TERMO WP 2.3 Distributed Cold Storages in the District Cooling System

Viktoria Martin, Saman Nimali Gunasekara
viktoria.martin@energy.kth.se; saman.gunasekara@energy.kth.se

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WP 2.3 Time Plan (2018-2020)

	Distributed cold storages in the District Cooling (DC) system	2018 April-Dec						2019 Jan-Jul				2019 Aug-Dec				2020 Jan-Jul				2020 Aug-Dec			
2.3.1	**System description and method-** a knowledge compilation on distributed cold storages in the DC system	Apr									Jul												
2.3.2	**Techno-economic performance evaluation:** a) Comparison of the cold storage alternatives b) Optimization of the operating strategies					Oct													Jun				
2.3.3	**Benefit analysis** (the avoided power in MW at peak load and the avoided consumption MWh peak load/day)														Nov					Aug			
2.3.4	**Reporting and communication** – 'Generalizability' in focus						Ded	Jan						Nov	Dec				Jul				Dec

KTH WP 2.3: Activity Overview

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2.3.1

1. System description & method-

1. a. SOA analysis: DC & distributed cold storages (& power-to-cold) in Sweden

1.b. International inspirations for cold storage

2.3.2

2. Techno-economic performance evaluation

2.3.3

3. Benefit analysis

2 & 3 a. Case-study system analysis of Norrenergi AB's DC-system

2 & 3 b. Choose and learn suitable software tools for this DC-system study

2 & 3 c. Benchmark, then compare & optimize the DC system with the integration of cold storages & other options

2 & 3 d. Overall performance analysis

2 & 3 e. Results analysis in the overall Swedish context

2.3.4

4. Reporting & communication

- Reports
- Workshops
- (IEA Annex meetings)
- International conferences
- Journal publications

KTH: Ongoing Activities- SOA analys

- With the help of a master's students project (Sep-Dec 2018):
  - *Distributed Cooling and Cold Storage in Sweden: The Current State and Potential for Improvements with International Cold Storage Inspirations*
  - **Literature study, Other channels** (e.g. interviews)

    Norrenergi AB, Göteborg energi, Hässleholm miljö, Halmstad energi och miljö, (Energiföretagen), …
  - **Eurotherm #112 conference** (abstract accepted)

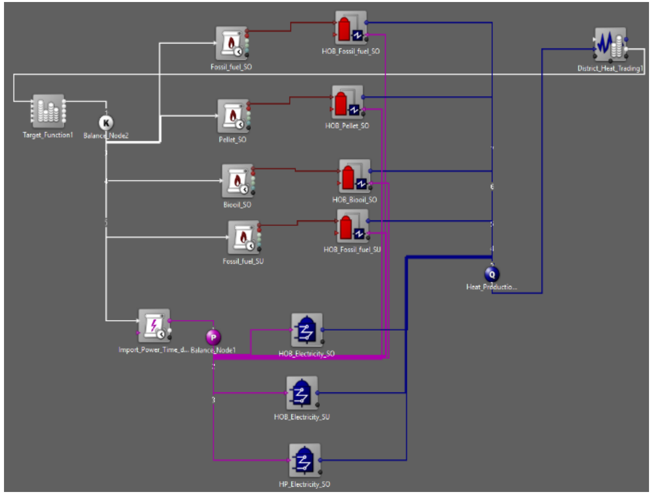
- Meeting Sven Werner (late-2018)
  - Information, sources on DC as in overall

Questions to the DHC companies:

- Daily cooling consumption (supply) profile?
- Annual cooling consumption (supply)?
- Used types and shares of cold production technologies?
- Electricity consumption for cooling production?
- Cold storage types, capacities, utility?
- Renewable energy production onsite, coupling with the DC?

KTH: Ongoing Activities- **Software tools**

- **BoFit (DHC-system modelling)** & PandaPower (electrical system modelling) via a course
- Priority on BoFit- have started with the Norrenergi's DH system modelling for the course
- Continuation towards the DC system as the next step



SOA Analysis

Highlights and Way Forward

District Cooling Supply (Delivered Energy) from 1992-2015

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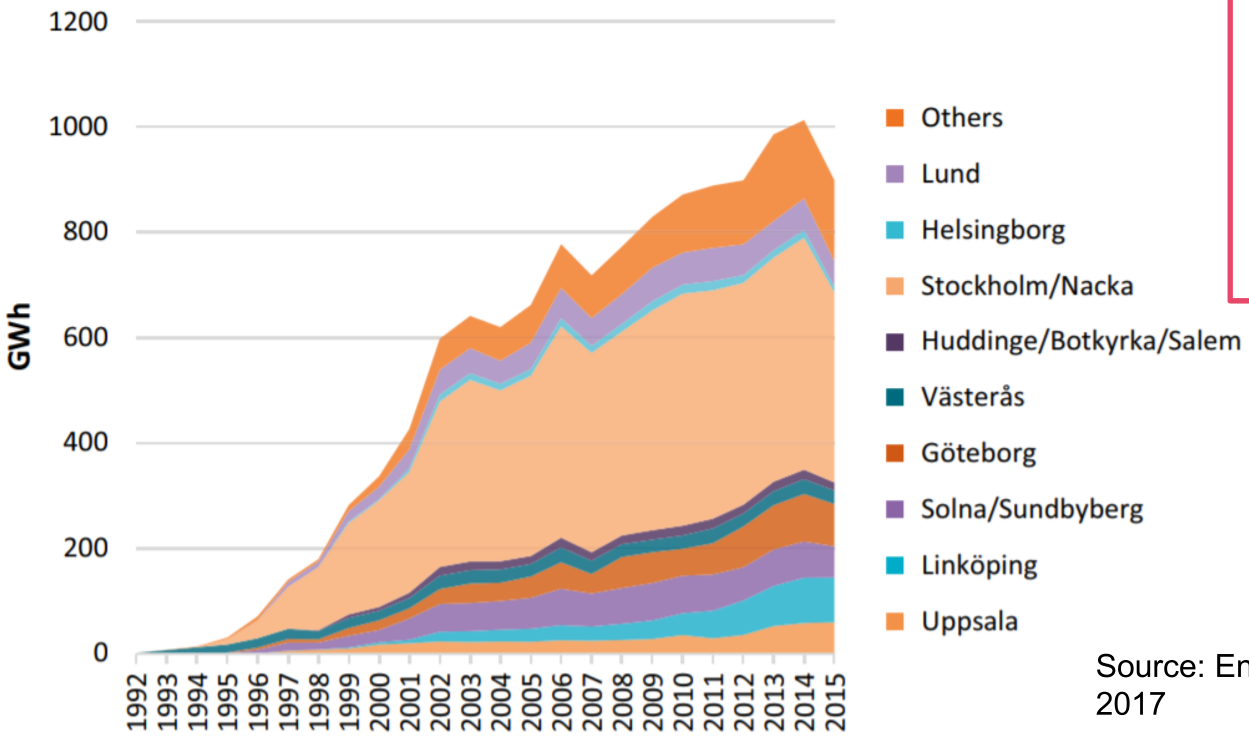


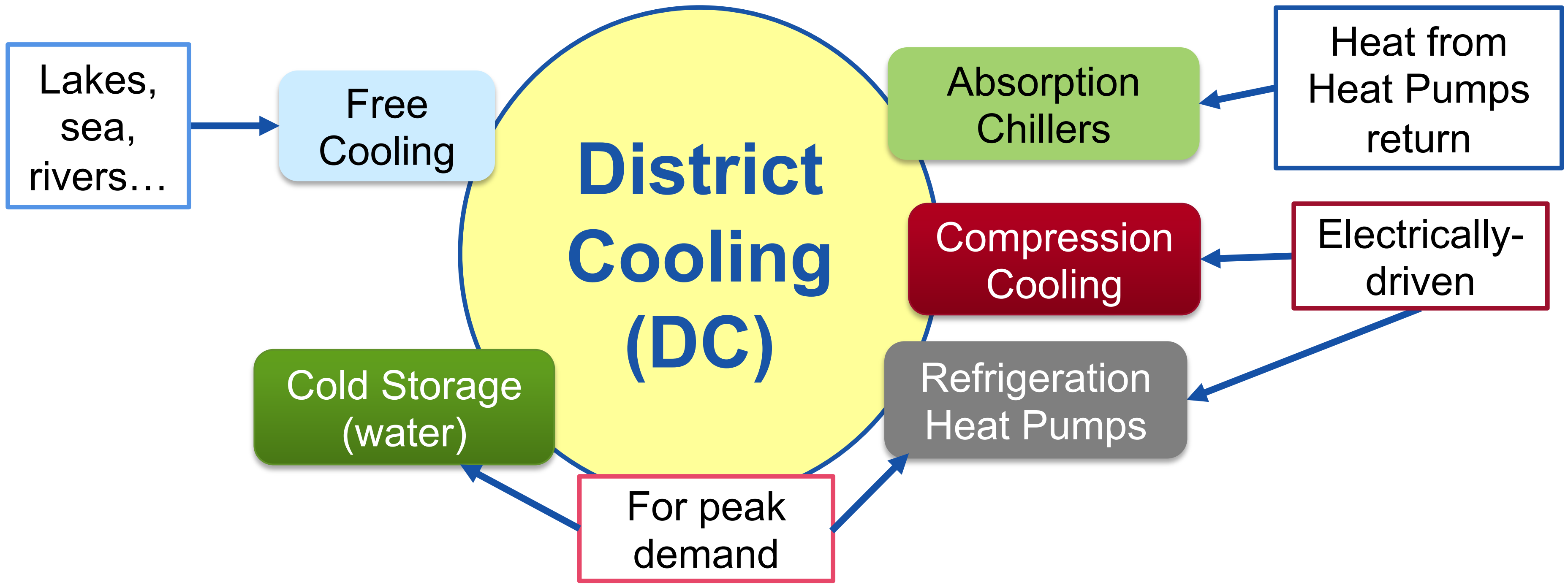
The potential demand for DC in Sweden is estimated to be **2-5 TWh** (Tullin, 2016)

Source: Energimydigheten, 2017

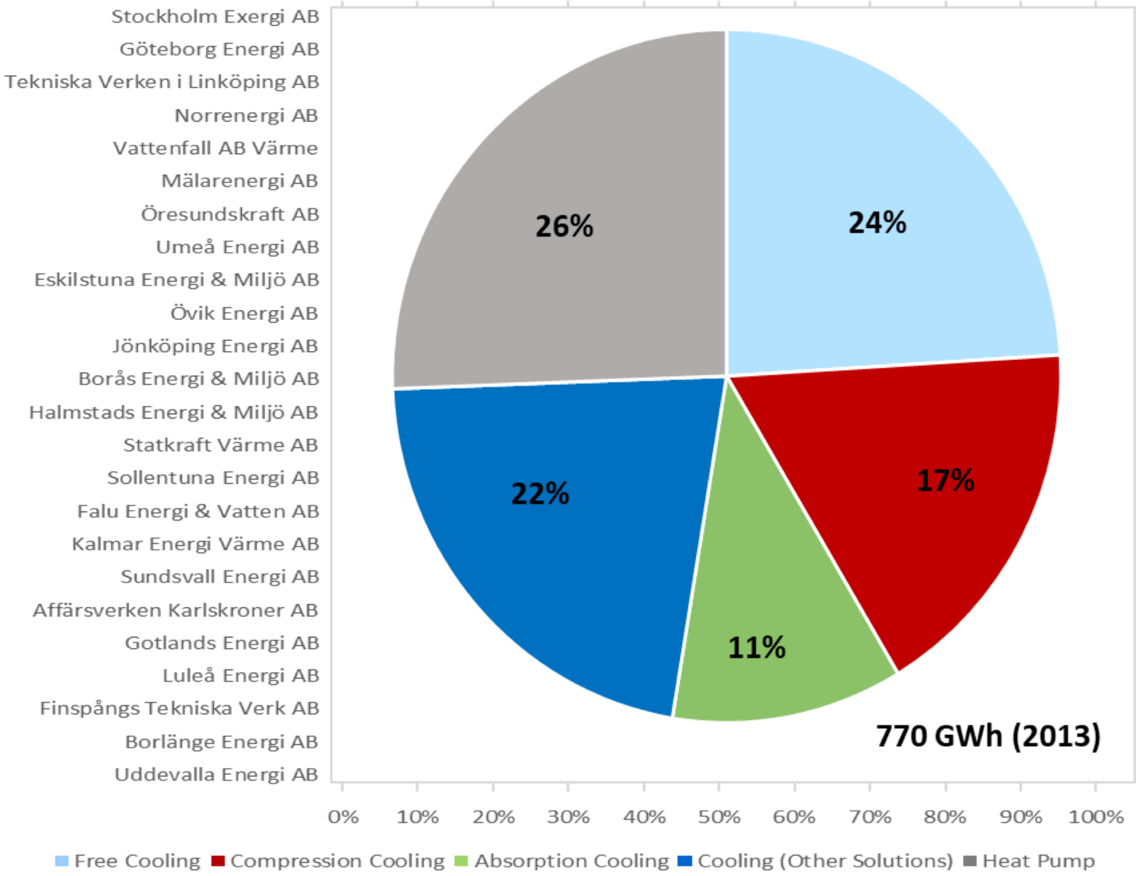
Energiforsk

Energimyndigheten

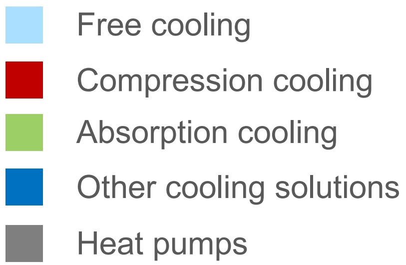
Technologies



Shares of Technologies to produce DC by all Producers in Sweden in 2013



Source: Profu, "Sammanställd statistik över 2012 års fjärrvärmepriser.," 2013



Cold Storages

Examples

	Cold Water Storages	Ice/Snow Storages
Natural caverns	Stockholm exergy: ○ 50 000 m^3, 55 MW, 0.4 GWh rock cavern storage (Hornsberg) Old rock caverns used for oil storage, e.g. in Stockholm ○ a feasibility study, Alfasfos 2017- stratified/non-stratified storage	Sundsvall seasonal snow storage 70 000 m^3 (by 2011) 480 MWh
Other built storages	• Norrenergi: ○ Solnaverket- 7000 m^3, plans to add 15000 m^3 to Sundbybergverket • Other built storages…	Industrial ice storages (electrically-driven chillers)…

International Examples -inspiration

Climaespaço, Lisbon	• Partially-underground chilled water storage tank, 15 000 m^3 (from tri-generation plant, 35 MW cooling) ○ Less requirements of insulation
The Pearl of Qatar	• Electrically driven chillers, 457 MW cooling capacity But can use water of poor quality (including sewage water)
JR Central Nagoya Train Station DHC	• Ice storage of 49 MWh Peak shaving using night-time cheap electricity Adapted to scarce space limitations by design

Way forward- SOA

- Further **collection of data on DC and cold storages** in Sweden
  - Reaching out ☺ to involved actors by emails, calls… → interviews
  - A workshop at KTH → ~April-May 2019

Way forward- Optimization Work

- **Modelling & Optimization of the Norrenergi AB’s DC system**
  - Modelling the existing DC system (using BoFit)
  - Benchmark the obtained results against existing data
  - Optimization of the grid for e.g. various cold storage scenarios
  - Feasibility of e.g. power-to-cold and other concepts integration and optimization

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Discussion

- Cold storage solutions
  - Besides cold water & ‘expensive’ ice?
- Power-to-cold?
- Other ?

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- Interest in taking part in the SOA data collection?
- Reflections?

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