Patented low-power technology for cooling of central offices applied on a Data Center established in 1985 with 30% reduction of total electricity consumption

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***Abstract*—This paper and presentation aims at present the outcome from a major reconstruction of a large Data Centre in Sweden with an energy consumption of app 26 GWh/year. It will also present technical solutions as well as the actual results.**

Key words: Indirect free air cooling, ground water, Data Center, SEE cooler, PuE

I. INTRODUCTION

Energy and carbon footprint is essential in the business of today. However how can these facts be taken into consideration if you are operating an older Data Centre that is based on a design from the mid 1980-ts? We will in this paper try to present our experiences of redesigning an older cooling infrastructure in a Data Centre, exchanging older compressor cooling solutions with indirect free air cooling and how this has resulted in a 30% reduction of electricity consumption as well as electricity costs and an increased redundancy at the site as such.

As a base for the reconstruction we have used the same kind of free air cooling solutions that TeliaSonera have been using during the last 10 years in our ordinary operations in smaller and medium sized sites however now scaled up to fit a large data center. It might be worth knowing that the applied technology is TeliaSonera's main option for new sites and modernization of older ones.

II. BACKGROUND

TeliaSonera has taken an active standpoint focusing on energy as a major issue when combating our environmental impact on society such as green house gases. This has lead to a decision not to continue to use existing and dominating techniques with a high share of electricity consumption for cooling.

This standpoint is not new, we have been focusing on this for the past 10-15 years and it can be very well illustrated in our energy efficiency performance. For instance, TeliaSonera in Sweden has between the years 2001-2010 increased our electricity consumption with approximately 6% (Total electricity consumption was app 417 GWh in 2010). It's an interesting fact that that the electricity consumption trend is declining and we are now reducing our electricity bills. At the same time the capacity in our network has increased with more than a factor of 5. As example we have since 2001 expanded our xDSL capacity (number of ports) from 10 000 to approximately 2 million ports today, 2G and 3G network have been expanded (and now also 4G), data storage capacity has expanded at least 6 times and finally the backbone network capacity has expanded more than 10 times compared to the situation in 2001. The development per traffic category compared to electricity consumption is illustrated in Figure 1 as an index model.

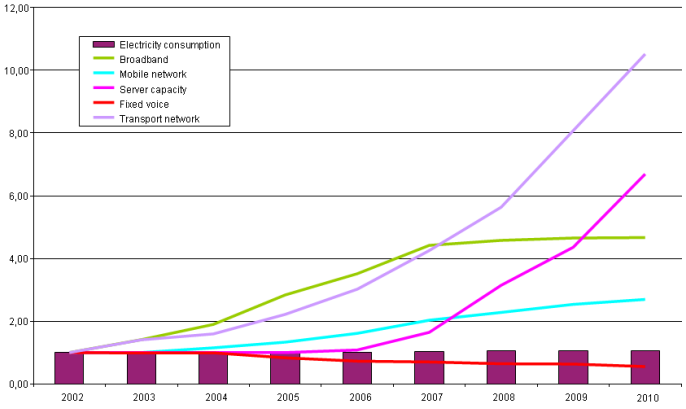

Figure 1. Electricity consumption VS capacity improvements

However cooling and free air cooling is only one of many other activities to keep control over energy consumption. Other important factors are for instance:

- Energy consumption of the network equipment it selves
- Temperature range of the network equipment
- Network equipment location in the actual site
- Power distribution and rectifier and back up power efficiency

Etc. In this paper we will focus on the indirect free air solution used at the Haninge Data Centre

III. FREE AIR COOLING IN TELIASONERA IN SWEDEN

In TeliaSonera there exists more than 12 000 telecom sites with different sizes and different technologies; some are used as fixed sites, other for mobile applications. A of the site uses TeliaSonera Cooling concept = Direct and Indirect free air cooling. Or more specific: >99% sites used only free air cooling.

We estimate that our energy savings is approximately 45-55 GWh/year or 5 000 000 €/year compared to a regular compressor cooling solution.

However the concept has been developed over many years and has passed several generations and phases to where it stands today. From the beginning it was implemented on only some middle sized telecom sites but then it has evolved further into what it is today, a baseline for our cooling infrastructure in telecom sites and in data centers, se Figure 2.

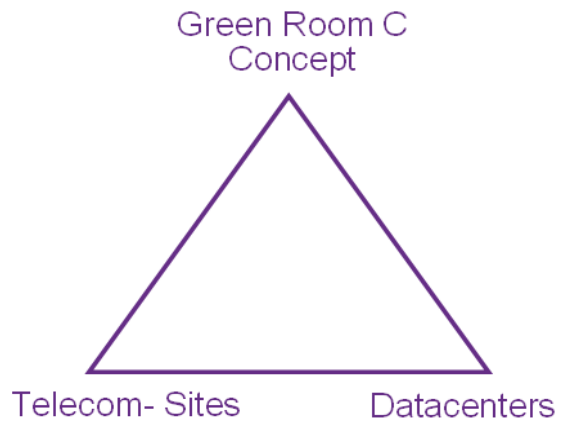

Figure 2. TeliaSonera Cooling Concept

The following step was to develop a cooling infrastructure solution for high density racks (>10kW/rack), the so called "TeliaSonera Green Room concept". But that's part of separate presentation.

IV. Brief description of the SEE/ TeliaSonera Cooling Concept:

- Patented air- supply system equipped with a technique for a minimum use of internal power.
- Extreme Coolant temperature of + 20 °C permitting 100% free cooling up to + 15 °C outdoor temperature without any use of peak-cooling.
- Optimized operation minimizes the, in many cases, very dominating share for the subsystems consumption.
- Efficient free-cooling with the latest updated technologies gives extreme free-cooling periods with a minimum of internal consumption.
- Prepared for GEO Cooling system for peak periods

V. Some reasons for an indirect free aire solution

- Outstanding economy with an investment of around 20 % or less above the conventional system and with an energy consumption of approximately 1/10 of the conventional system . This results a LCC (Life cycle cost) of approximately 45% less than a conventional solution. Se figure 3.
- Very good availability due to its robust construction with few moving parts and well tested control system.
- Environmentally preferable design using only clean water and indirect out door air without any form of refrigerants that might jeopardize the ozone layer or cause Green house gas emissions.

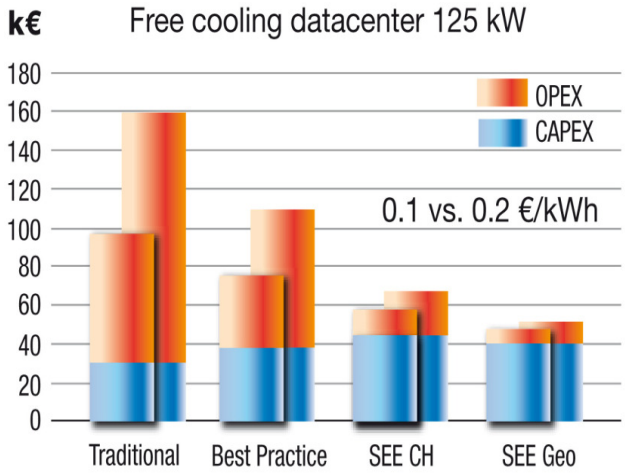

Figure 3. TeliaSonera / SEE Cooling Concept, Economy
(Source: Internal calculations, S. Enlund)

VI. Haninge Data Center, a technical overview

- One of the largest Data Centers in Sweden.
- 4200 m^2 of data rooms with approx 8200 m^2 infra aerials + offices.
- Critical Data production 24/7.
- 2 separated UPS system (1200kW/unit).
- 100 tons Batteries (>2000 units).
- 4 Kongsberg Diesel Turbiner (2MW/unit). 18 000 rpm (generator 1,500 rpm) 800 liter of Diesel consumption per hour.
- Electricity Consumption in 2008: 26GWh (= ~1300 private homes).

The Data Center was originally established in the end of 1980 I combination with the former Telia organizations need of printed media/invoices. It included a conventional compressor cooling solution. The cooling system was reconstructed in the year of 2000 where they achieved an indirect free cooling capacity up to 3°C).

VII. OBJECTIVES FOR THE PROJECT

- Requirement on doubling PROC capacity from approximately 1500 kW to 3000 kW (option up to 4500 kW).

- Increased demands on operation security and access. Single point of failure had been identified.
- High internal focus on increased energy efficiency and lower OPEX!

VIII. PROJECT APPROACH

- Circumspectly mapping of all included Prerequisites and needs.
- Investigation and mass calculations of reasonable approaches related to the TeliaSonera / SEE Cooling Concept.
- Design of Piping, Air handling, Cooling, Control , Power distribution and construction.
- Severe control of all Design.
- Meticulous Pre planning of all critical phases.
- Construction Phase.

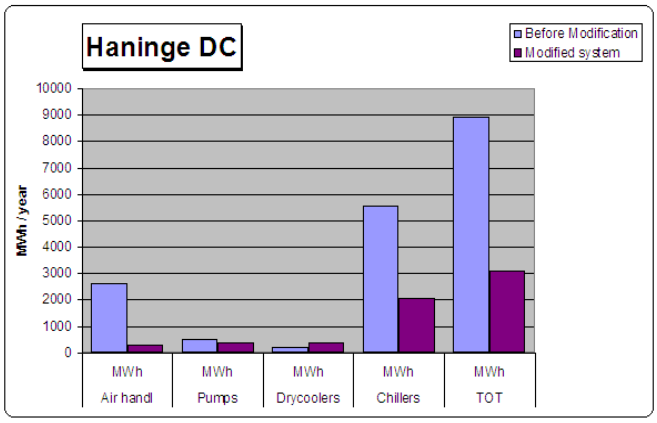

Figure 4. Preccalulations of planned modification

IX. THE NEW SOLUTION - OWERVIEW

- The “one single point of failure” Coolant system has been doubled. A new autonomous Coolant system feeded from a physically separated Cooling central has been installed.
- Coolant temperature increased (from 5,5°C to 16°C).
- Two new autonomous control system (n+1) have been installed.
- Modified air distribution system for computer rooms for lowered energy consumption and raised capacity, coolant temperature and availability.
- 4 dry cooling units (AIA DXP120-15- 450) installed for extended free air cooling up to 14°C
- 17 new SEE Coolers installed.
- A fourth 1,15 MW Chiller has been installed in the Cooling Central.
- Identified corrosion problems in the existing coolant system (KB21) eliminated.
- An Aquifer based peak cooling and backup system is under design (ongoing authority approval process).

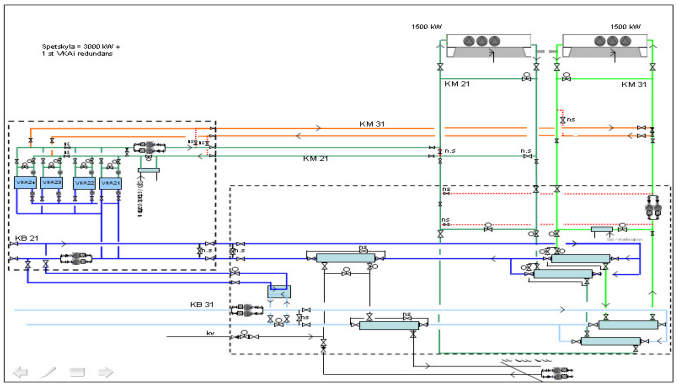

Figure 5. System design - drawing

X. THE NEW SOLUTION – IN DEPTH

- New geographically separated Cooling Central installed in a physically separated part of the DC with one new autonomous Coolant system covering 100% of the Process load.
- Two new and autonomous control systems (n + 1) for new and existing Coolant production.
- Modified Air distribution in the 9 data rooms including elevated capacity and lowered total electricity consumption.
- New system for HEPA cleaning of all process air for the 9 data Rooms.
- Raised Coolant temp from approx 5,5°C to 16°C.
    - *Extended free air cooling period to approximately 76% of the year.*
    - *Extended chilling capacity (approximately 22 %) with elevated COP.*
- Installation of additional chilling equipment (1150 kW).
- Extended total capacity from 1500 to 3000 kW process load (including redundancy and safety factors).
- The project was nominated as one of the most sustainable IT projects during 2010 in Sweden.

XI. RESULTS / OUTCOME

Indirect free cooling verified savings:

- -30% = 7 GWh/annually for the whole Data center. (Figure 6)
- =700 000 €/year in OPEX savings.

There is still a variation over the year (Figure 7) however that will be managed when the Ground water cooling solution has been installed.

To be noticed! The system has not yet been properly tuned so there might be additional possible savings just by optimization of the system as such.

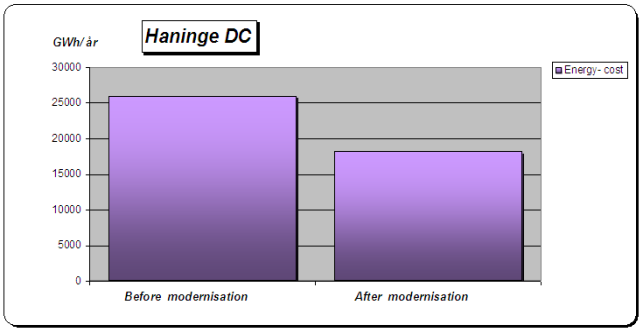

Figure 6. Energy consumption befor and after the reconstruction

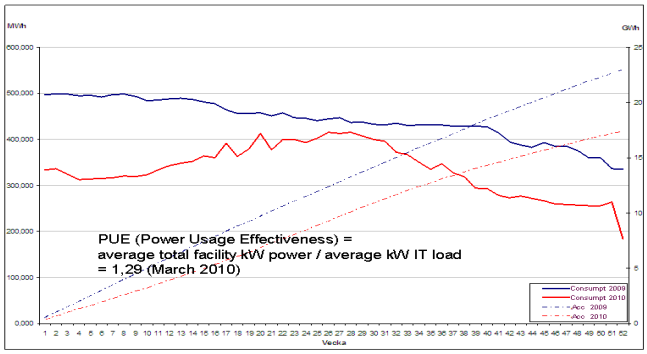

Figure 7. Energy consumption development. 2009 vs 2010 per week.

XII. CONCLUSION: OR MORE PRECISE, WHAT'S IN IT FOR US?

- Everything can and must be improved to meet the requirement from our shareholders, customers and authorities. Even a 20 year old datacenter with a PuE value of 2,1.
- There exist a number of new and interesting solutions on the market but to achieve payback you need to take a holistic view and combine a number of different solutions and activities including modernization of servers, power distribution and rectifiers, back up systems as well as cooling solutions.
- "- The color of money is green". Or: How will your CEO react if you state that you are able to save 700 000 € per year (based on the present energy prize)?

XIII. REFERENCES AND SUPPORTING MATERIAL

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