

Datacenters can achieve double green benefits

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Keywords:

ABSTRACT: Government policies, Green IT Amsterdam and a Long Term Agreement in the IT sector play an important role in reducing CO₂ and HFC greenhouse gases in the period 2008-2020. The Netherlands has about a hundred 'datacenters'. They consume a tremendous amount of electricity for the IT hardware and the massive cooling demand. It's a fast growing market. But new solutions, developed with the support of the Dutch government, for renewable cooling systems are underway, eventually skipping the HFC-airconditioning systems. This paper informs on renewable cooling in datacenters (pilot projects in the Netherlands) and on enthusiasm in the IT sector for more energy efficiency as a direct result of government programs to stimulate technical breakthroughs.

1 INTRODUCTION

Datacenters are dust and moisture-free industrial halls, packed with endless rows of IT servers. Anyone needing disk space simply hires part of a row in these commercial 'data hotels'. These datacenters generate a huge cooling demand: the chips in the servers can only cope with a limited variation in temperature. Every server is therefore fitted with cooling fans, and the roof of the datacenter itself sports huge cooling installations that use HFCs as a cooling agent; gases that make a substantial contribution to global warming. Thirtyfive percent of the total electricity demand is used for cooling of the IT hardware.

The datacenters consume a tremendous amount of electricity: cables as thick as your wrist supply these datacenters with almost five percent of all Dutch power, a situation that is rapidly reaching both its physical and social limits. This, along with the Green IT project in Amsterdam and long-term agreements with the Government for energy-efficiency in 2020, has prompted the IT sector to start looking into possible ways of cutting back.

Green-IT initiative in Amsterdam

The Amsterdam communal Climate Office cooperates with the Amsterdam

IT sector to start Green IT program with initiatives, pilots, awareness and communication activities, since local datacenters are responsible for 8% of the CO₂-emissions of all the Amsterdam industrial companies. It can help to cut the energy-costs by 30% for the datacenters, a win-win situation.

2 HOW TO CUT THE GREENHOUSE GASES: GOOD, BETTER, BEST

Research into the reduction of non-CO₂ greenhouse gases caused by the datacenters is focusing on the area of cooling, promising double green benefits: energy savings and HFC reduction. Having identified this promising reduction opportunity, SenterNovem started up a subsidy process¹ for ideas for alternative non-HFC cooling installations.

Research problems for renewable cooling are: IT hardware needs dust and moisture-free industrial halls and rather strictly controlled temperatures. Therefore, inside air recirculation and airconditioning was the norm, and the use of fresh outdoor air was long time not done. In short, a year round need for airconditioning.

What are the options for energy-saving and renewable cooling?

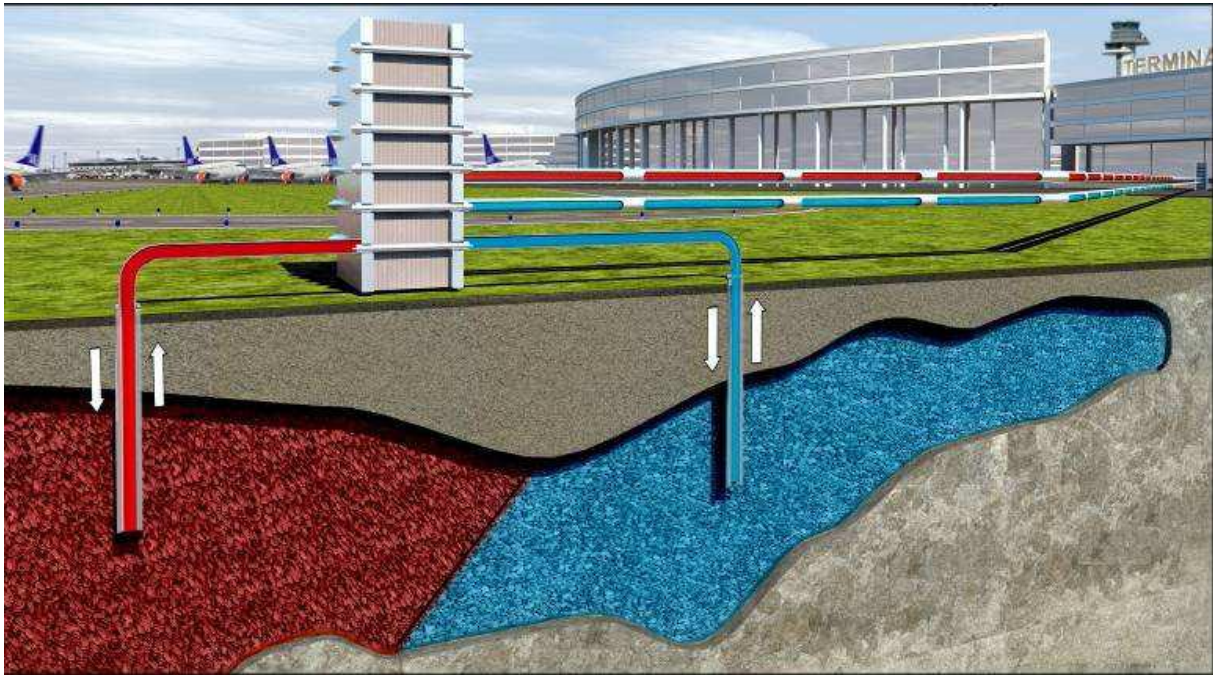
2.1 *GOOD: lower cooling demand*

An good option in datacenters is to start with the reduction of the cooling demand in the server halls and to separate the climate around the server racks into hot and cold corridors (aisles). This becomes common in new datacenters, and it improves both the cooling demand and the energy performance of the airconditioning systems considerably.

A further positive trend in Green IT is using less temperature critical chips in the servers, chips that can stand higher temperatures. The higher the critical chips temperature, the more efficient the different 'free cooling' systems can be operated. Free cooling systems operate by using the cooling tower, without running the cooling compressor unit.

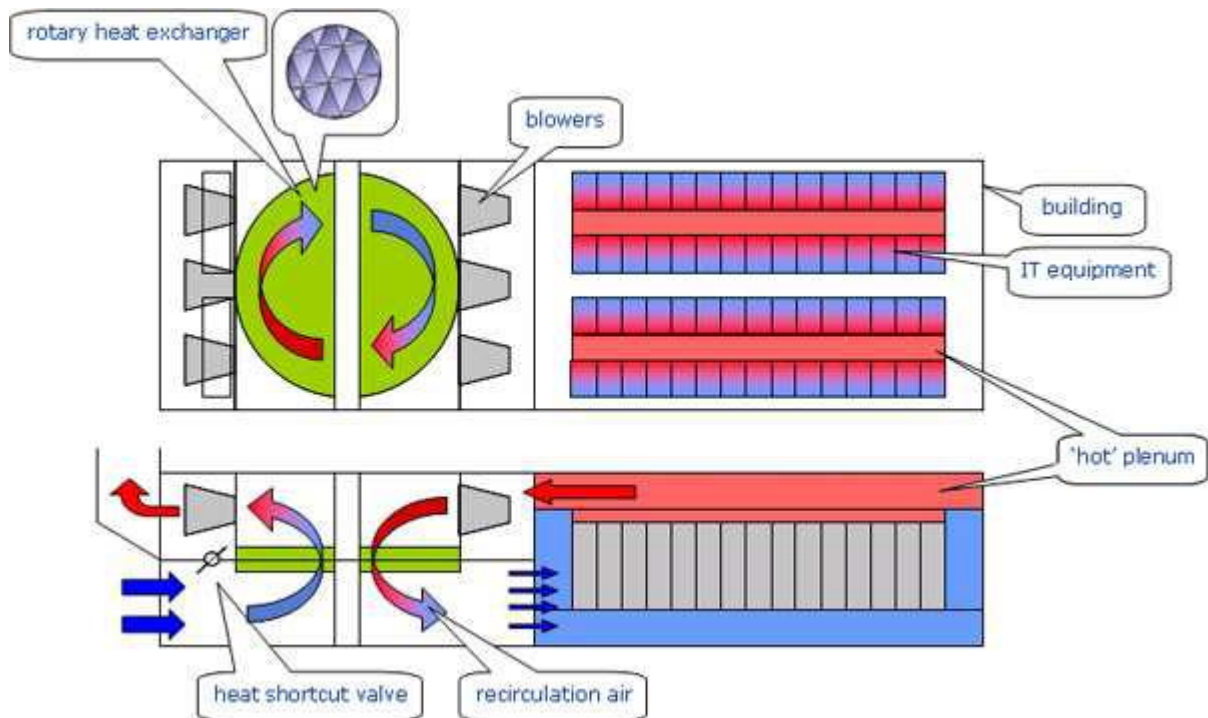
A rather common renewable cooling option in the building area is the seasonal energy storage in the underground (waterlayer – see Figure). Some 750 buildings are using heat and cold storage combined with heatpumps in winter. For datacenters this is less practical because there is no energy balance over summer and winter (only cold extraction).

¹ SenterNovem subsidises the market developments concerning renewable cooling with two stimulation programs: Energie Onderzoek Subsidie (EOS) en Reductie Overige Broeikasgassen (ROB).



2.2 *BETTER: renewable cooling ('KyotoCooling')*

In 2007, a promising free cooling option 'thermal recovery wheel' (patented 'KyotoCooling', see figure) is demonstrated in a datacenter pilot plant in the Netherlands and since then full scale realised. A mechanically-driven thermal recovery wheel that extracts warm air and carries in cool air, without bringing in dust, seasalt and above all moisture, without bringing direct fresh air into the building. Result: seventy percent less power consumption for cooling over the year. But the back up HFC cooling (redundant) is still needed. The market is showing a keen interest, specially because of the very short pay back time.



2.3 BEST: skipping the HFC cooling system ('StatiqCooling')

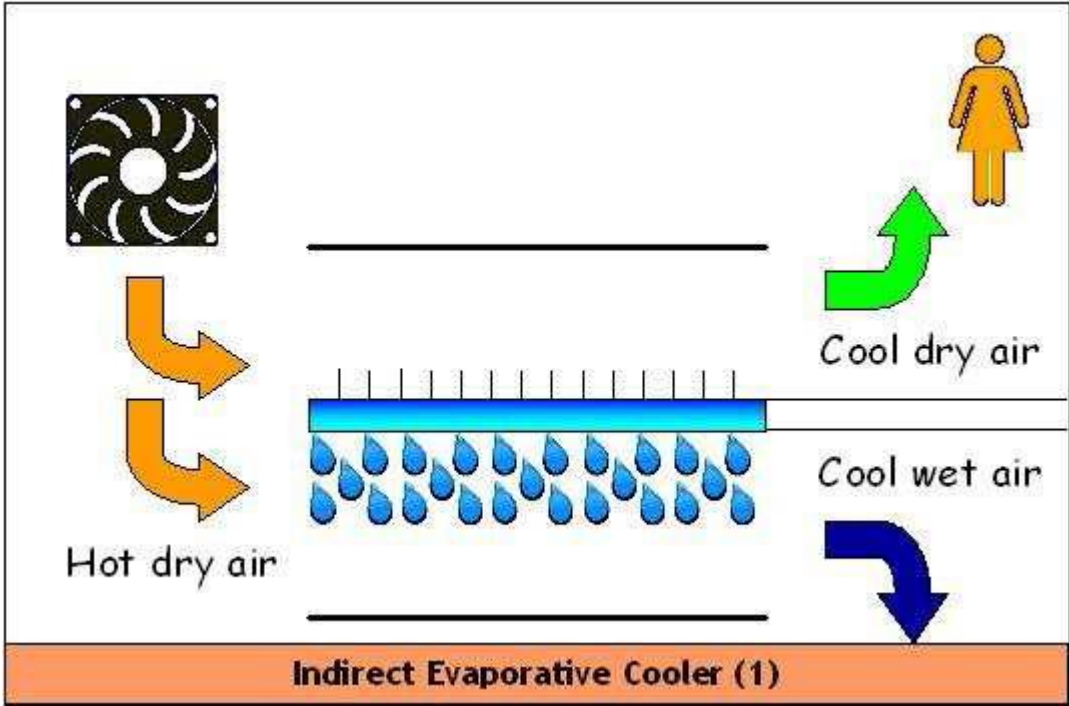
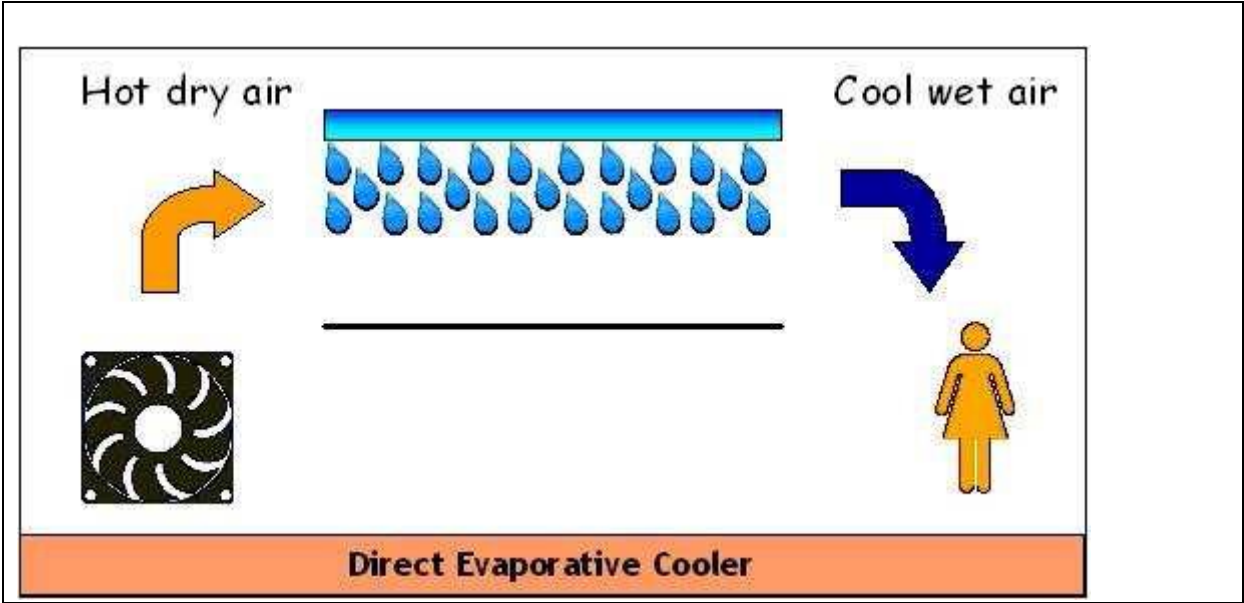
In 2009 an even more promising cooling option for datacenters will be demonstrated, using an alternative cooling principle, the so called 'indirect evaporative cooling or dewpoint cooling' (patented 'StatiqCooling'), see figure. This renewable cooling system is shortly on the market in the Netherlands, with a handfull airconditioning projects in offices, a workshop, school, prison. This system will be realised in a datacenter in Amsterdam in 2009 and prove an energy reduction for cooling of 80-90%, without using a backup system with HFC refrigerants.

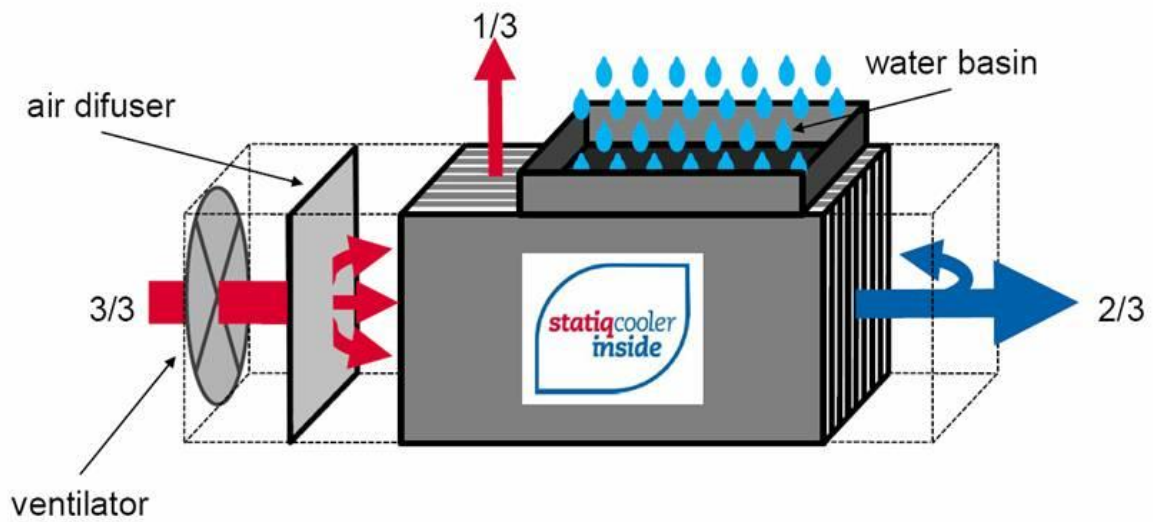
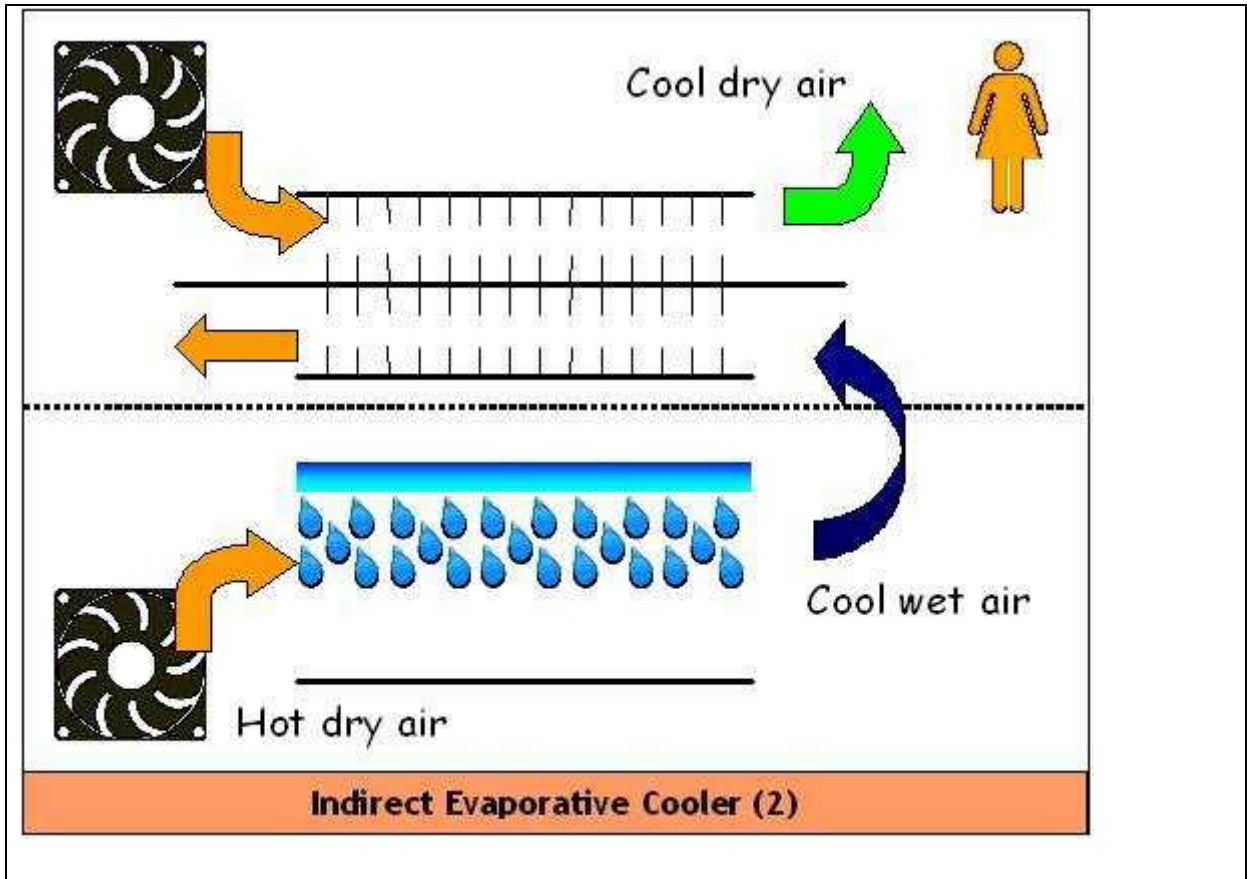
This StatiqCooling system has to meet severe market bottlenecks: using fresh outdoor air is not done in the IT-sector (risk of humidity, seasalt, dust and pollution), a cooled conditioned air of approx. 25°C , the limit of the indirect evaporative cooling system on a hot humid Dutch day with ambient air 28°C and RH 50%, is on the edge of the standard ICT-hardware. Skipping the back up HFC cooling system is not done. Yet the perspectives are impressive: smarter cooling systems with lower energy costs, more installed server capacity!

Evaporative cooling – indirect two-stage systems

Evaporative cooling was already used in ancient Egypt. By using porous jugs and letting the water evaporate from the surface, the contents were cooled. Heat is needed to evaporate the liquid. This heat is taken from the jug surface, which in turn cools the contents. Nowadays evaporative cooling is used, based on the same principle, to cool buildings. Clever "two stage" designs are introduced, to use the cold without increasing air humidity, and to cool below the wet bulb temperature limit. One indirect system uses extra outdoor air as proces air, the other indirect system uses airflow from out the building as proces air.

See the 3 figures below : the direct or 1-stage systems and the indirect or 2-stage systems.





3 GOVERNMENTPROGRAMMES STIMULATE TECHNICAL BREAKTHROUGHS
The first results of pilot projects of the Green IT renewable cooling systems were quickly followed by awareness and enthusiasm in the IT sector. Within one year after the introduction of the KyotoCooling system, the IT branch organization and the government made a long-term agreement in 2008: objectives with commitments to speed up the energy-efficiency. The government parties are the national government, the provinces and the municipalities and the IT branch. The government parties come up with ideas for solutions, possibilities for subsidies and other support. It is the companies and branch organizations themselves that set to work with concrete measures. Sixteen leading IT companies signed the LTA agreement: KPN, IBM, MicroSoft, Oracle, HP, Canon end others.

3 CONCLUSIONS AND RECOMMENDATIONS
Energy costs in datacenters are high. Datacenters reach the limits of the local or regional electricity grids. Main focus on cutting the energy costs and greenhouse gases is on the huge cooling demand.
Pilot plants with innovative renewable cooling systems show technical breakthroughs and interesting returns on investment.
It is recommended that governments and Green IT action programs stimulate the awareness in the IT sector, by solutions, possibilities for subsidies and other support, specially for renewable cooling alternatives.

REFERENCES

SenterNovem, ROB program, subsidised project 'Indirect evaporative cooling' by StatiqCooling (patented 'StatiqCooling'), 2005.
SenterNovem, ROB program, subsidised project 'Kyoto cooling wheel' by Uptime Technology (patented 'KyotoCooling'), 2006.
SenterNovem, EOS program, subsidised pilot project 'datacenter pilot with KyotoCooling' by KPN, 2007.
SenterNovem, EOS program, subsidised r&d project 'Renewable Cooling systems (EOS-LT-04013) by TNO and Wageningen-University. Project is finishing in 2009.
SenterNovem, ROB program, subsidised project 'Datacenter Amsterdam with indirect evaporative cooling, without HFC airconditioning' by StatiqCooling and Data Solution Infra Structure, 2009.

ADDITIONAL INFORMATION

Dutch stimulation program by SenterNovem:

ROB, non-CO2 greenhouse gases - www.senternovem.nl/rob

EOS, energie r&d, www.senternovem.nl/eos

LTA, long term agreements with industrial sectors – www.senternovem.nl/lta

KyotoCooling – www.kyotocooling.com

StatiqCooling – www.statiqcooling.com