# The TeliaSonera Green Room Concept for high and mid density ICT equipment

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***Abstract*—This paper and presentation aims at present an new concept for construction and cooling of mid and high density equipment (>10 kW/rack), often located in designated areas in Data Centers. Several of the highlighted solutions has not been invented by TeliaSonera however the concept to combine several of the different solutions in one location and then perform actual verification tests and energy/cooling optimization has not to our knowledge been performed before and that's why we have choosen to call this approach "The TeliaSonera Green room Concept". The concept includes al infrastructure at a site such as power, back up and cooling but in this paper we only focus on the cooling part.**

**Key words: Mid-Density, High-Density, Data rack, Indirect freecooling, Freecooling, Climate, Data Center, SEE Cooler, SEE Cooler HDZ .**

## I. INTRODUCTION

As has been described in another paper presented on this conference TeliaSonera has during a number of years beeing focusing on energy consumption and energy efficient solutions. The company has taken an active standpoint not to continue to use existing and dominating techniques with a high share of electricity consumption for cooling.

This also includes high- and mid density racks that has been tricky to deal with due to extreme temperatures in concentrated areas. Eather you keep the whole site on a temperature that keeps the high dencity racks in operations - But this is very energy consuming. Or you invest in additional cooling precicely where the High Density racks is located – but that will require extra investments.

## II. BACKGROUND

The TeliaSonera Green Room Concept for high and mid density ICT equipment for high- COP cooling has its origin in the three major questions that has dominated the discussion related to internal climate in Data centers and central offices during the past years:

- Drastic increased power consumption trends in individual data racks (Figure 1).
- Increasing share of costs for cooling related to high density racks in combination with increased energy prices (Figure 2)
- Refrigerants and the environmental aspect, both related to Greenhouse gas as well as possible ozone depletion potential.

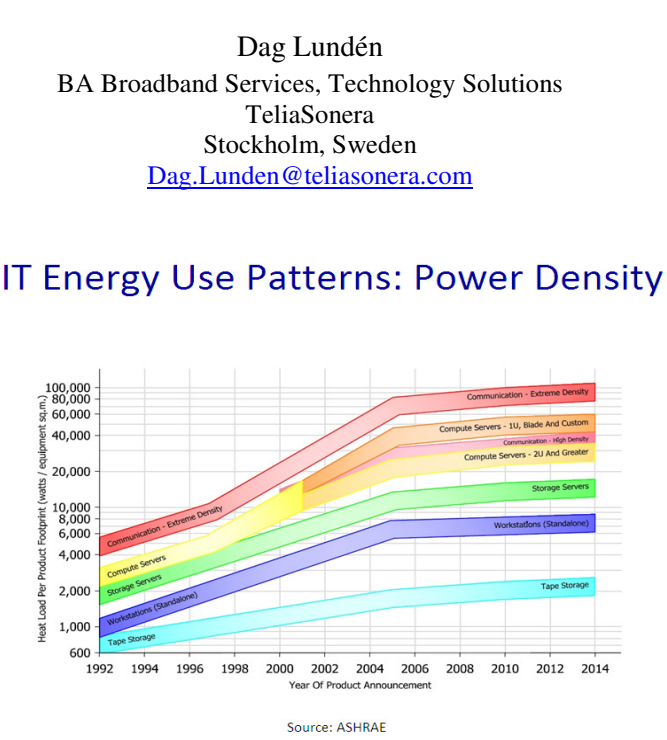


Figure 1. Powertrend of individual Dataracks (Source: ASHRAE)

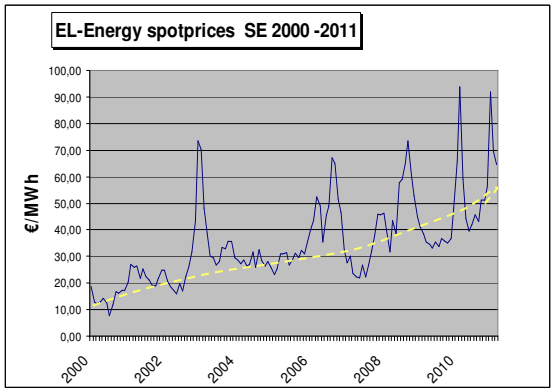


Figure 2. Spotprices: Electrical Energy price development

When continuing the internal work in relation to high density racks the following objectives for the project were decided:

- No water direct on circuit board level.
- As low GWP factor as possible.
- Lowest possible energy consumption due to both infrastructure and fast rising energy costs.
- Severe availability.

## III. Other available solutions for High Density Cooling on the market

Brief summery of different solutions for High Density Cooling on the market :

- Water direct on circuit board level including all integrated complications.
- Solutions with considerable refrigerant amounts, the involved environmental impact, future significant costs and the uncertain risk for total prohibition.
- Solutions with Cooled outlet doors and multi-mountings for refrigerants or cold water systems.
- High level of energy consumption/costs with in many cases considerable share of help energy and only limited free cooling hours.
- Availability problems with systems at such densities due to the temperature effects at the point of capacity loss of Cooling.

## IV. Decided direction: Or why did TeliaSonera chouse the Green Room concept?

- A solution based on the 2-3 years of Industrial development including The TeliaSonera / SEE Cooling concept and the TSVP (TeliaSonera Virtual Platform) Cooling concept for Cooling of dense Blade servers.
- Outstanding economy an investment of around 20 % or less above the conventional system with an energy consumption of approximately 1/10 of the conventional, gives a LCC ( Life cycle cost ) of approximately 45% less then a conventional solution.
- Very good availability. Due to its robust construction with few moving parts and well tested control system.
- Environmentally preferable design using clean water and indirect outdoor air without any form of refrigerants.

All together, this has resulted in that TeliaSonera has chosen to continue with the Green Room concept for high density (HDZ). This includes a first step of establish a 300 kW zone in an area of approximately 70 $m^2$ to verify the exact design and necessary calculation values of the concept.

## V. TeliaSonera Green Room consept – short description

- 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.
- GEO Cooling system as an alternative for peak periods.

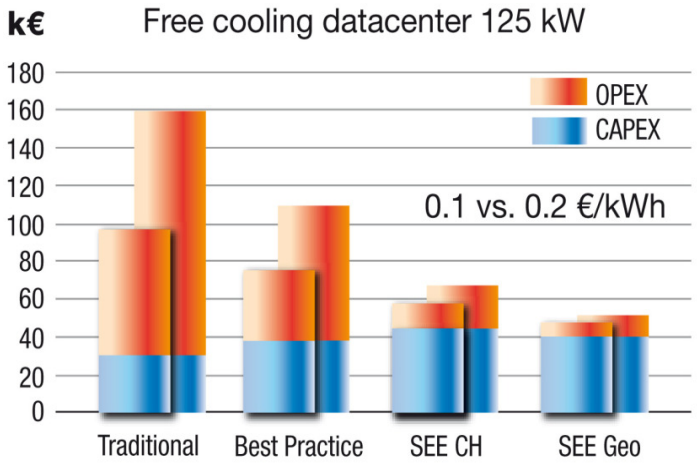


Figure 3. TeliaSonera / SEE Cooling Concept. Economical comparission. (Source: Enlund. S. Internal calculations)

## VI. TeliaSonera Green Room concept: Technical overview

- High airflow volumes .
- Low internal pressure drop.
- EC Fans.
- Use of the newest HDZ Coolers.
- Coolant A and Coolant B ( n+1 ) supply.
- Strict Cold and Hot ailes.
- Minimized pressure in Coolant System.
- New modified control system.
- UPS- A and UPS-B power feeding of the cooling system.
- The result measured and verified with the TSVP technique shows temperature efficiency far beyond the traditional raised floor solution and also other high density systems available on the market.
- Theoretical calculations indicate a maximum Process Power >700 kW on the 70 $m^2$ area with individual data rack >75 kW and a total system COP at approximately 23.

## VII. TELIASONERA GREEN CONCEPT LAYOUT AND DATA MODULATION OF AIR FLOWS

As early described The TeliaSonera Green room is 70 $m^2$ large. The outline is illustrated in figure 4.

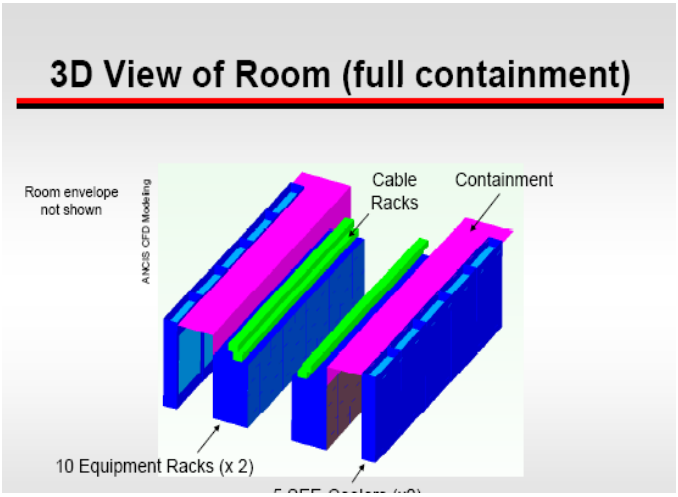


Figure 4. TeliaSonera Green room concept: Room layout - high density

It's worth mentioning that al rows are sealed on both sides. It's not possible for air to pass from the cold to the hot ail without passing though the racks. If there are non used spaced in racks these parts is also sealed.

Through our collaboration with ANSIS we have been able to perform data modeling ahead of the actual air flows, temperature consekvenses and theoretical efficiency in the high density Green room. From a temperature point of view the Green room will be seen as illustrated in figure 5 (Side) and figure 6 (Top down) perspective.

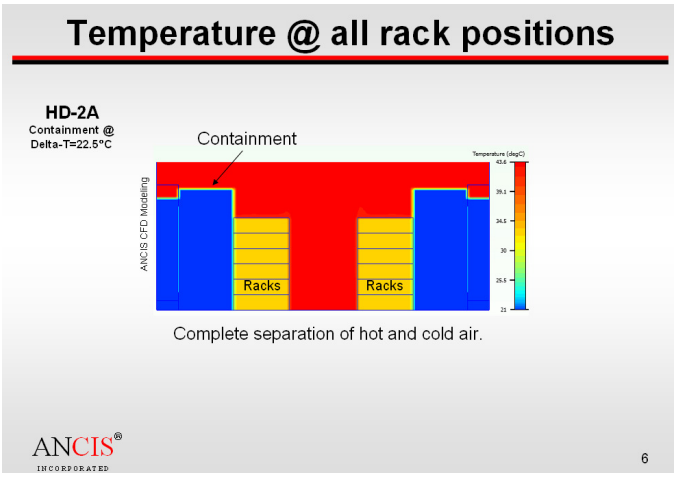


Figure 5. TeliaSonera Green room concept: Temperatures in section, full containmet - high density (Side)

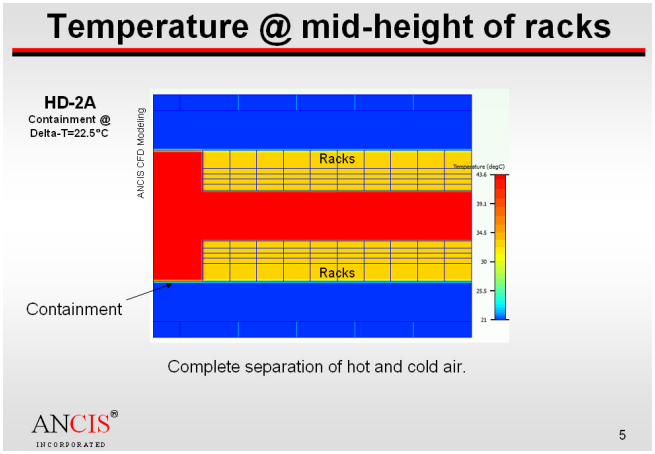


Figure 6. TeliaSonera Green room concept: Temperatures in section, full containmet - high density (Top down)

In these modeling we have also implemented some cases where there are some breaks in the "full containment" or to be more precise, to illustrate what will happened if a network element in a rack was removed and the rack was not properly sealed afterwards. In figure 7 it's quite visible that a recirculation of hot air in to the cold side will be the end result and this will of course interfere with the operation and reduce the efficiency.

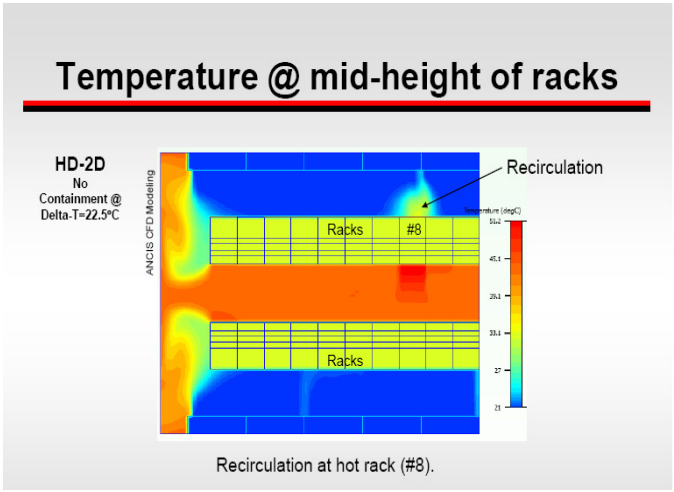


Figure 7. TeliaSonera Green room concept: Tempeartures in section, full containment, high density – where there are a breake though between the hot and cold ail (Top-down).

The loss of efficiency can be even better modulated and visualized in a model where there's no containment what so ever (Figure 8). It's quite easy to se that hot air passes over to the cold ail interfering with the cold air coming directly from the chillers. This will force the chillers to lower the air temperature to be able to keep the temperature limits and this will lower the overall energy efficiency of the system as well as increase energy consumption as such.

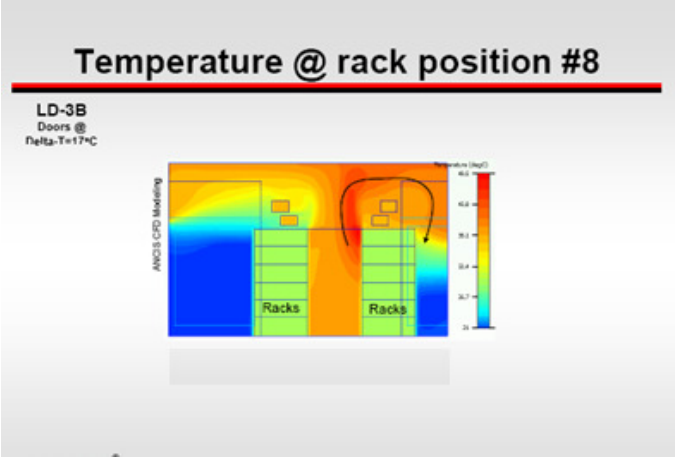


Figure 8. High denseity, no containment (side).

It's not a huge surprise that the full containment results in the highest effect compared to no containment at al. But to be able to identify the most important aspects and construction practices, availability and maybe the most important issue related to high density rack, the temperature rise in the green room if the cooling capacity disappears, these solutions must be tested in real life. And that's the reason why TeliaSonera has constructed a "Green room" in one of our major sites in Stockholm prepared to test energy and temperature/climate variations in the system with variation in the actual power load. But we will also be able to test the containment concept from a totally sealed to a relatively open solution without doors and free access under and between the cooling walls (Se also chapter VII).

The TeliaSonera/SEE Green room concept is also adoptable on low and middle density racks. Such a solution is illustrated in figure 9. In this solution we have not used a "cold wall", instead two ordinary HDZ Coolers has been used. Two such sites are under construction and will be in operation later on this year.

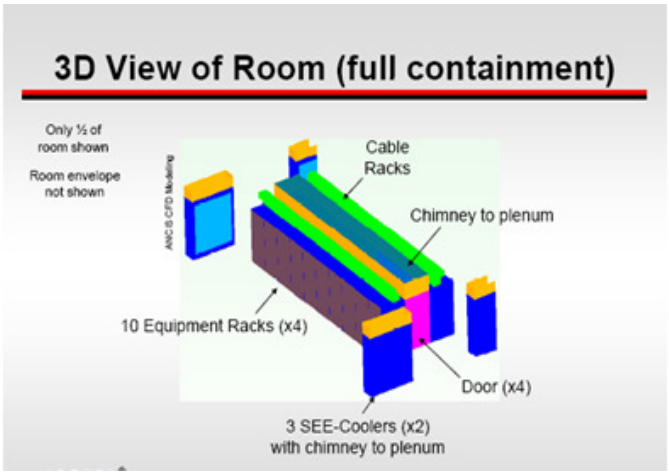


Figure 9. TeliaSonera Green room concept: Room layout, mid density solution

In the low- and mid density solution the containment has been replaced by doors in both ends of the hot ailes and a "chimney" has been added on top of the hot ail as well to secure that the air flow is transported in the proper direction (Figure 10).

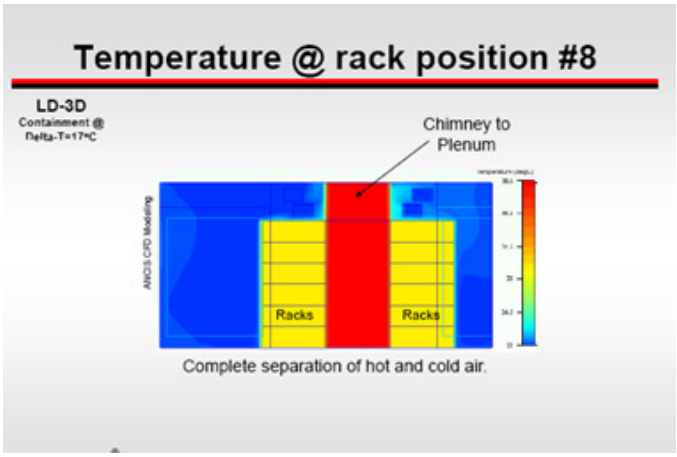


Figure 10. Teliasonera Green room consept: Tempeartures in section, full containment, high density – where there are a breake though between the hot and cold ail (Side).

It is clearly understandable that without containment there would be recirculation of hot air whit losses in energy efficiency as a result (Figure 8 and 10).

## VIII. TESTSITE AND TESTPROGRAM FOR HIGH DENSITY

The TeliaSonera Green room pilot site in Stockholm will be operational during August 2011 and our aim is to perform verification tests of the performance as well as trials to be able to optimize the design and construction according to a specified test program. Different power loads, Delta t and variation of containment in the cold and hot ail will be tested. A specially designed 40 kW power load has been designed for this purpose since there was no solution available on the market that fulfilled our requirements.

In addition to this we have external support. Four students from the Royal institute of technology [KTH] will perform their final MSc work related to this project. Two students is focusing on energy measurements and verification work. The other two will perform a Life Cycle Assessment (LCA) on the whole concept as well as comparing them with other available solutions on the market. The verification phase as well as the MSc studies is scheduled to be finalized during the autumn of 2011 and our goal is to have al information publicly available.

More information will come.

## IX. CONCLUSION: OR MORE PRECISE, WHAT'S IN IT FOR YOU?

- "Many drops make a river". Energy efficient infrastructure is not only a matter of efficient cooling, don't forget backup systems, contamination and localization!
- High density racks (>10 kW/rack) can be cooled just by using a freecooling system in a energy efficient and environmental sustainable manner.
- Don't forget the importance of identifying and eliminating "single point of failure"
- TeliaSonera Green Room concept might be a solution for other operators with equal requirements. When finalized the concept will be fully documented (and externally published) as well as externally verified

## X. REFERENCES


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