Introduction

Vision
• Your Perfect Climate

Mission
• Munters' mission is to be a globally leading supplier of energy efficient solutions for air treatment and climate control technologies.

Facts and Figures
• Global presence with sales and manufacturing in over 30 markets
• In excess of SEK 6 billion in annual net sales (600m Euros)
• Approx 3,600 employees
• 17 manufacturing plants, 7 smaller assembly hubs, and 55 sales and service Centres
• Installed base of more than 300,000 air treatment systems
• Install base in excess of 200MW of Data Centre Facilities
• Owned by private equity partner Nordic Capital Fund VII
A Corporate Culture of Technical Innovation and a History of Customer Service

- Swedish inventor and entrepreneur
- A pioneer in desiccant rotor & evaporative cooling/humidification
- Applied for close to 1,000 patents
- Invented Desiccant rotor technology over 30 years ago

Carl Munters (1897-1989)

Over 60 years of experience in Evaporative Cooling technology
Worldwide Award Winning Organisation

Carl George Munters – 1897- 1989
ASHRAE PIONEER OF THE INDUSTRY
Contributions to Air Conditioning, Heating and Ventilation
The Facts:

- Connected things...some predict that by 2020, the number of Internet-connected things will reach or even exceed 50 billion.

- In 2015, over 1.4 billion smart phones will be shipped and by 2020 we will have a staggering 6.1 billion smartphone users.

- By 2020, a quarter of a billion vehicles will be connected to the Internet, giving us completely new possibilities for in-vehicle services and automated driving.

- Today, the market for Radio Frequency Identification (RFID) tags, used for transmitting data to identify and track objects, is worth $11.1 billion. This is predicted to rise to $21.9 billion in 2020.

- Machine-to-machine (M2M) connections will grow from 5 billion at the beginning of this year to 27 billion by 2024, with China taking a 21% share and the U.S. 20%.

- CISCO believes the IoT could generate $4.6 trillion over the next ten years for the public sector, and $14.4 trillion for the private sector.

Source: Forbes “2017 Internet of Things Facts”
World of data centres
# World Wide Energy Consumption by Country

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>China</td>
<td>4.69 Trillion kWh</td>
</tr>
<tr>
<td>2</td>
<td>United States</td>
<td>3.89 Trillion kWh</td>
</tr>
<tr>
<td>3</td>
<td>Russia</td>
<td>1.04 Trillion kWh</td>
</tr>
<tr>
<td>4</td>
<td>Japan</td>
<td>859.7 Billion kWh</td>
</tr>
<tr>
<td>5</td>
<td>India</td>
<td>698.9 Billion kWh</td>
</tr>
<tr>
<td>6</td>
<td>Germany</td>
<td>549.1 Billion kWh</td>
</tr>
<tr>
<td>7</td>
<td>Canada</td>
<td>499.9 Billion kWh</td>
</tr>
<tr>
<td>8</td>
<td>France</td>
<td>471 Billion kWh</td>
</tr>
<tr>
<td>9</td>
<td>Brazil</td>
<td>455.8 Billion kWh</td>
</tr>
<tr>
<td>10</td>
<td>South Korea</td>
<td>455.1 Billion kWh</td>
</tr>
<tr>
<td>11</td>
<td><strong>DATA CENTRES</strong></td>
<td><strong>416.2 Billion kWh as of 2016</strong></td>
</tr>
<tr>
<td>12</td>
<td>United Kingdom</td>
<td>329.3 Billion kWh</td>
</tr>
<tr>
<td>13</td>
<td>Italy</td>
<td>313.8 Billion kWh</td>
</tr>
<tr>
<td>14</td>
<td>Spain</td>
<td>249.7 Billion kWh</td>
</tr>
<tr>
<td>15</td>
<td>Taiwan</td>
<td>242.2 Billion kWh</td>
</tr>
</tbody>
</table>

From Modular to Hyperscale
Climate Conditions

World map of Köppen climate classification for 1901–2010

Letter
A: Tropical
B: Dry
C: Mild temperate
D: Snow
E: Polar

Data source: Terrestrial Air Temperature/Precipitation: 1900-2010 Gridded Monthly Time Series (Y 3.01)
Resolution: 0.5 degree latitude/longitude
Website: http://hanschen.org/koppen
Oasis IEC Family Product Evolution

- **2007**: OASIS EPX Introduced in USA
- **2008**: First success in USA
- **2009**: IEC as technology gets accepted
- **2010**: OASIS IEC Introduction in EMEA
- **2011**: EPX Technology transfer to EU starts & IEC is introduced
- **2012**: IEC as technology is accepted & the success continues
- **2013**: Next Generation Oasis IEC 2.0
- **2014**: OASIS DCIE GLOBAL PRODUCT

**Timeline:**

An effective Data Center cooling solution must be:

- Flexible
- Efficient
- Suitable for all climates
- Resilient
- Global product / Global reach
- Configurable
- Scalable
Recommended 18-27°C at server inlet (5.5 dew point - 60% rh)
Allowable 15-32°C at server inlet (20-80% rh)
Indirect Evaporative Cooling

How Does IEC Work?

- Scavenger Fans
- DX Condenser Coil
- Evaporative Cooling Water Sprays
- Polymer Heat Exchanger
- Hot Aisle Return 38°C
- Room-Side Fans
- Ambient Air Intake

Room Supply 26°C

Top-Up Cooling Pack (DX or ChW)

Cooling Water Pump

Sump
Hours per year that Oasis™ IEAC can provide 23°C or below for locations around EMEA

Based on Hot Aisle return air temperature of 35DegC

Hours of operation per year
Hours per year that Oasis™ IEAC can provide 27°C or below for locations around EMEA

Based on Hot Aisle return air temperature of 39DegC

Hours of operation per year

London (Gatwick)  
Paris  
Berlin  
Barcelona  
Madrid  
Stockholm  
Vienna  
Moscow  
Rome  
Istanbul  
Abu Dhabi

Hours run with EPX only  
Hours run with EPX and supplementary cooling
Expected annual costs of Energy and Water

Figure 5.1.2. Total annual costs of energy and water consumed by the data hall.
# Oasis™ Indirect Evaporative Cooler Energy savings vs Chillers

<table>
<thead>
<tr>
<th>Seasonal Cooling COP</th>
<th>Standard Chillers</th>
<th>Free Cooling Chillers</th>
<th>Munters Oasis™</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chiller + Evaporative</td>
<td>6.5</td>
<td>11.9</td>
<td>175</td>
</tr>
<tr>
<td>Total Cooling*</td>
<td>4.5</td>
<td>6.5</td>
<td>18.6</td>
</tr>
<tr>
<td>PUE (partial)**</td>
<td>1.22</td>
<td>1.16</td>
<td>1.05</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chiller Operating hours [h]</th>
<th>Standard Chillers</th>
<th>Free Cooling Chillers</th>
<th>Munters Oasis™</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8760h</td>
<td>8760h</td>
<td>DX - 14h</td>
</tr>
<tr>
<td>Evaporative</td>
<td></td>
<td></td>
<td>Evaporative - 8388h</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Energy Consumption [kWh]</th>
<th>Standard Chillers</th>
<th>Free Cooling Chillers</th>
<th>Munters Oasis™</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chiller + Evaporative</td>
<td>1,419,282</td>
<td>776,906</td>
<td>52,914</td>
</tr>
<tr>
<td>Fans (cooling only)</td>
<td>581,865</td>
<td>581,865</td>
<td>496,712</td>
</tr>
<tr>
<td>Pumps</td>
<td>73,866</td>
<td>73,866</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>2,075,013</td>
<td>1,432,637</td>
<td>496,782</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Annual Costs [£]***</th>
<th>Standard Chillers</th>
<th>Free Cooling Chillers</th>
<th>Munters Oasis™</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>124,501</td>
<td>85,958</td>
<td>29,807</td>
</tr>
<tr>
<td>Water</td>
<td>0</td>
<td>0</td>
<td>5,721</td>
</tr>
<tr>
<td>Total Costs</td>
<td>124,501</td>
<td>85,958</td>
<td>35,528</td>
</tr>
<tr>
<td>Cost Savings [%]</td>
<td>0%</td>
<td>31%</td>
<td>71%</td>
</tr>
</tbody>
</table>
Where is Energy Consumed?

The largest energy consuming element apart from the IT load is the Compressor.
Where is Energy Consumed?

Annual Energy Consumption
Best Practice: Free Cooling chillers and CRACs
PUE: 1.3 – 1.35

Even when Free Cooling Chillers are used, the largest energy consuming element apart from the IT load remains the Compressor.
Where is Energy Consumed?

**Annual Energy Consumption**
Best Practice: Indirect Air Optimisation

**PUE: 1.2**

Compressor Energy (kWh)

Compressor Energy may be significantly reduced by use of IAO
**pPUE Comparisons IEC vs Free cooling chiller**

Lower capital cost for key cooling plant

40% lower annual operating cost

Low partial PUE

<table>
<thead>
<tr>
<th>Region</th>
<th>Oasis IEAC pPUE</th>
<th>Free-Cooling Chiller pPUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>London Heathrow</td>
<td>1.05</td>
<td>1.16</td>
</tr>
<tr>
<td>Madrid</td>
<td>1.05</td>
<td>1.18</td>
</tr>
<tr>
<td>Abu Dhabi</td>
<td>1.09</td>
<td>1.32</td>
</tr>
<tr>
<td>Beijing</td>
<td>1.06</td>
<td>1.2</td>
</tr>
<tr>
<td>Shanghai</td>
<td>1.07</td>
<td>1.22</td>
</tr>
<tr>
<td>Moscow</td>
<td>1.05</td>
<td>1.14</td>
</tr>
</tbody>
</table>

*based on hypothetical test case 1MW data centre (N+1) full details in Cundalls product engineering review, copy available on request*
**Oasis Capital cost won’t cost you more**

<table>
<thead>
<tr>
<th>System Description</th>
<th>Main Cooling Plant</th>
<th>Capital Cost per unit (£)</th>
<th>Total Cost (£)</th>
</tr>
</thead>
</table>
| **Oasis™ Indirect Evaporative Air Cooler (floor mounted)** | Oasis unit (x6)  
Smaller Oasis units (x2)  
AHU (x1)  
Ductwork  
Water storage for 2no. tanks | £110k  
£87k  
£25k  
£50k  
£ for water tank  
£ for pumps  
£ for water treatment  
£4k for pipework  
= £24k | £660k  
£174k  
£25k  
£50k  
£48k  
£957k |
| **Water-side Economisation Chilled Water** | Free-Cooling Chillers(x3)  
CRAC units (x14)  
Pumps + Pipework  
AHU (x1) | £132  
£18k  
£350k  
£25k | £396k  
£253k  
£350k  
£40k |
|                       |                    |                           |                |

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**Munters**
Capital Costs (CAPEX)

- When considering the lower capacity requirement of the electrical to mechanical power loads, the plant, equipment and machinery power infrastructure can be reduced:

Diesel generator size:

Transformer size:

Proportional diesel storage, electrical distribution, switchgear savings, etc.

Or alternatively, this ‘stranded capacity’ within power infrastructure can be re-engineered to deliver additional power capacity to the DC.
Cooling by Evaporation
Air Quality – Why Indirect?

Server Reliability vs. Contamination

Particulate and gaseous contamination becomes a more important consideration when there is an increased use of economizer systems.

The air quality and building materials should be checked carefully for sources of pollution & particulates and additional filtration should be added to remove gaseous pollution and particulates, if needed.
Indirect Evaporative Cooling

OASIS™ Indirect Evaporative Cooler
Indirect Evaporative Cooling
**Data Centre Test Facility**

- ✔ Leakage testing
- ✔ Controls and Alarm simulation testing
- ✔ A visual inspection of the unit
- ✔ Variable load/performance testing, 1.7°C up to 33°C WB
- ✔ Real server rack simulation over 300kW load

Tests performing in accordance with ASHRAE Std 143-2015

Fully Calibrated & Certified by LEUVEN KUL University
Test Facilities

- Leakage testing.
- Controls and alarm simulation testing.
- Variable load performance testing, in a climate controlled chamber 2°C up to 33°C WB, 45°C DB.
- 60,000m³/hr airflow capacity
- Real server rack simulation with up to 300kW load.
- Tests in accordance with ASHRAE Std 143-2015.
- Fully calibrated & certified by LEUVEN University.
DigiPlex

- Energy efficiency of 1.12 PUE

- Annual pPUE of 1.06
- Data Centre air fully separated from outside
- Lower capital costs on refrigeration/switchgear
- 52 Oasis IEC 200's

Greg MCCulloch, DigiPlex's Chief Operating Officer:

"Driving energy efficiency in our industry is a major focus for us and this system halves the amount of energy used to keep our servers working at an ideal temperature."

"This not only helps save our customers thousands of pounds in energy costs but also ensures that our facilities are amongst the most sustainable in the sector"
EQUINIX Slough LD6

- One of the most energy efficient data centres in Equinix Portfolio
- 8,000m²
- Two three-storey, air-cooled buildings, for Phase 1
  - 2,770 Cabinets
  - 8MW IT Load
  - 80 x Munters Oasis IEC
  - Aim to become accredited to LEED Platinum Level
  - Predicted cooling pPUE 1.06
  - Predicted project PUE1 1.2
  - Building Innovative design
    - Mechanical plant on top level to be closer to the airflow entry
    - Rainwater harvesting system
For more information

www.munters.com/datacenters

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