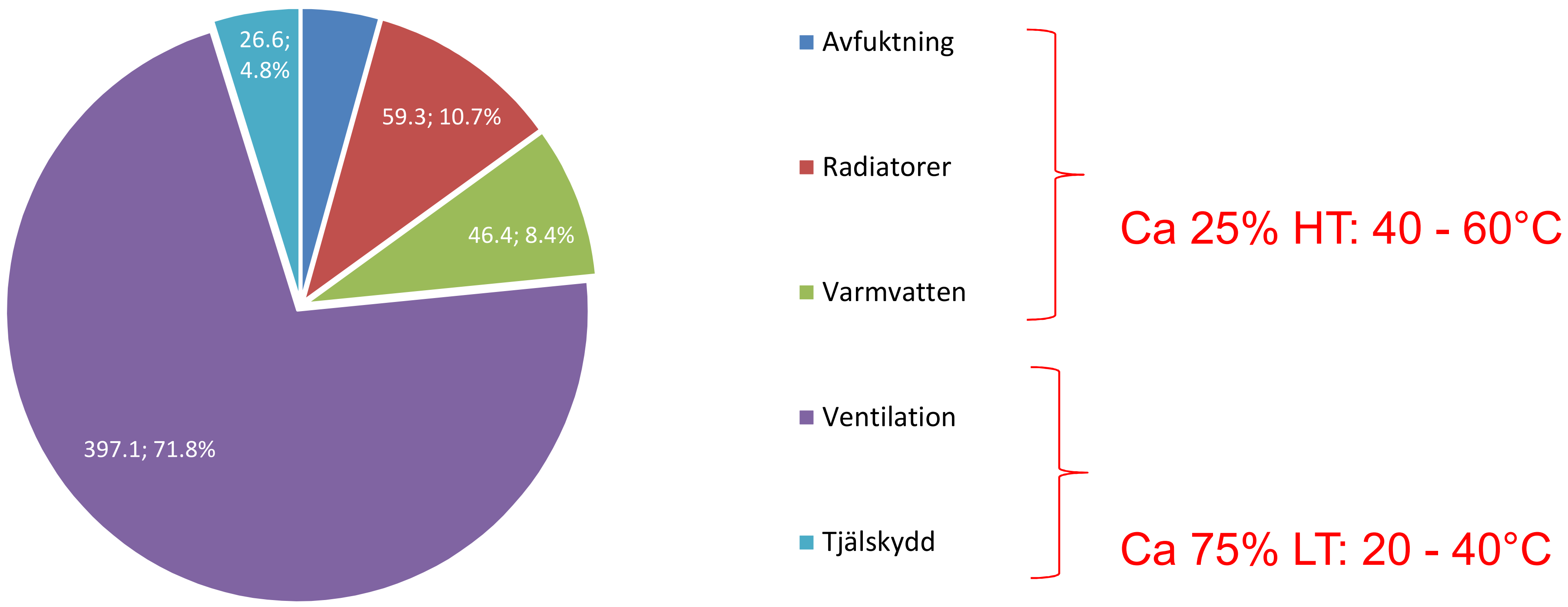
- Refrigerants and **GWP** (Global Warming Potential)
  - R744 (CO_2) 1
  - R134a 1430
  - R404A 3922
  - R410A 2088
  - R1234yf 4
- This is the reason to look at CO2…....
  ….or other natural refrigerants!

CO2 + Optimoitu Lämmöntalteenotto = Energiakeskus



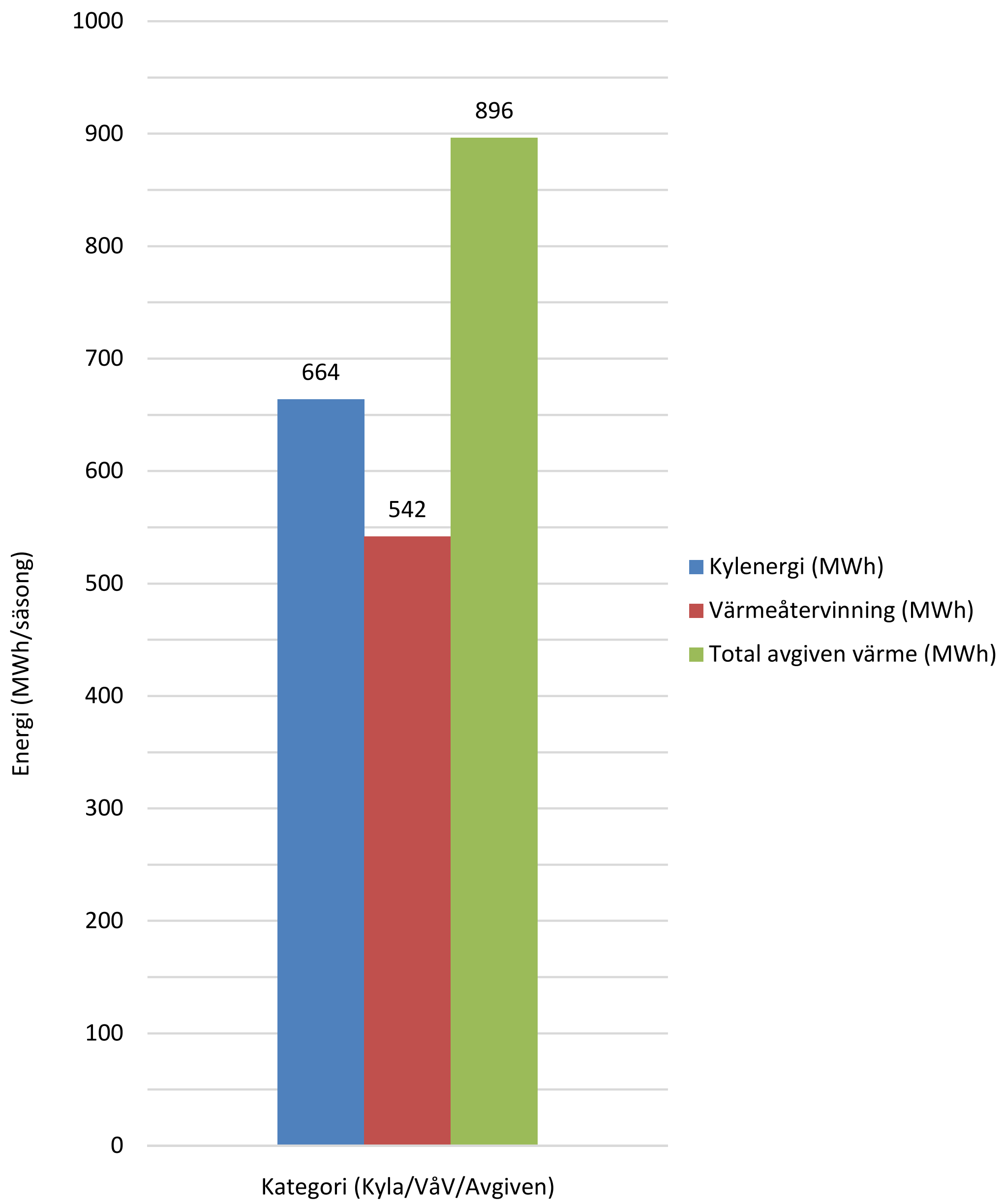
Suurin energiansäästöpotentiaali jäähallissa on jäähdytysjärjestelmän lämmöntalteenoton maksimihyödyntäminen rakennuksen kaikkien lämmitystarpeiden kattamiseen

Lämmitys- ja lämpötilatarpeet jäähallissa



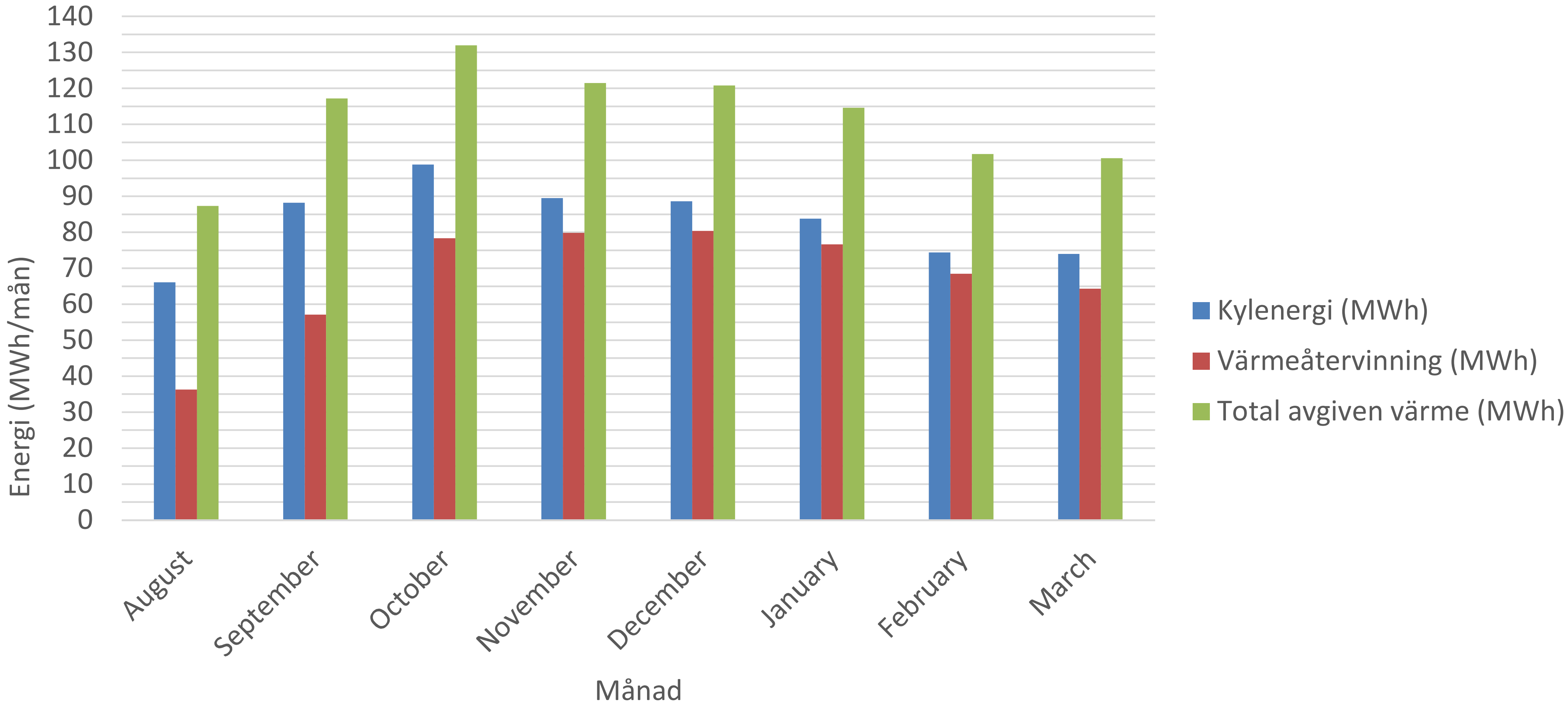
- Korkeat lämpötilat (~ 60°C) – ainakin 25%
- Keski- ja alhaislämpötilat (20-40°C) – noin 75% tai vähemmän
- **CO2-energiakeskus täyttää nämä vaatimukset**
  - **Muut kylmäaineet (HFC, NH3, etc.) tarvitsevat tukea**
    - **Lämpöpumppu, kaukolämpö, sähkö..**

Lauhdelämmön määrä - Esimerkki



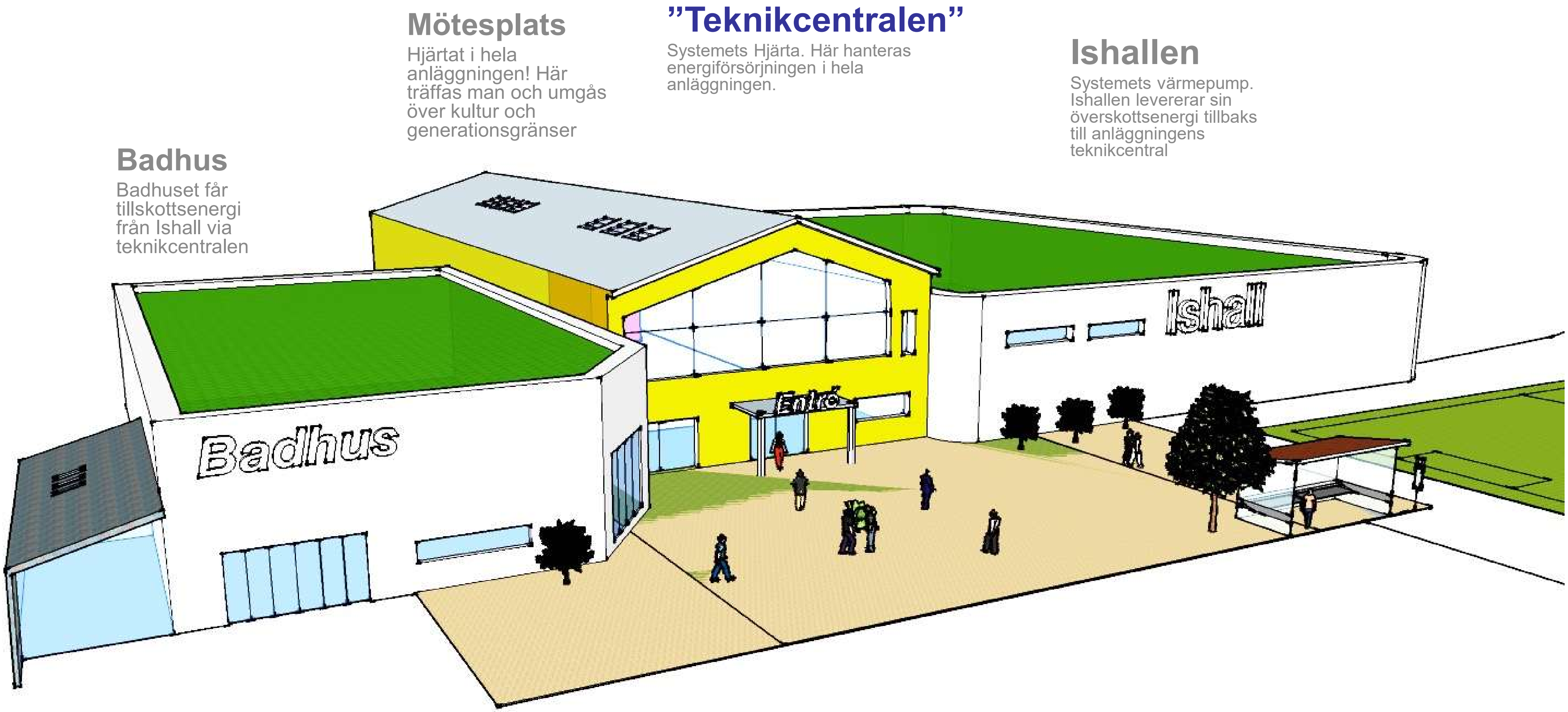
- Olosuhteet:
  - Pieni kilpahalli (500 hlö katsomo)
  - Jääkausi: 8 kuukautta
  - Puolilämmin hallitila: 5 - 8°C
- Jäähdytystarve:
  600 – 900 MWh
- Lämmitystarpeet:
  400 – 700 MWh
- CO_2-Lauhdelämmön määrä:
  700 – 1500 MWh

Lauhdelämmön määrä - Esimerkki



- CO2-jäähalli tuottaa enemmän lämpöä kuin mitä se tarvitsee
  - Lämmön vienti mahdollista

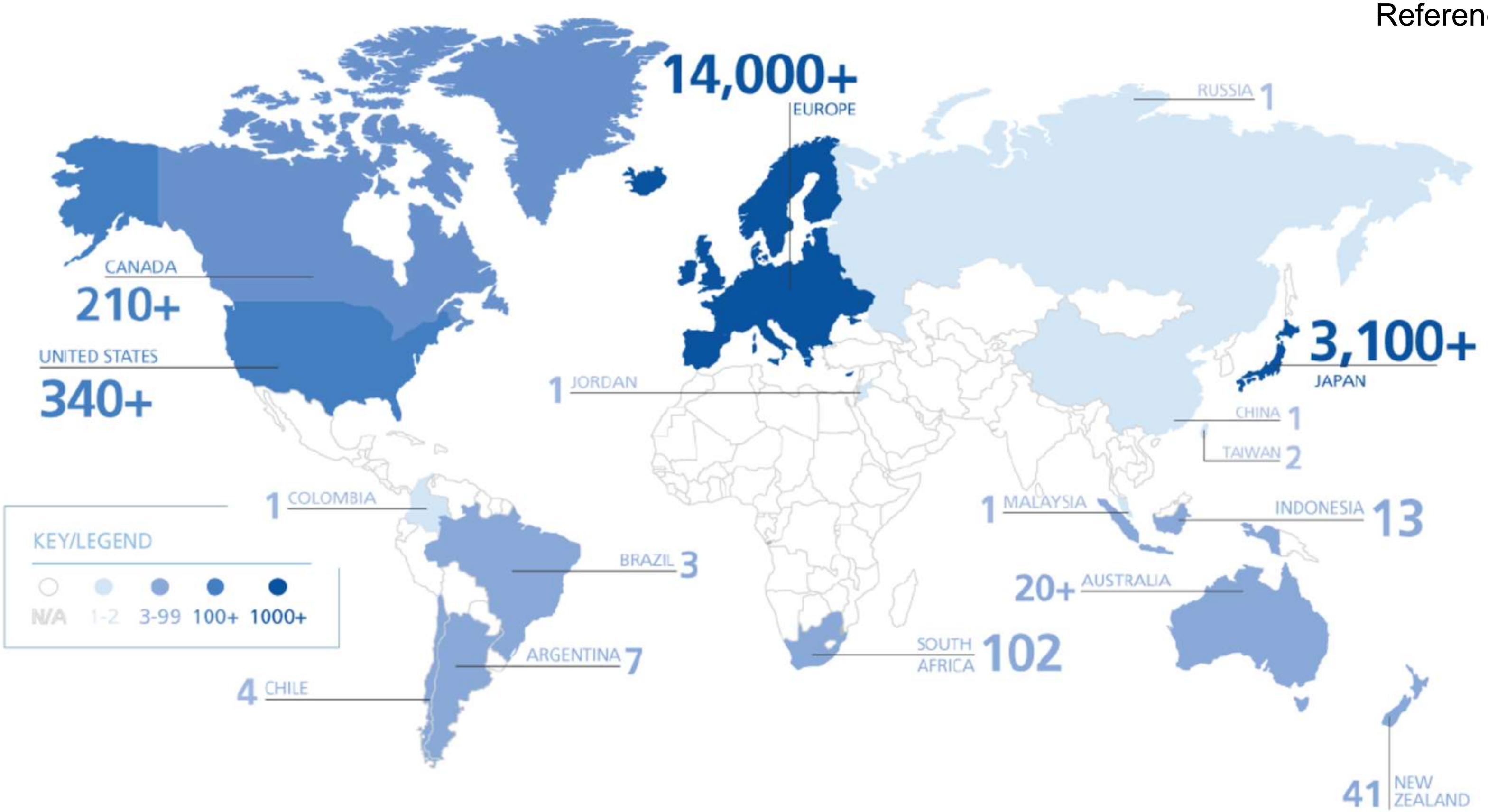
Energy/Heat export and storage



- Sport facilities have great potential in exchanging energy!

TC CO2 systems globally 2018

Reference: Shecco 2018

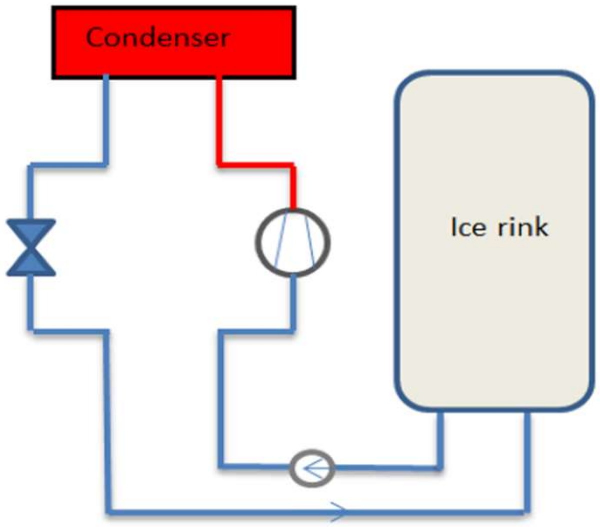


- **Today CO2 for ice rinks has competitive advantage in:**
  - Investment cost
  - Service cost
  - Overall energy cost
  - Total Life-cycle cost

KANSAINVÄLINEN KEHITYS 2

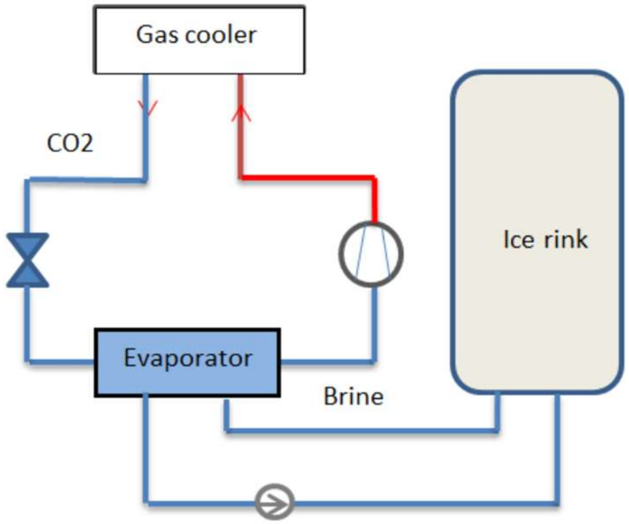
VANHAAN RATAPUTKISTOON AMMONIAKKIVETTÄ

CO2 – direct (Type A)



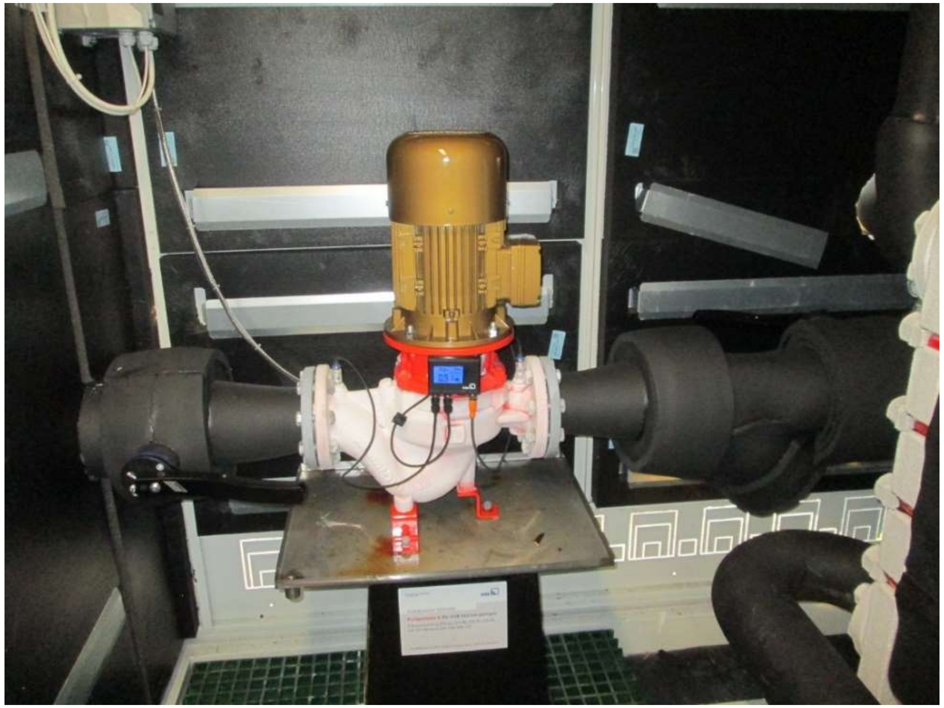
- Carbon dioxide - CO_2 (Non toxic and non flammable)
- Direct – i.e. CO_2 is pumped in the rink floor
  - Rink pipes of copper or stainless steel
- Very efficient
- Excellent heat recovery properties

CO2 – indirect (Type B)



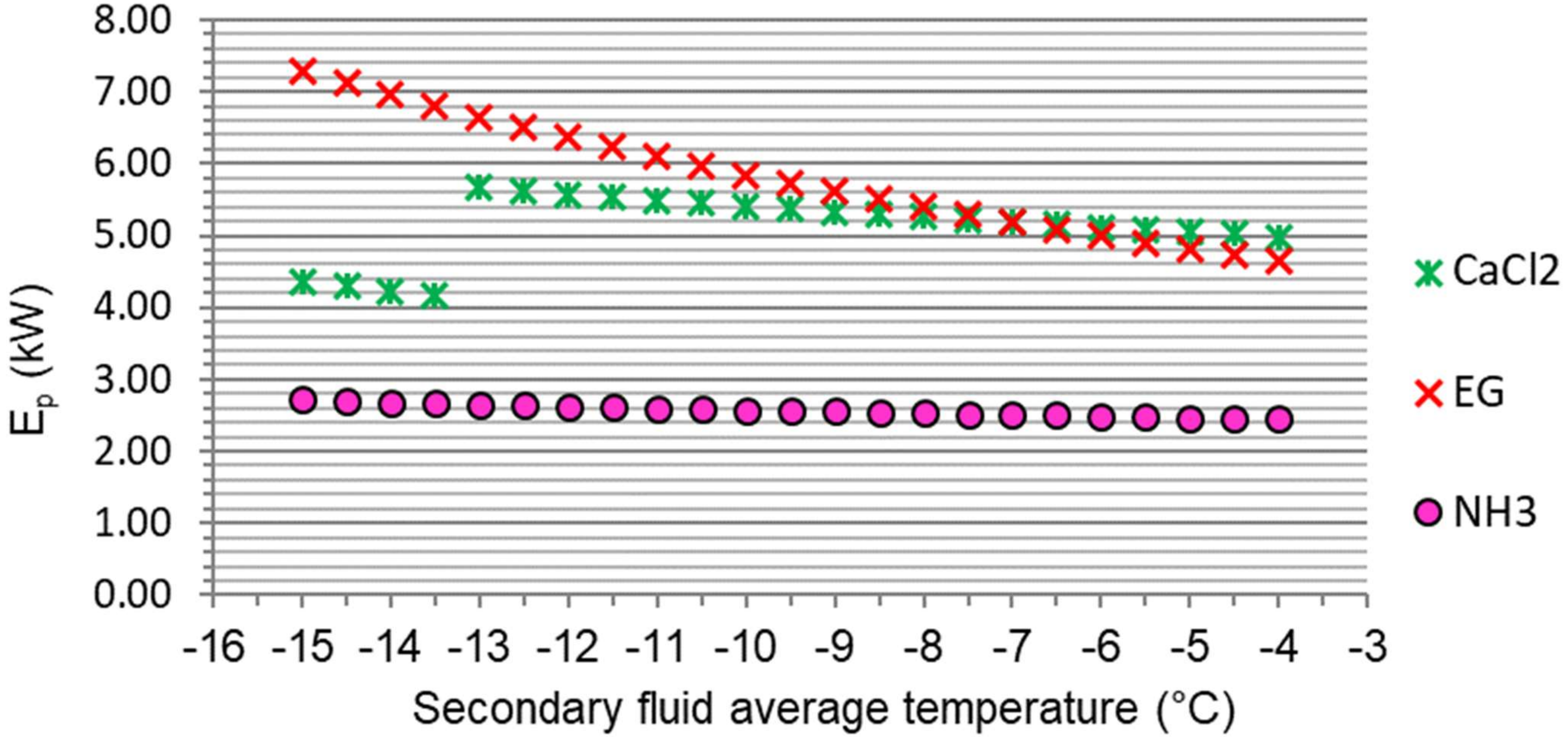
- Carbon dioxide - CO_2 (Non toxic and non flammable)
- Indirect – i.e. CO_2 in the machine room – a secondary refrigerant is pumped in the rink floor
- Very efficient
- Excellent heat recovery properties

Secondary refrigerant



- Aqua ammonia – 15%
- Technically: ammonium hydroxide
- Very good properties
  - Reduces pump work with 50% (appr. 30-50 MWh/yr)
- Low corrosivity
  - Copper or brass non compatible!

Beräknad pumpeffekt i ett isbanesystem

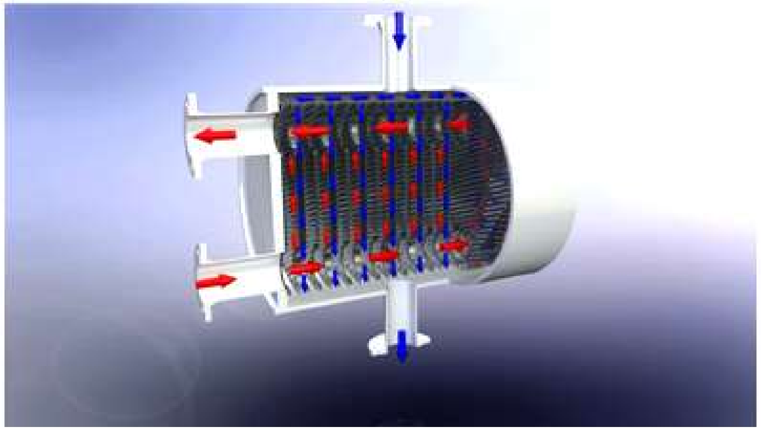


Ref. Mazzotti 2012

- En isbana inklusive samlingsrör, förångare, mm
- Resultatet visar på ungefär <u>halva pumpeffekten jfrt CaCl2</u>

Kylsystem - prisjämförelse

- Förångaren gör skillnaden – framförallt om det handlar om CO2!



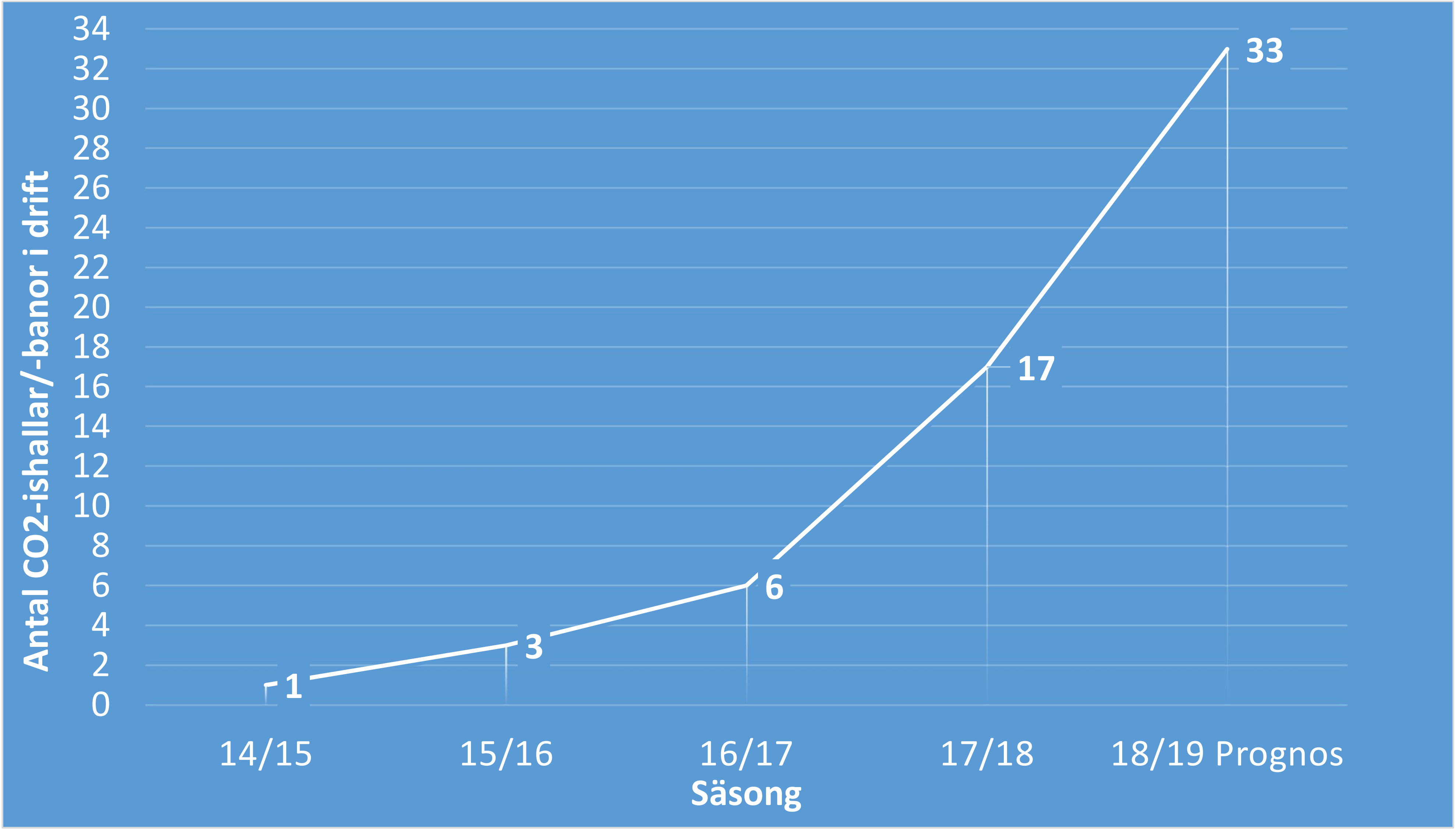
CO_2 / $CaCl_2$ (titan)

CO_2 / ammoniak-vatten (rostfritt)

Kyleffekt	Prisskillnad
Ca 300 kW kyleffekt	200 – 400 tkr
Ca 500 kW kyleffekt	600 – 800 tkr

CO2 ICE RINKS IN OPERATION

No of CO2 ice rinks in Sweden 2018/2019

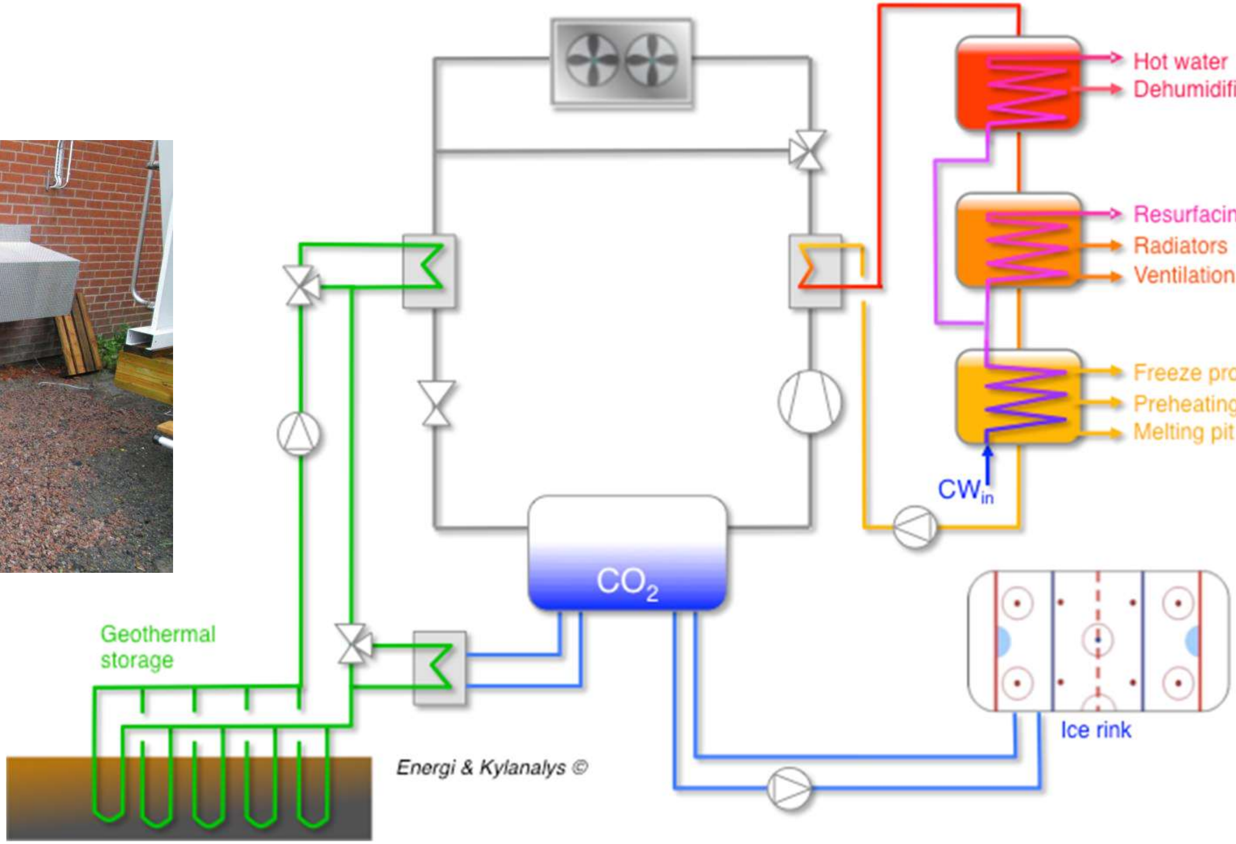


Equivalent to ca 10% of the ice rinks in Sweden

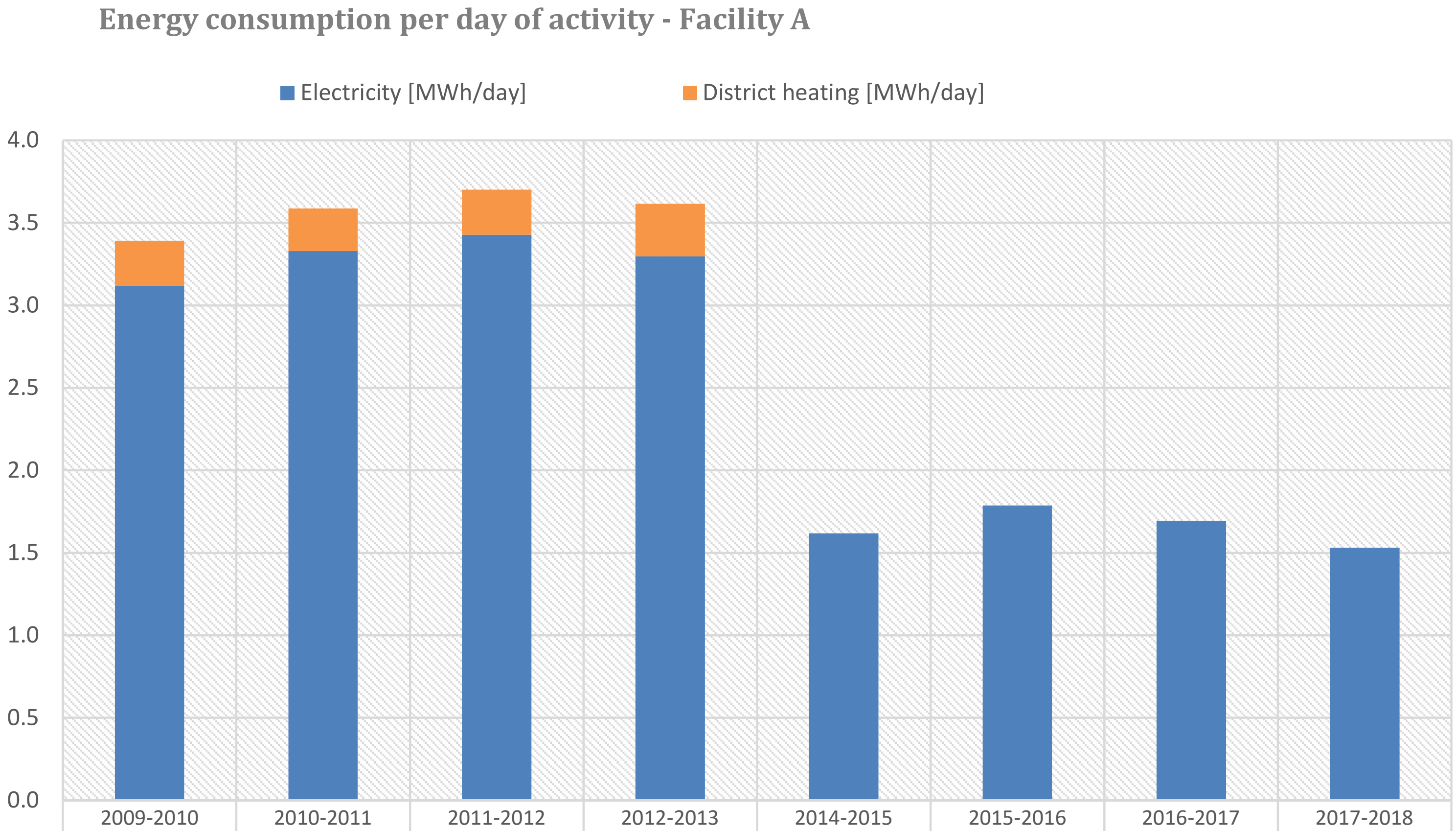
Case 1: Gimo ice rink, Sweden, 2014

- Retrofit from ammonia to direct CO2-refrigeration system
- ”Full” heat recovery – to the entire complex

Energy hub


Hot water
Dehumidification
50-70°C
Resurfacing water
Radiators
Ventilation
30-50°C
Freeze protection
Preheating
Melting pit
10-30°C
CW$_{in}$
CO_2
Ice rink
Geothermal storage
Energi & Kylanalys ©

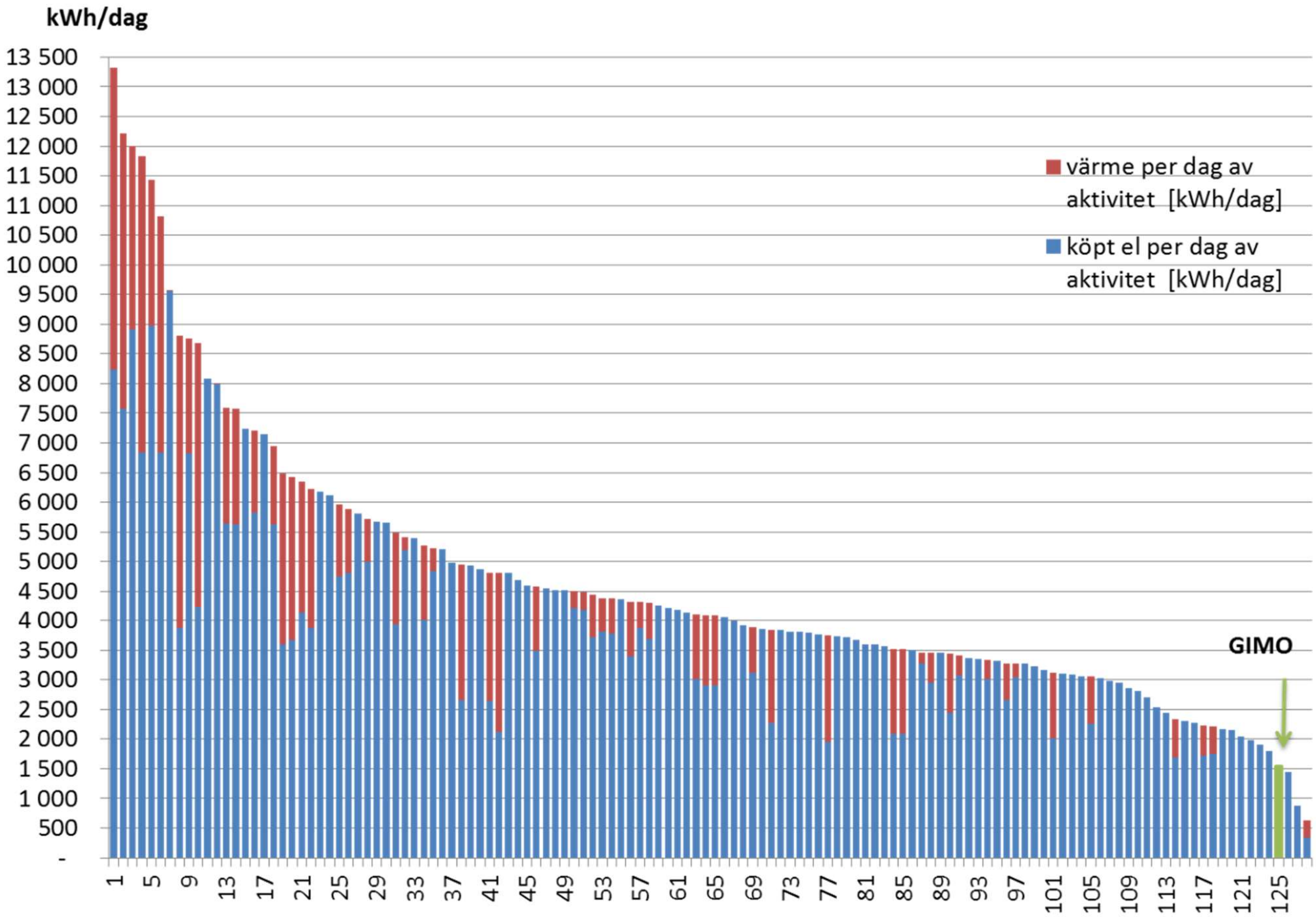
Gimo ice rink – Before/After



	2009-2010	2010-2011	2011-2012	2012-2013	2014-2015	2015-2016	2016-2017	2017-2018
District heating [MWh/day]	0.27	0.26	0.27	0.32	0.00	0.00	0.00	0.00
Electricity [MWh/day]	3.12	3.33	3.43	3.30	1.62	1.79	1.69	1.53

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

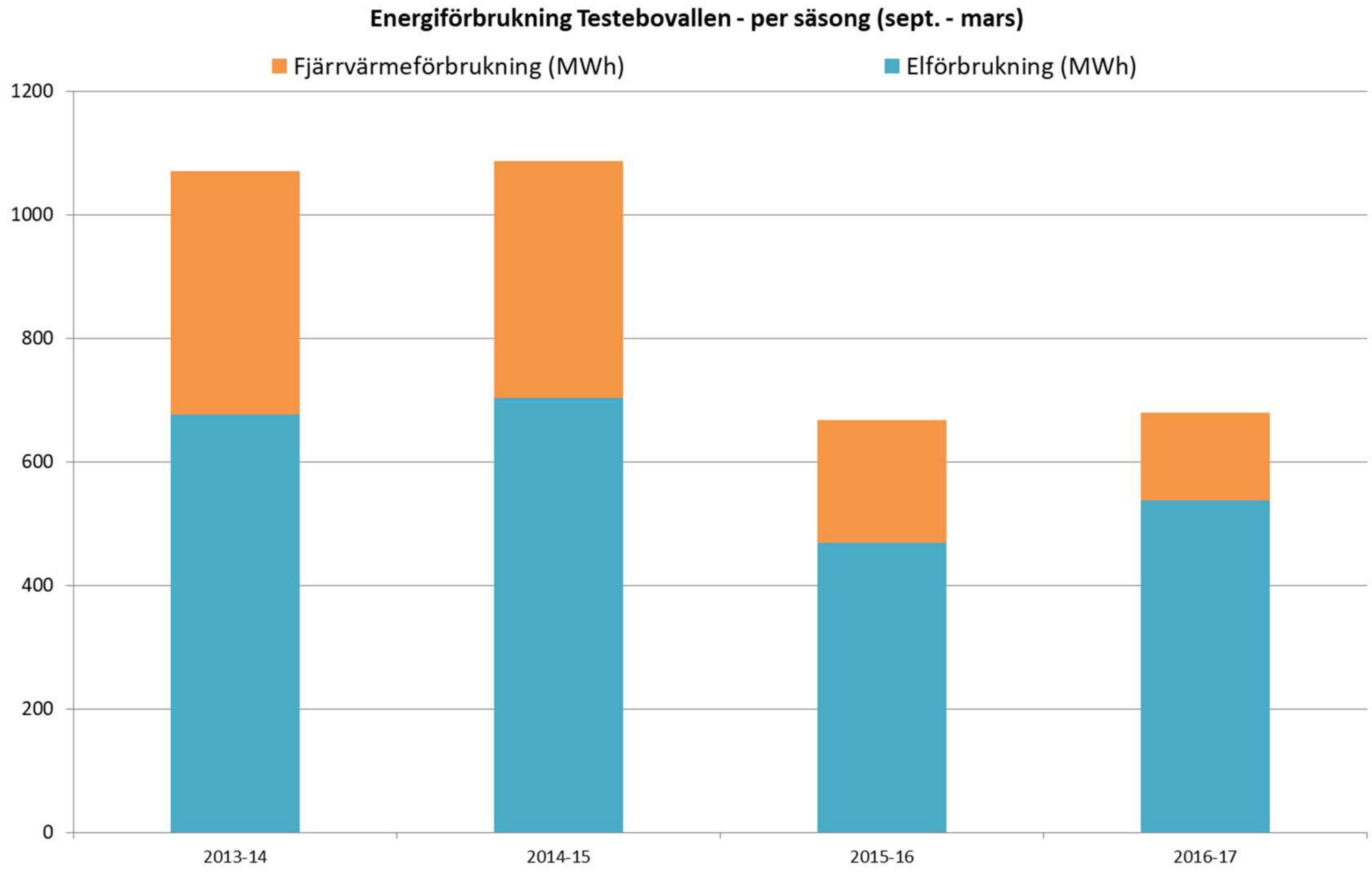
Comparison of Gimo and other Swedish ice rinks



Case 2: Testebovallen, Sweden (2015)

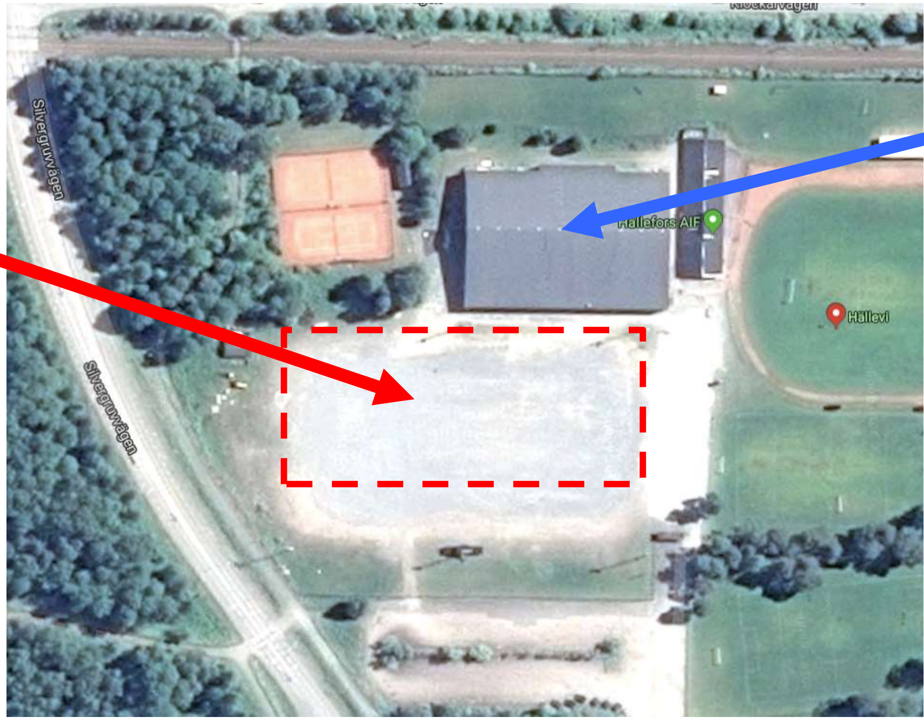
- ”Cold” arena room – i.e. non heated
- Retrofit from R404A to indirect CO2-refrigeration system
  - With aqua ammonia in rink pipes
- ”Full” heat recovery – to the entire complex
- Energy usage (during season):
  - Previously: +1100 MWh per year
  - Today: 650 MWh

Testebovallen – Before/After



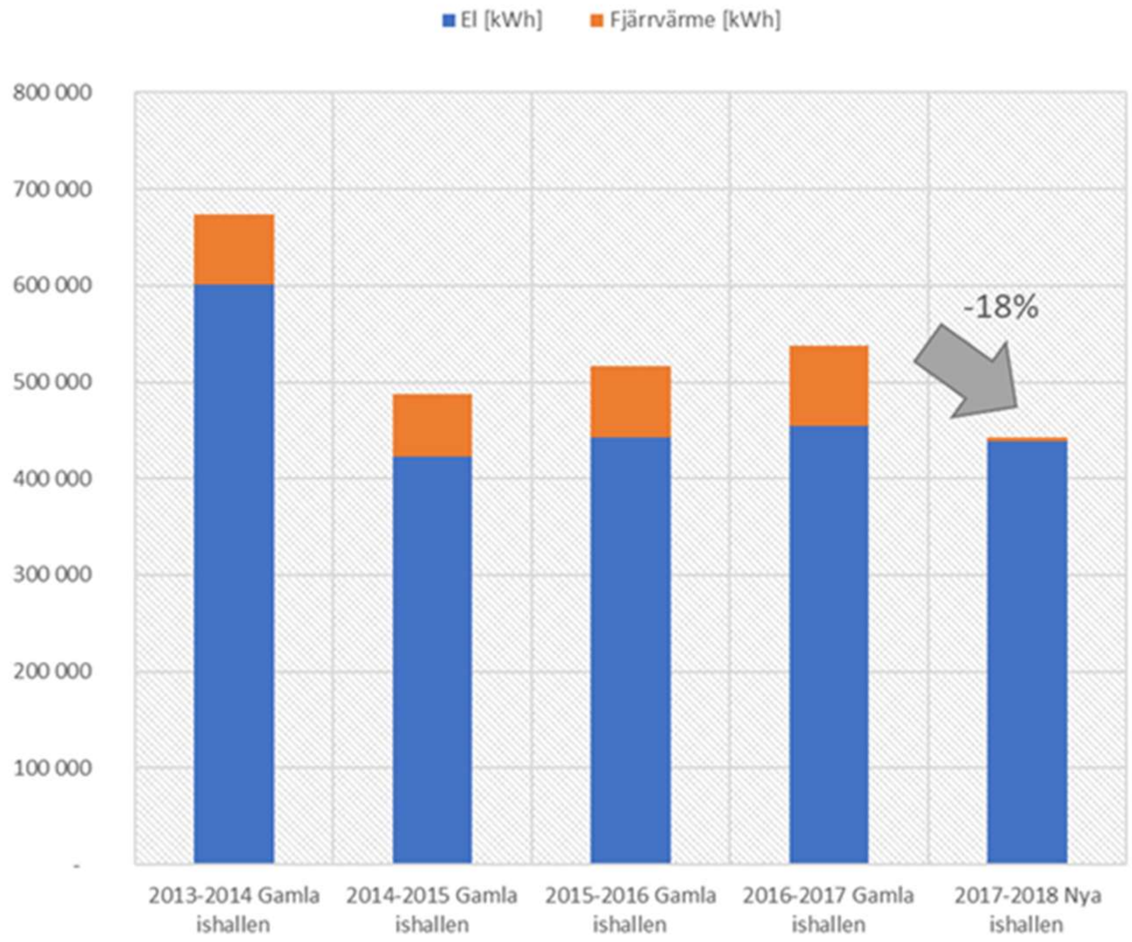
- ”Seasonal energy usage” (Sep-Mar)
- Saving el.: appr 150 MWh and district heating: appr. 200 MWh
  - Heat recovery system has delivered appr. 300 MWh!

Case 3: Hällevi ishall, Sweden (2014/2017)



- ”Publik C” with 500 + spectators
- CO_2-system with two stage heat recovery
- Prepared for heat export to:
  - Swimbath
  - Geothermal storage
- Aqua ammonia as secondary refrigerant

Hällevi ice rink – Before/After

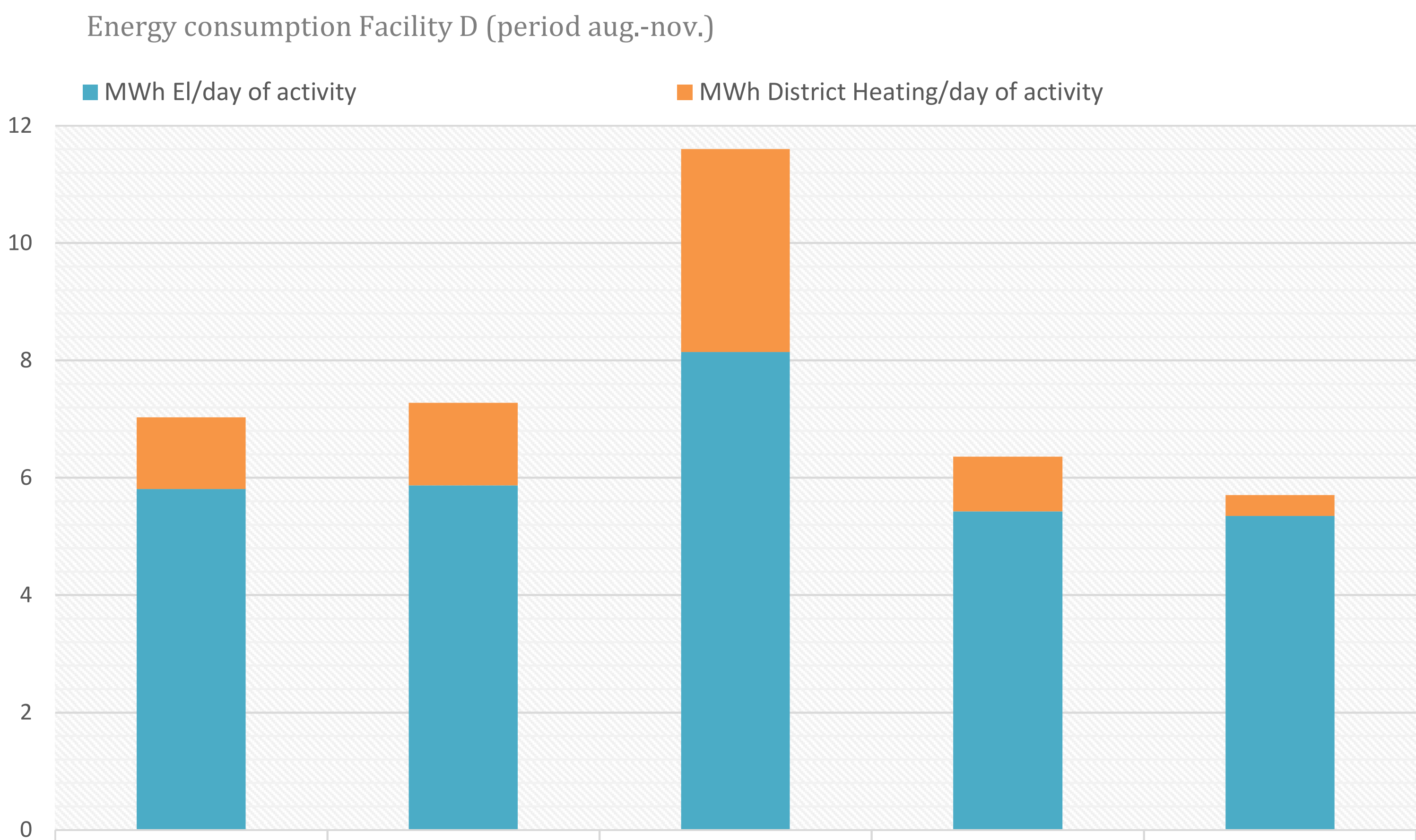


- ”Publik C” +500 spectators, single sheet
- Heat recovery covers 99% of the heat demand….
- …..+ prepared for heat export

Case 4: T3 Center, Umeå, Sweden (2017)

- Retrofit from ammonia to CO_2 (indirect)
- Two ice sheets – Arena, 5400 spect. + training rink, 200 spect.
- 650 kW + full heat recovery (with district heating back up)
- Rink floor retrofitted (from brine) to aqua ammonia

T3 Center – Before/After (Oct-Feb)



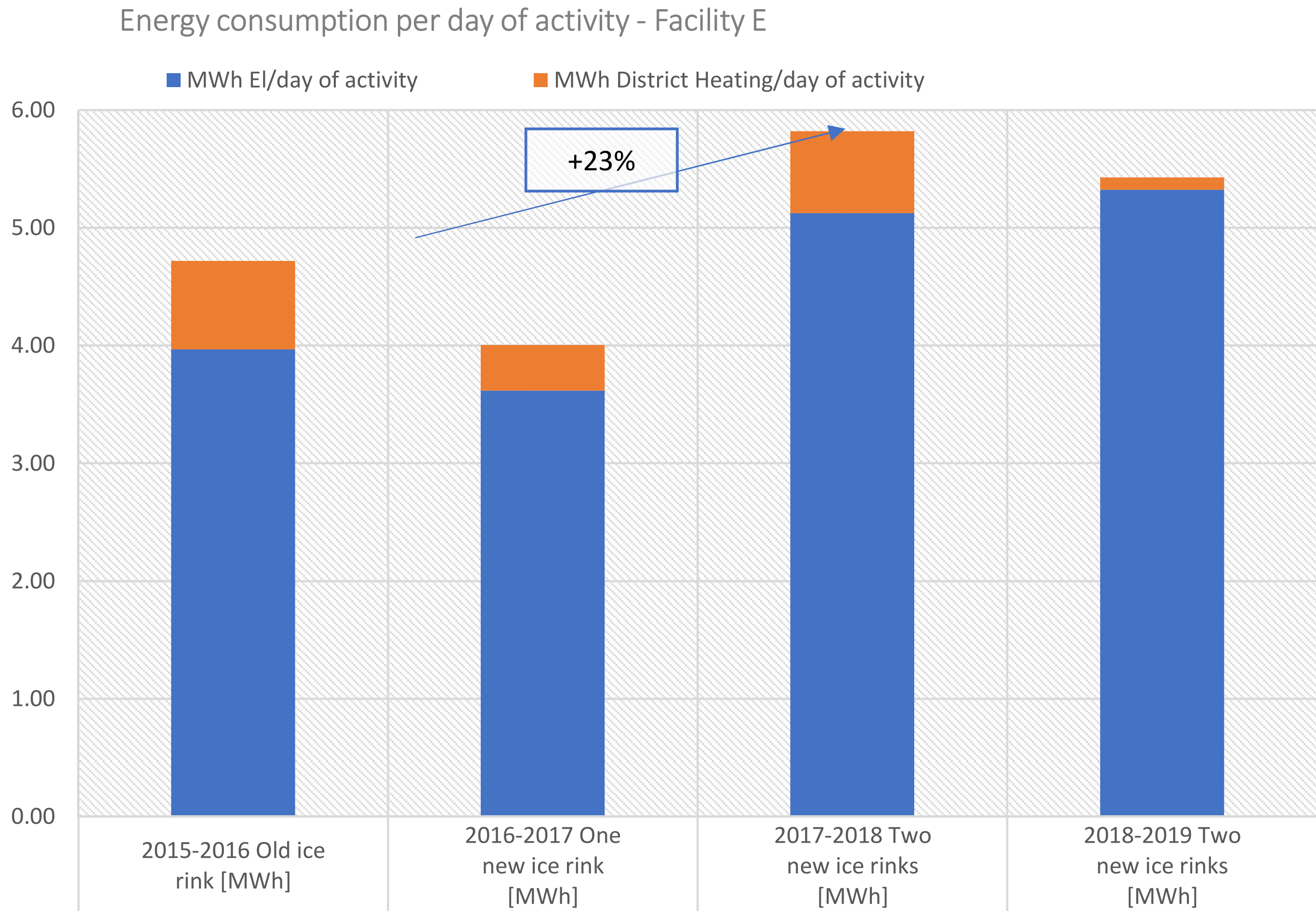
	2014-15	2015-16	2016-17	2017-18	2018-19
MWh District Heating/day of activity	1.2	1.4	3.5	0.9	0.4
MWh El/day of activity	5.8	5.9	8.1	5.4	5.3

- Arena +5000 pers., two ice-sheets
- Energy consumption reduced so far by 22%
- New CO_2-cooling-/heat recovery-system covers ca 90% of the heat demand

Case 5: Bahcohallen + new ice rink, Sweden (2016)

- Retrofit from ammonia to CO_2 direct
  - Two ice sheets (new ice rink as well)
  - 450 kW + full heat recovery (with district heating back up)
- Rink floor retrofitted with CO_2 (copper) tubes

Bahcohallen + new ice rink - Before/After



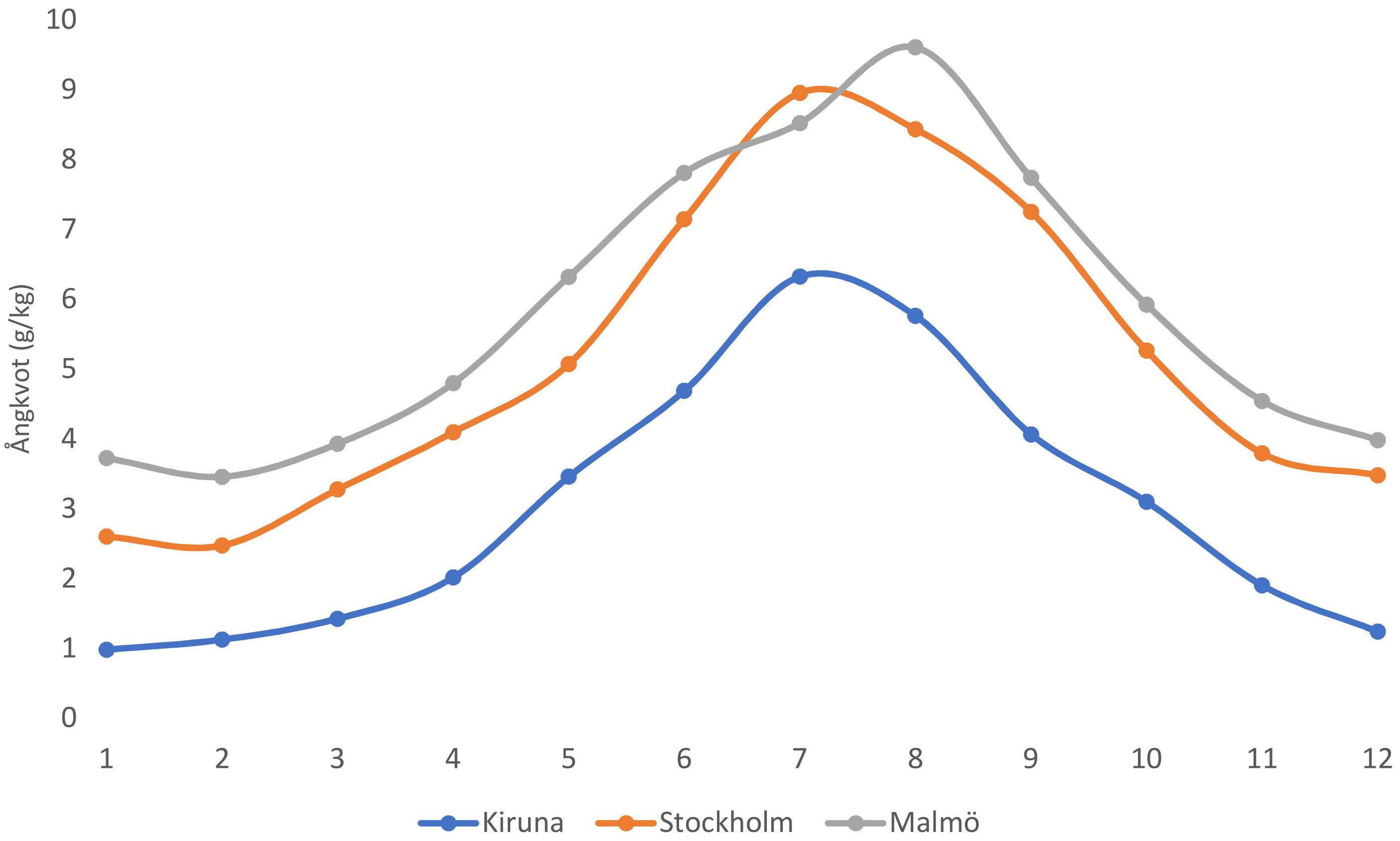
	2015-2016 Old ice rink [MWh]	2016-2017 One new ice rink [MWh]	2017-2018 Two new ice rinks [MWh]	2018-2019 Two new ice rinks [MWh]
MWh District Heating/day of activity	0.75	0.39	0.69	0.11
MWh El/day of activity	3.97	3.62	5.12	5.32

- First year CO_2-system energy consumption +23 %!
  - After further improvements in control: +15 % only compared to old system in one rink!
- CO_2-system is running two ice rinks almost for the price of one!

KANSAINVÄLINEN KEHITYS 3

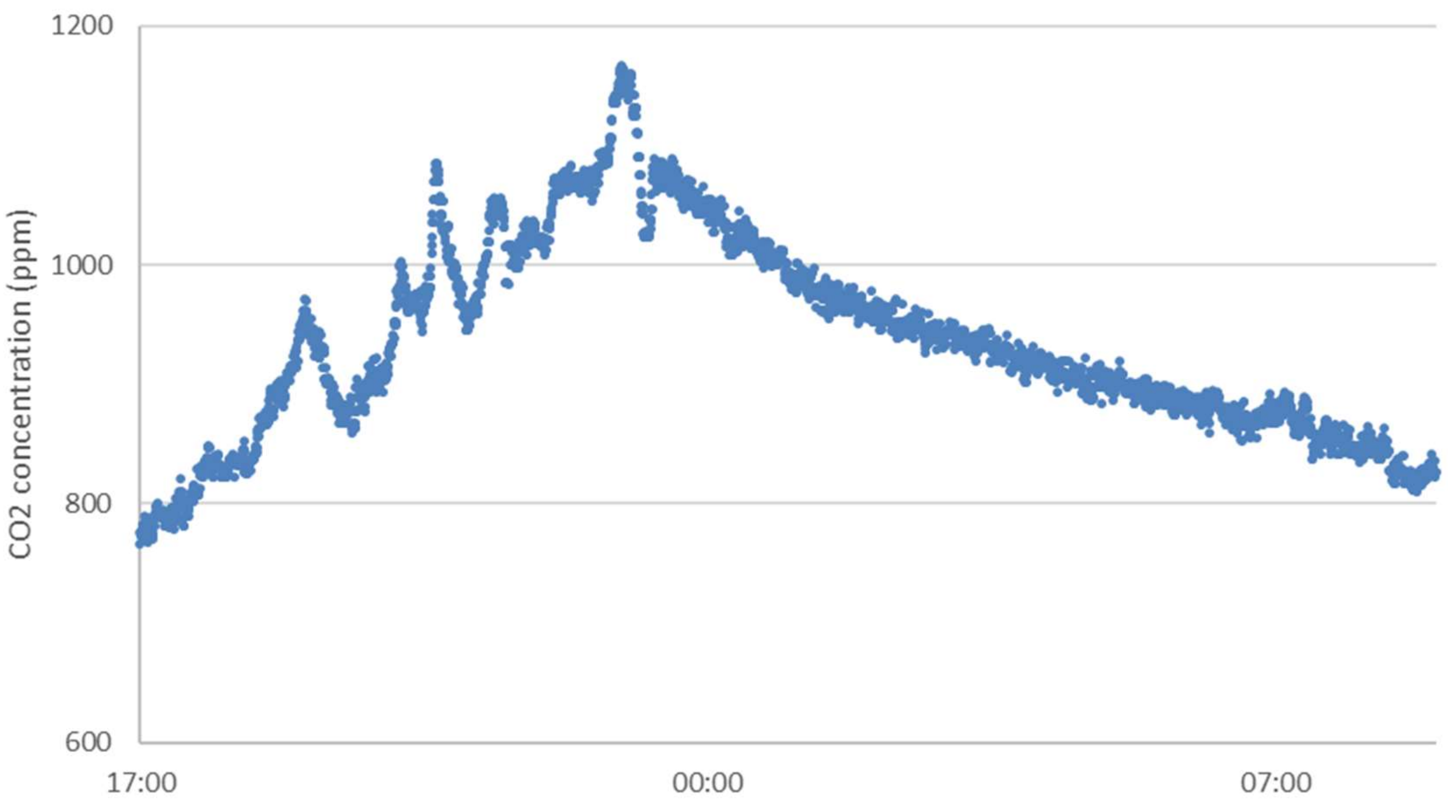
KUSTANNUSTEHOKAS ILMANKUIVATUS

Ulkoilman kosteusmäärä



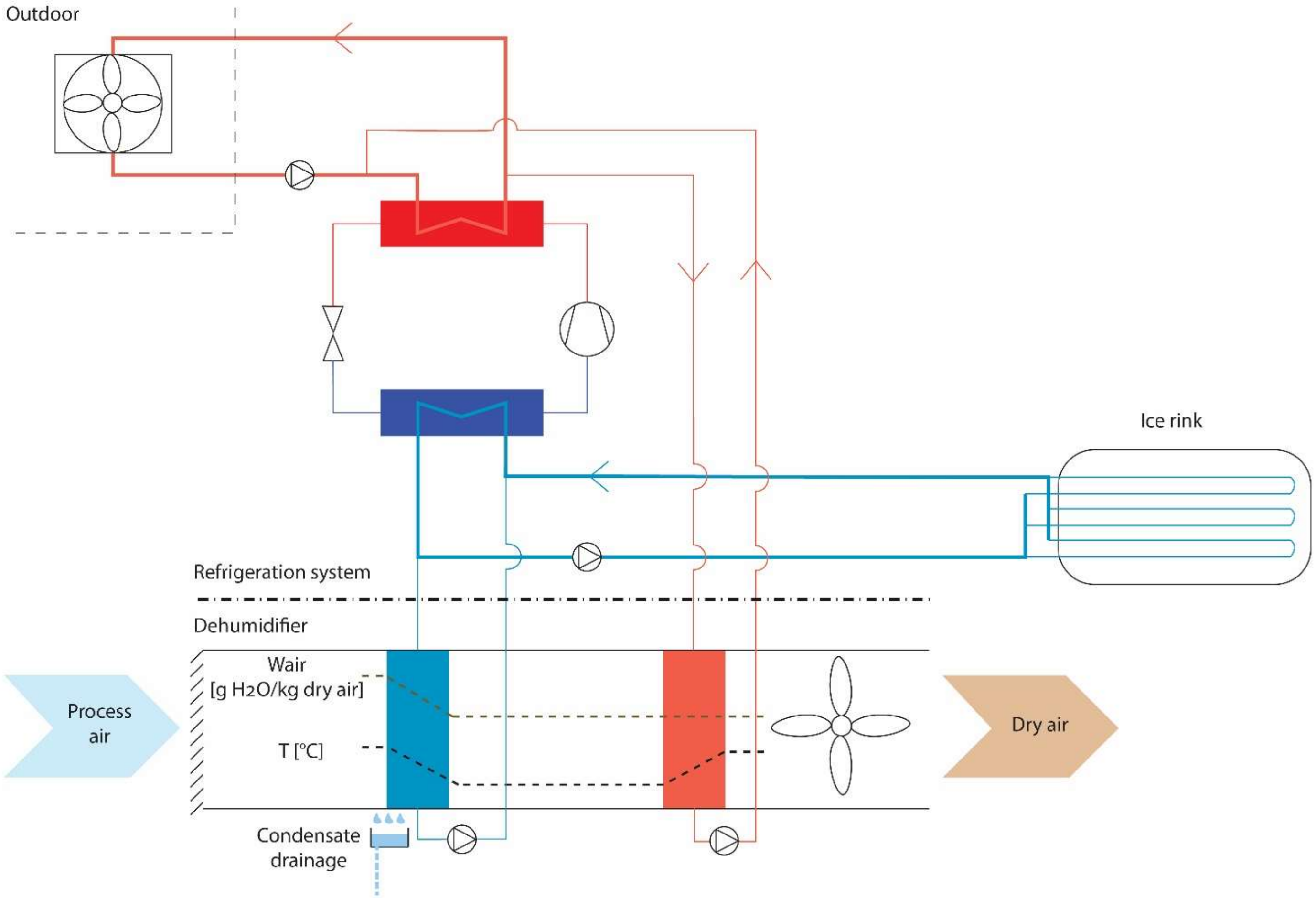
- Ulkoilmavuoto on jäähallin ylivoimaisesti suurin kosteuslähde
- Kosteuskuorma nousee kun ulkoilman lämpötila nousee
  - Jäähdytys- ja ilmankuivausjärjestelmien maksimitarpeet iskevät samaan aikaan

Ulkoilman vuoto jäähalliin



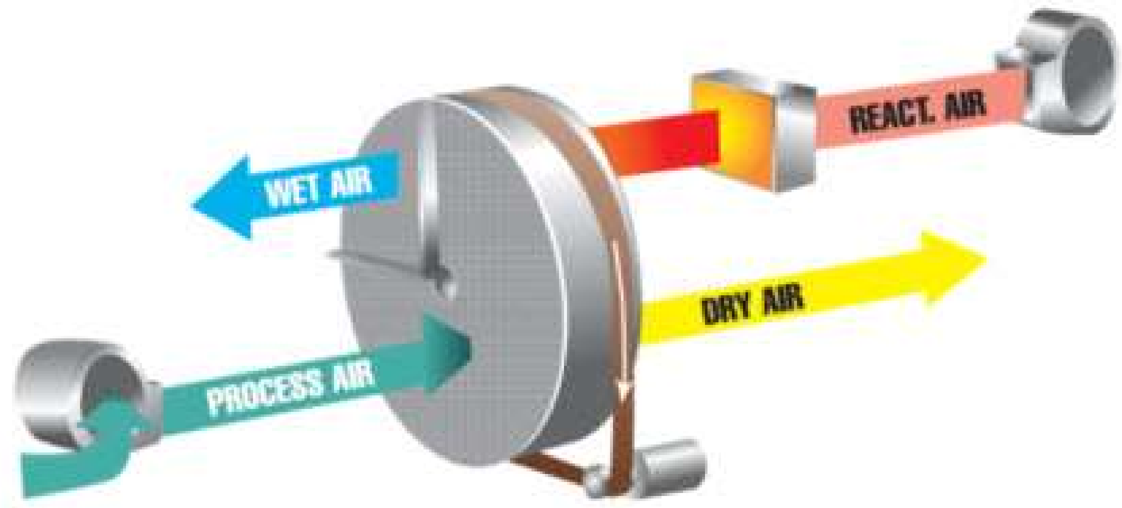
- CO2-mittauksilla voidaan laskea ilmavuodon (ja kosteuskuorman) määrää
  - Tyypillisesti noin 5-15 % hallin tilavuudesta per tunti
  - Raitisilma halliin IV-koneen kautta harvoin tarpeen!

Kondenssikuivain



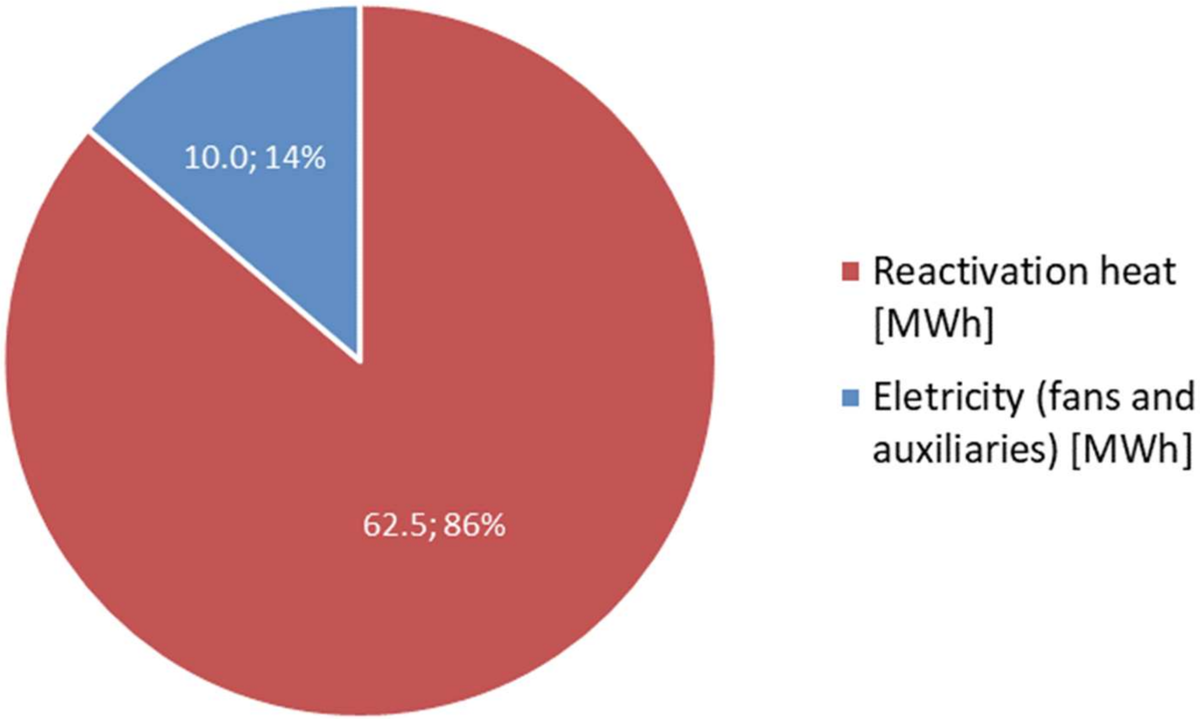
- Tällä menetelmällä vaikeampaa saavuttaa tarpeeksi kuiva ilma jäähallissa
- Jäähdytyksen maksimikapasiteettitarve kasvaa
- Jäähdytysjärjestelmän sähkönkäyttö kasvaa kun on lämmintä ulkona

Sorptiokuivain



- Kondenssikuivain tarvitsee jäähdytystä – Sorptiokuivain lämpöä (paljon)
- Sorptiokuivaimen lämmönlähteenä usein ollut sähkö..
- Nyt: Sorptiokuivaimen lämmönlähteenä jäähdytysjärjestelmän lauhdelämpö!
  - Lämpötilan kuitenkin oltava riittävän korkea – noin 60-70 astetta.
  - CO2-energiakeskuksen ”ilmainen” lauhdelämpö pystyy tähän.
    - Merkittävä säästöpotentiaali!

CO2-lauhdelämmöllä toimiva sorptiokuivain



- Mittaukset osoittavat noin 85% säästöä ostoenergian käytössä!
- CO2-energiakeskuksen lauhdelämpömäärä suurimmillaan jäähallin kuivaussesongin aikana

KANSAINVÄLINEN KEHITYS 4

HYVÄN KILPAILUTUSMATERIAALIN MERKITYS

Tarveselvitys

- Tapauksia on nähty jossa:
  - Tilaaja ei tarkkaan tiedä mitä haluaa ja/tai miksi
  - Tilaajalta epäselvät ohjeet tarjoajille miten tulee toteuttaa
- Tarveselvityksessä
  - Kartoitus
    - Tekniikka
    - Energiankäyttö
  - Toimenpideehdotuksia (mitä)
  - Kustannusanalyysejä (miksi)
    - Investointi
    - Energiankäyttö
    - Huolto

Pirkkalan Jäähalli –
Pirkkalan Jäähalli Oy
Tarveselvitys
21 joulukuuta 2018

Raportin tekijät:
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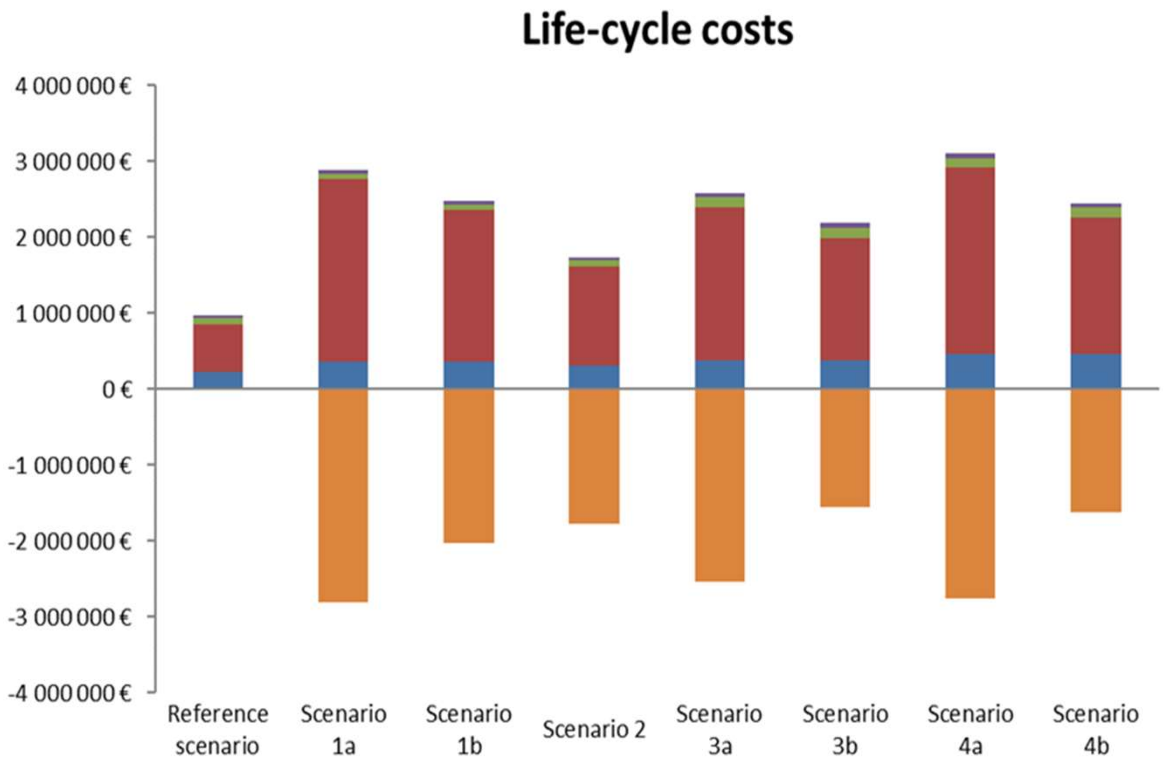
EKA - Energi & Kylanalys AB

EKA I Prästgårdsgränd 4 I 125 44 Älvsjö I Tel. 08-550 102 10 I www.ekanalys.se

LCC results: Case X (a mall in Estonia)



	Reference scenario	Scenario 1a	Scenario 1b	Scenario 2	Scenario 3a	Scenario 3b	Scenario 4a	Scenario 4b
Heat export life-cycle income	- €	-2813 542 €	-2021 168 €	-1778 410 €	-2528 506 €	-1553 381 €	-2757 626 €	-1612 707 €
Periodic service life-cycle cost	37 444 €	37 444 €	37 444 €	37 444 €	56 927 €	56 927 €	54 893 €	54 893 €
Yearly service life-cycle cost	75 010 €	75 010 €	75 010 €	75 010 €	136 381 €	136 381 €	129 562 €	129 562 €
Operation life-cycle cost	622 307 €	2413 127 €	2006 848 €	1301 076 €	2006 848 €	1612 843 €	2447 495 €	1795 730 €
Investment life-cycle cost	235 000 €	356 000 €	356 000 €	320 000 €	385 000 €	385 000 €	470 000 €	470 000 €

- Life Cycle Cost analysis of different system solutions
- Illustrating the effect of investment, operation and servicing

Hankesuunnitelma

- Tarveselvityksen jälkeen tilaaja tietää mitä haluaa ja miksi

- Hankesuunnitelmassa:
  - Tehdään selväksi miten hankkeen tulee toteuttaa
    - Tarjoajille jää selvä kuva projektin vaatimuksista
    - Tarjoukset hyvin vertailukelpoisia
    - Hanke toteutetaan ongelmitta
  - Lopputulos: Tilaaja saa juuri mitä haluaa parhaalla mahdollisella hinnalla

Pirkkala

Pirkkalan Jäähalli
New Refrigeration System

Pirkkalan Jäähalli Oy
Takamaantie 1
33960 Pirkkala

Appendix 1: Technical description
Refrigeration/HVAC
CONTRACT DOCUMENT FOR DESIGN AND BUILD CONTRACT

Date 2019-02-18

Composed by:
Jörgen Rogstam, Cajus Grönqvist and Simon Bolteau
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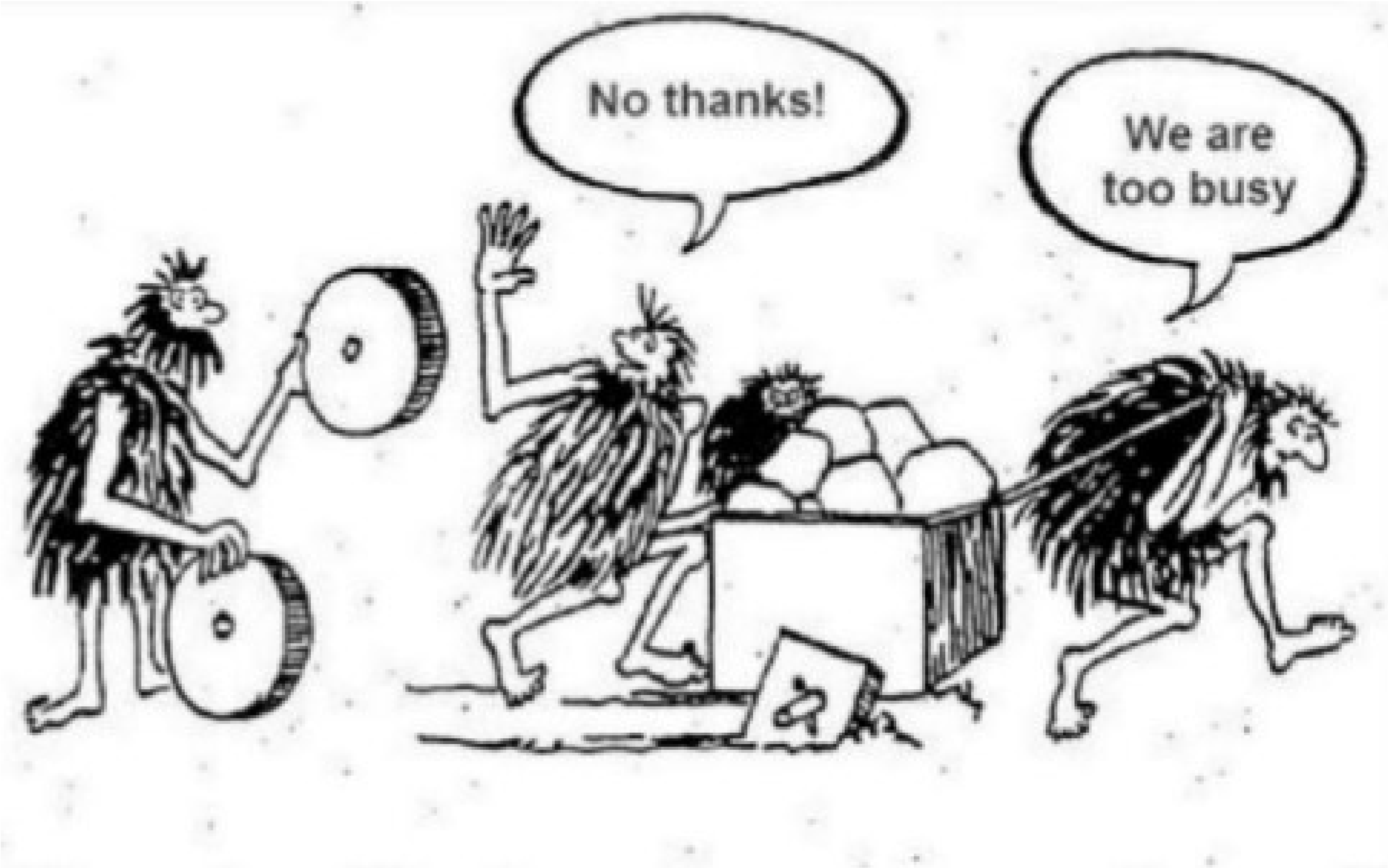
To implement new technology…..!!



Kiitos

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