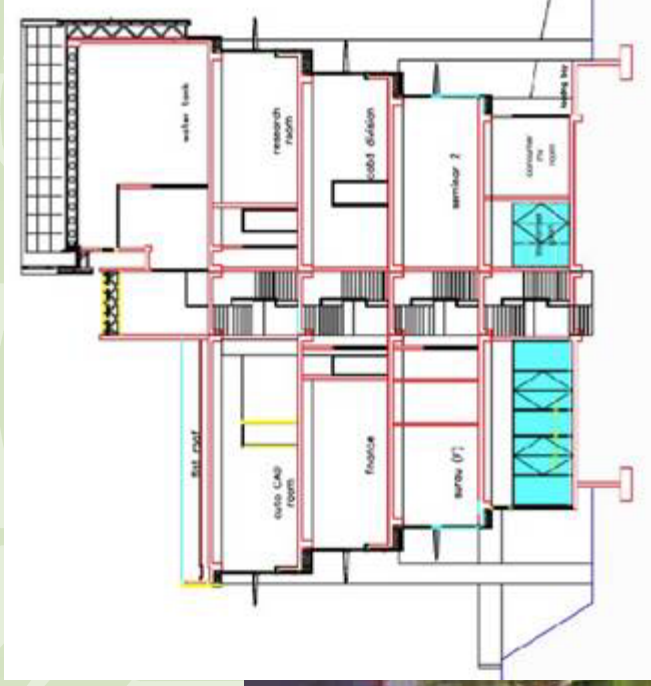


# Green Building features

Ministry of Energy, Water and Communication  
ZEO - Zero Energy Office Building



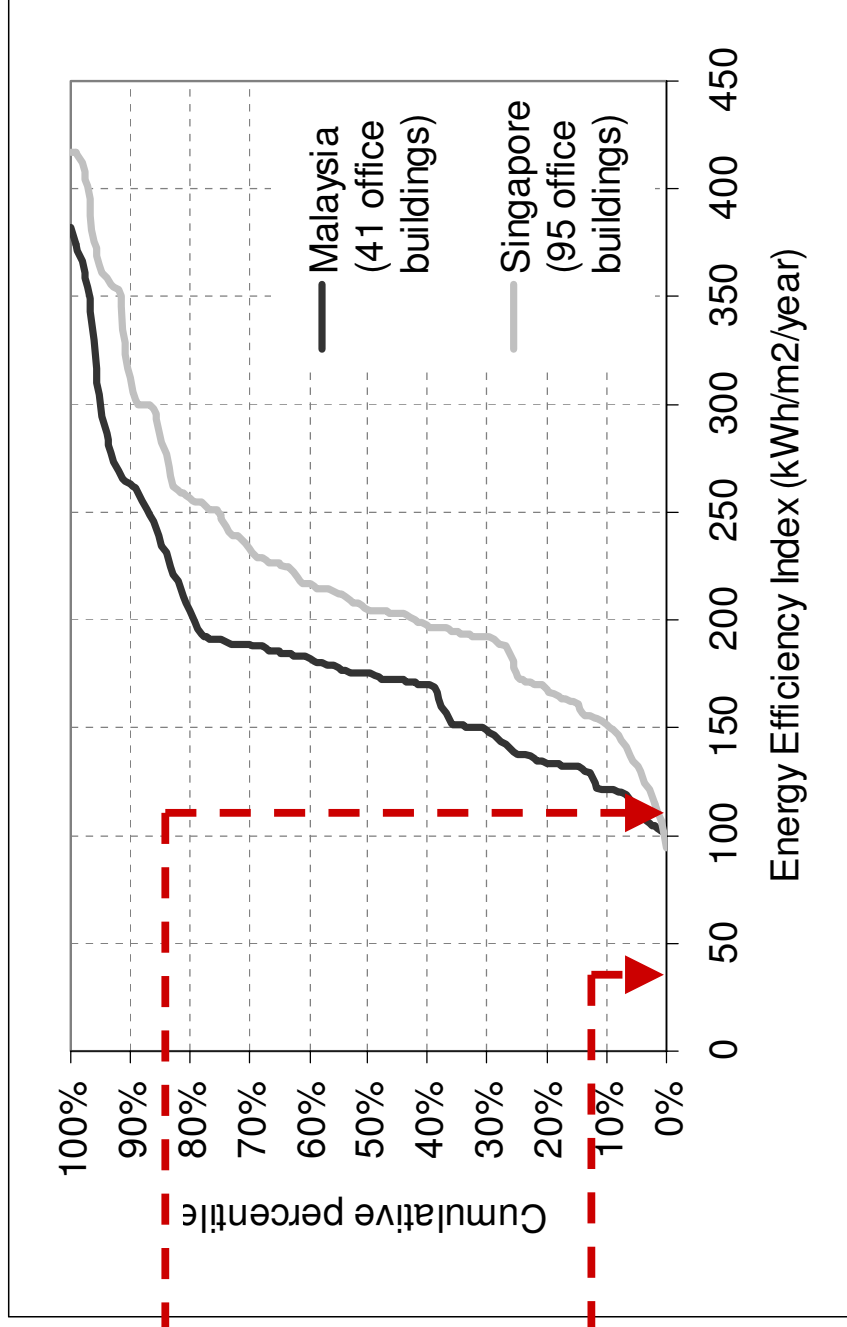
[www.pcmproducts.net](http://www.pcmproducts.net)

# Low Energy Buildings by IEN Consultants

**LEO Building**  
Low energy office building  
Malaysia, 2004



**ZEO Building**  
Zero energy office building  
Malaysia, 2007



Source of chart: **EAEF Project 64**

Project leader: Energy Sustainability Unit, Singapore, 2006



IEN Consultants  
[www.ien.com.my](http://www.ien.com.my)

“Low Energy Office Buildings, Towards Zero”  
By: Gregers Reimann

ISEAS, Singapore  
22nd June 2007

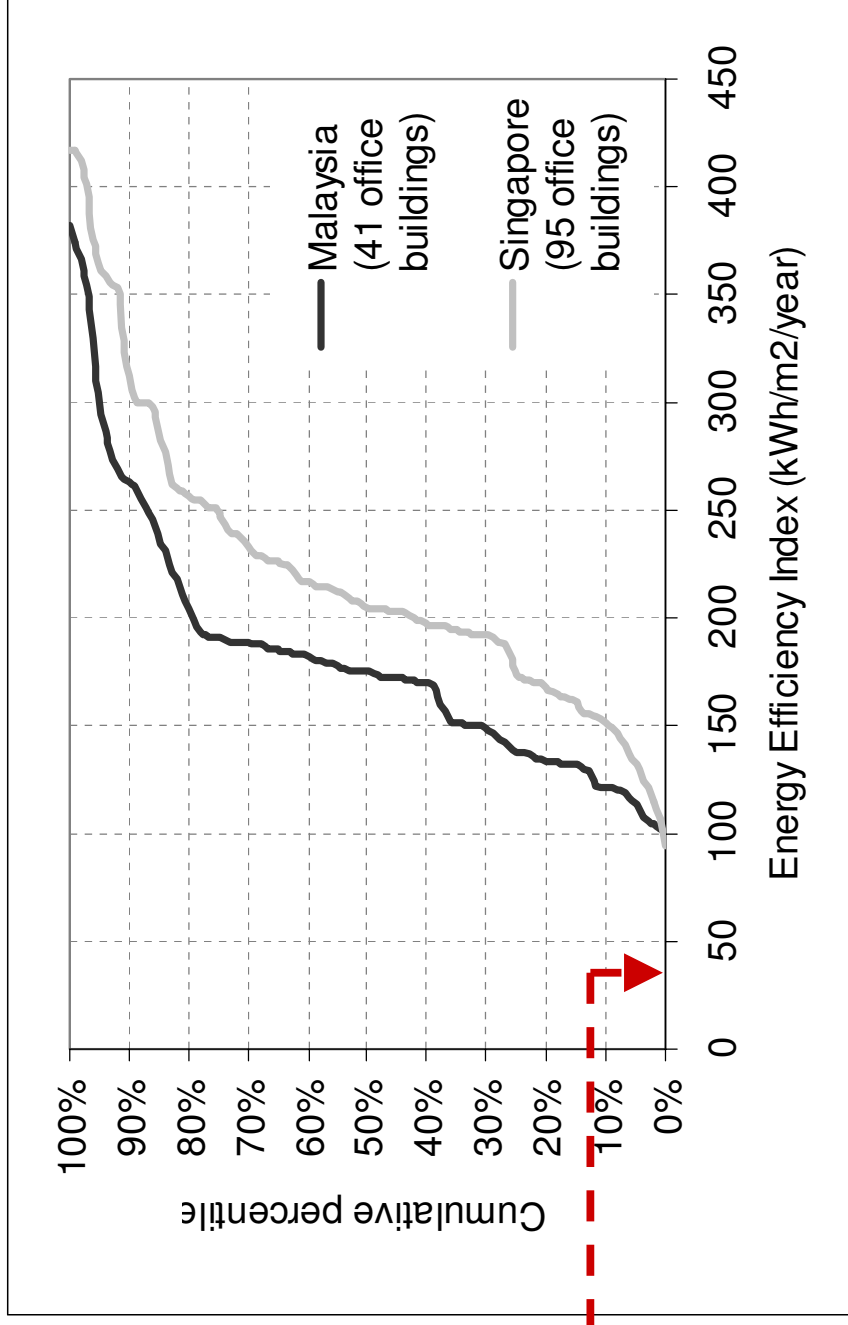
# LEO: Lessons Learned

- Building not air tight  
(1.8 air change rate per hour)
- Some glare issues from window above lightshelf
- Do not over-size UPS  
(efficiency drops to 50%)
- Occupants can be taught to switch off lights upon leaving rooms  
(not open plan offices)



# Case 2: Zero Energy Office (ZEO)

**ZEO Building**  
Zero energy office building  
Malaysia, 2007



Source of chart: **EAEF Project 64**

Project leader: Energy Sustainability Unit, Singapore, 2006



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[www.ien.com.my](http://www.ien.com.my)

“Low Energy Office Buildings, Towards Zero”  
By: Gregers Reimann

ISEAS, Singapore  
22nd June 2007

# Zero Energy Office (ZEO) in Malaysia

## Key data:

- Gross Floor Area: 4,000 m<sup>2</sup>
- Energy Index: 35 kWh/m<sup>2</sup>/year (excl. PV)
- Energy Index: 0 kWh/m<sup>2</sup>/year (incl. PV)
- Additional construction cost: 21% (excl. PV)
- Additional construction cost: 45% (incl. PV)



Malaysian Energy Centre, Bangi, Malaysia (completion July 2007)

## EE Features:

- Daylighting (almost 100%)
- EE lighting + task lights
- EE office equipment
- EE server room
- Floor slab cooling
- EE ventilation
- Controls & Sensors
- Double glazing
- Insulation



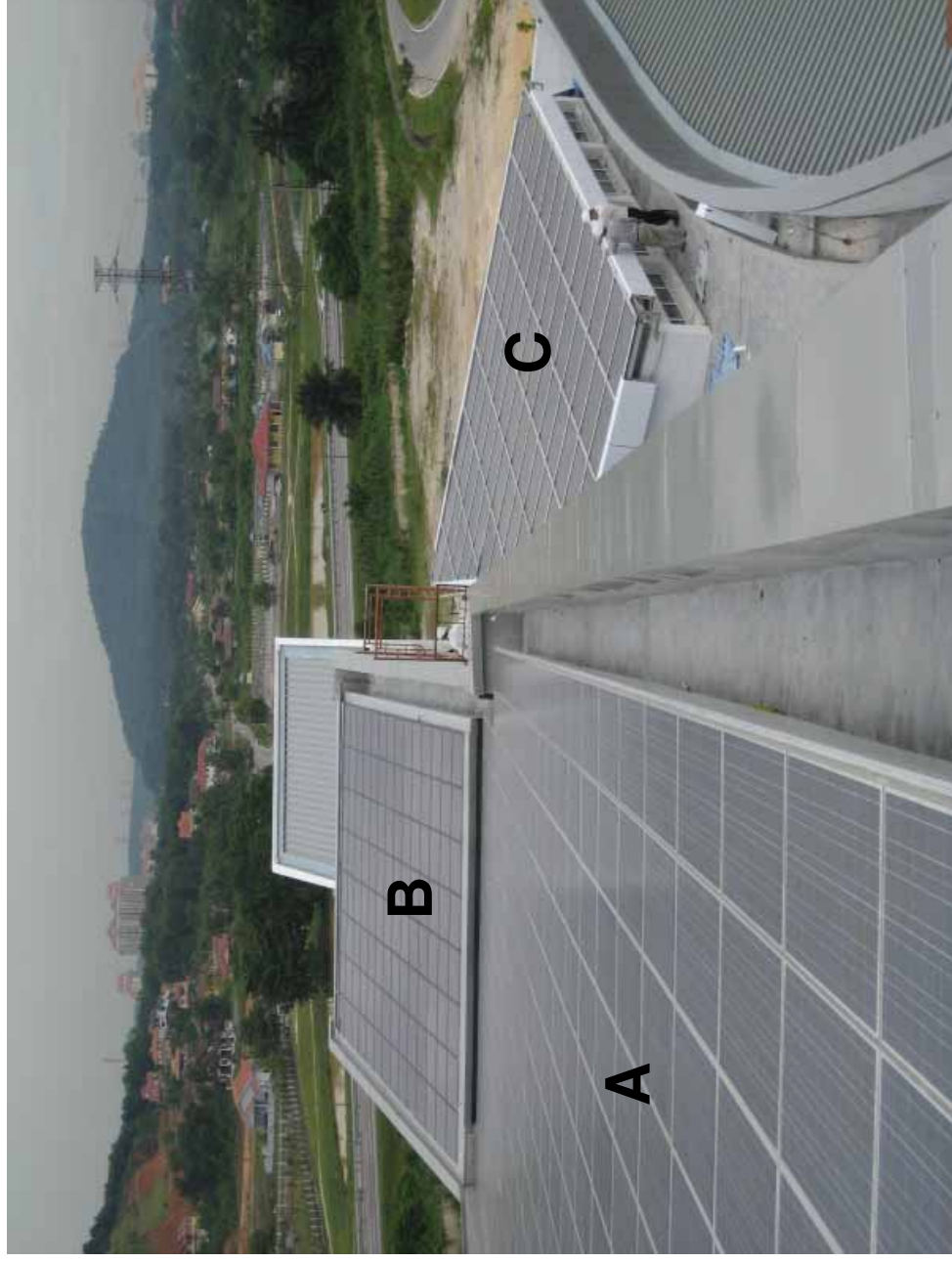
IEN Consultants  
[www.ien.com.my](http://www.ien.com.my)

“Low Energy Office Buildings, Towards Zero”  
By: Gregers Reimann

ISEAS, Singapore  
22nd June 2007

# ZEO: Photovoltaics

- A: 47 kW<sub>p</sub>  
(poly-crystalline)
- B: 6 kW<sub>p</sub>  
(amorphous silicon)
- C: 11.7 kW<sub>p</sub>  
(mono-crystalline,  
see-through)
- D: 27 kW<sub>p</sub>  
(mono-crystalline)



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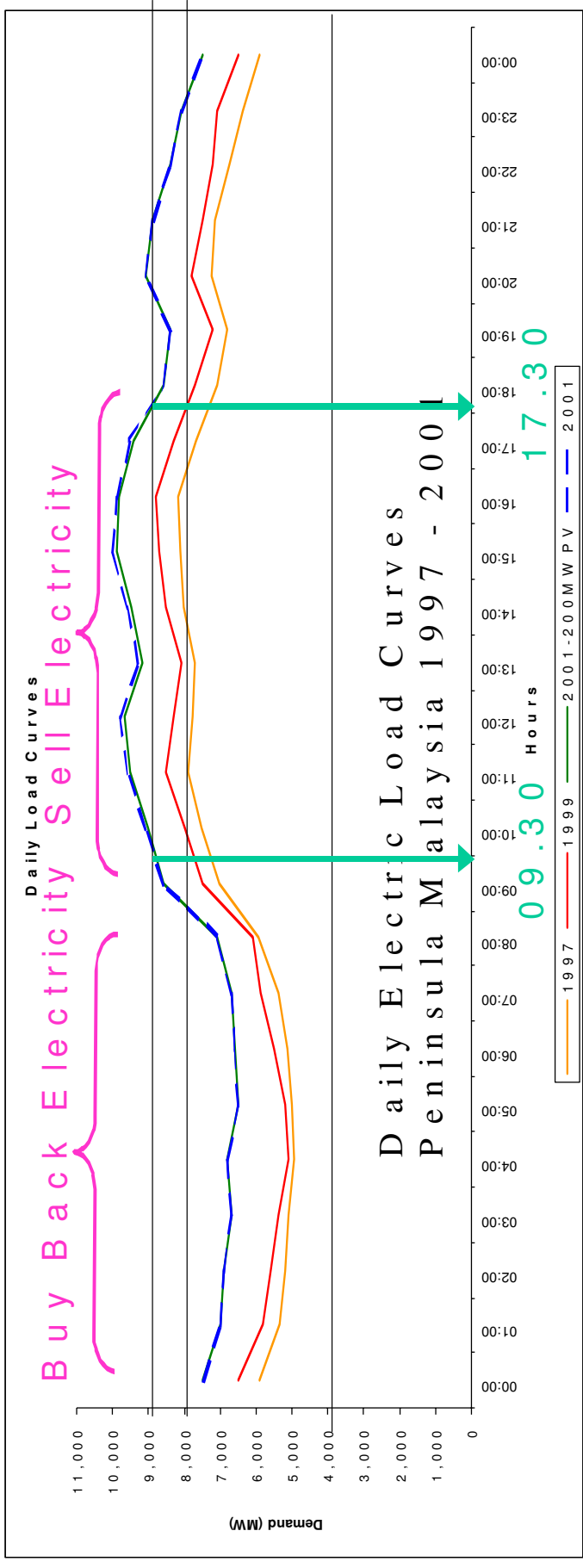
ISEAS, Singapore  
22nd June 2007

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# ZEO: Shifting Load to Night Time



## ZEO Thermal storages:

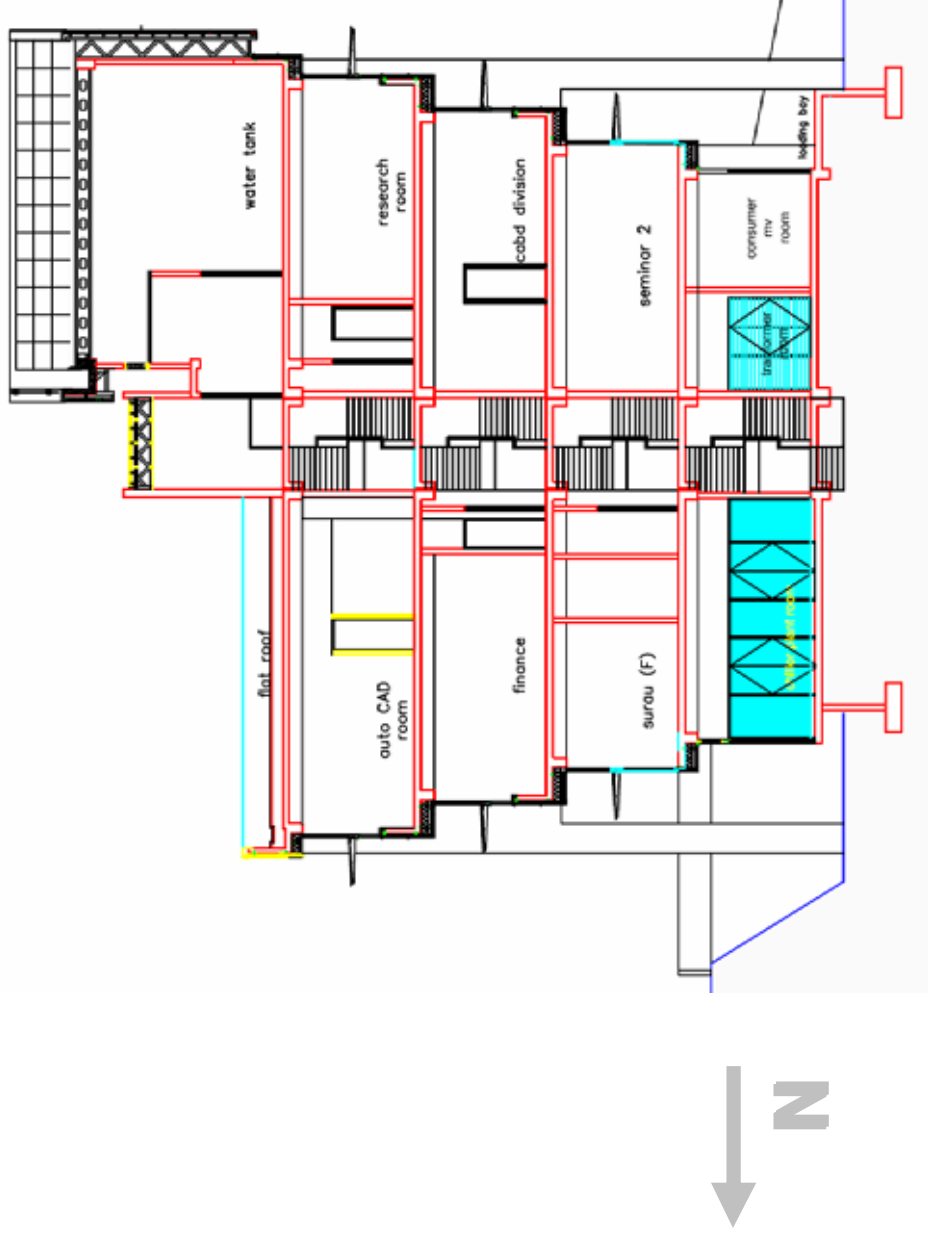
- Floor slab cooling (18 °C)
- Phase Change Material tank (10 °C)

## ZEO photovoltaics

- Area A, B, C and D (91 kW<sub>p</sub>)



# Step-in Design (Self-Shading)



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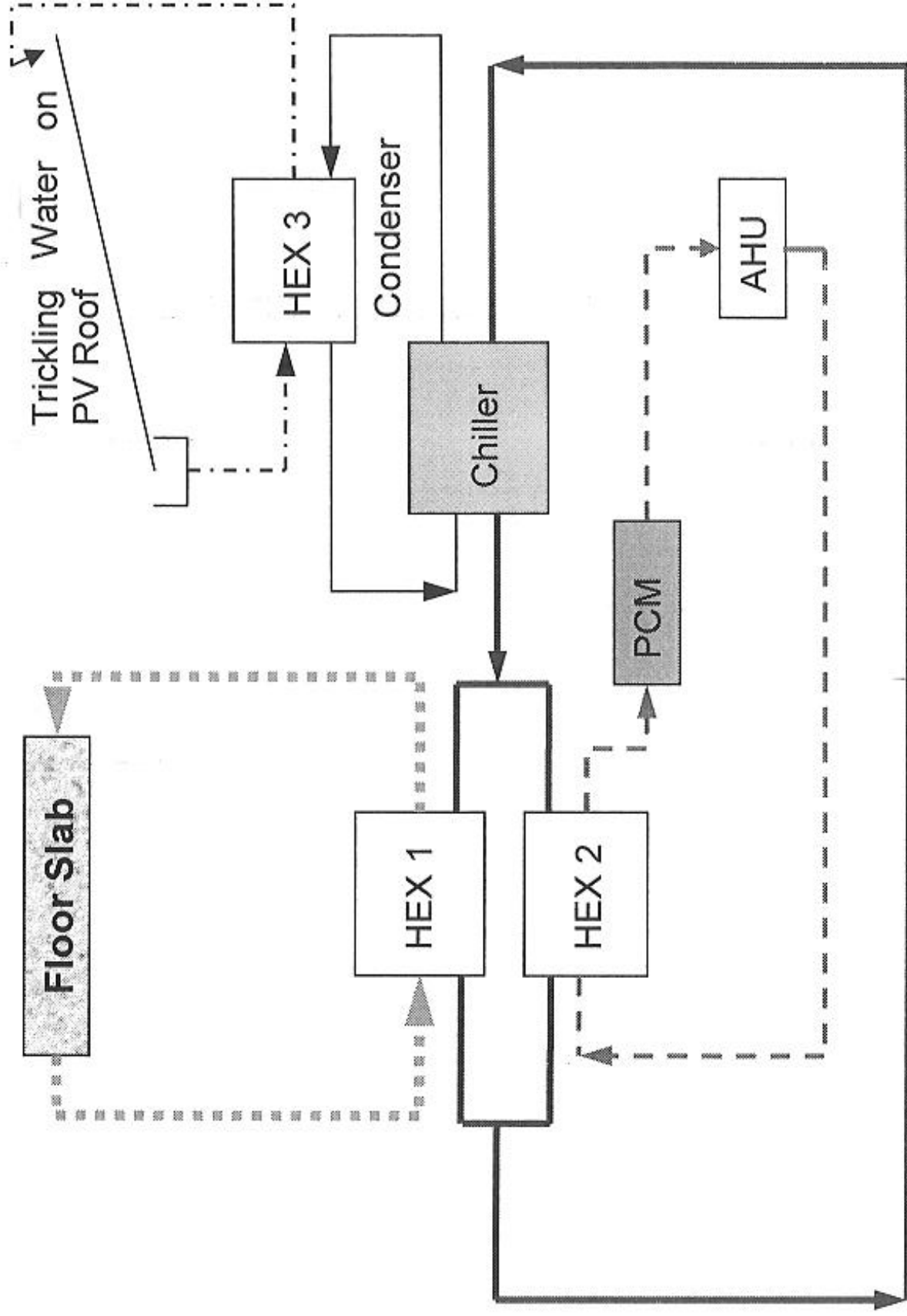
“Low Energy Office Buildings, Towards Zero”  
By: Gregers Reimann

ISEAS, Singapore  
22nd June 2007

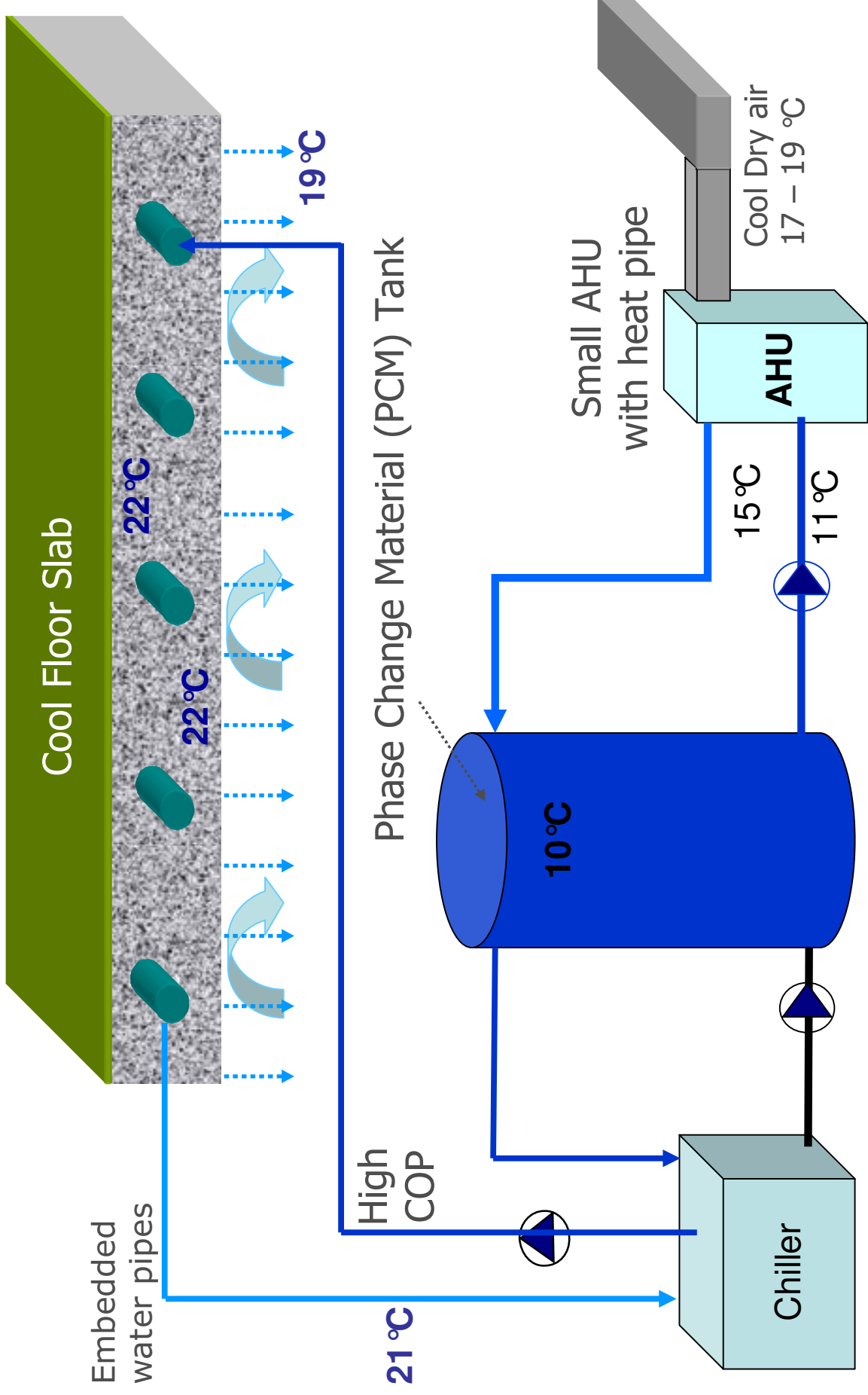
# Typical Section



Schematic of ZEO building Chiller System



# Cooling Storage in Floor Slabs and PCM Tank



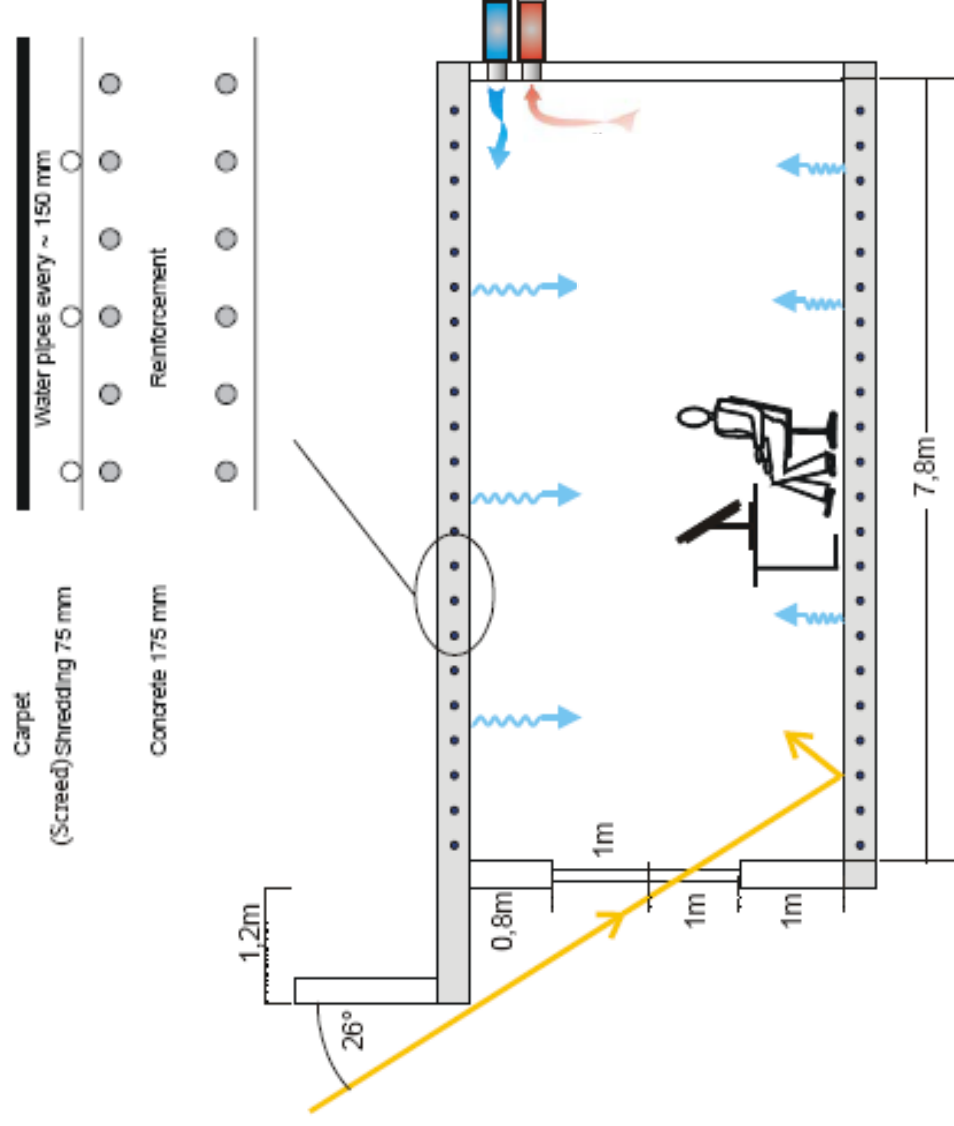
# ZEO: Floor Slab Cooling

- PEX pipes
- Embedded in concrete slab
- Supply temperature: 18-20°C
- Return temperature: 22-24°C
- Night time operation only

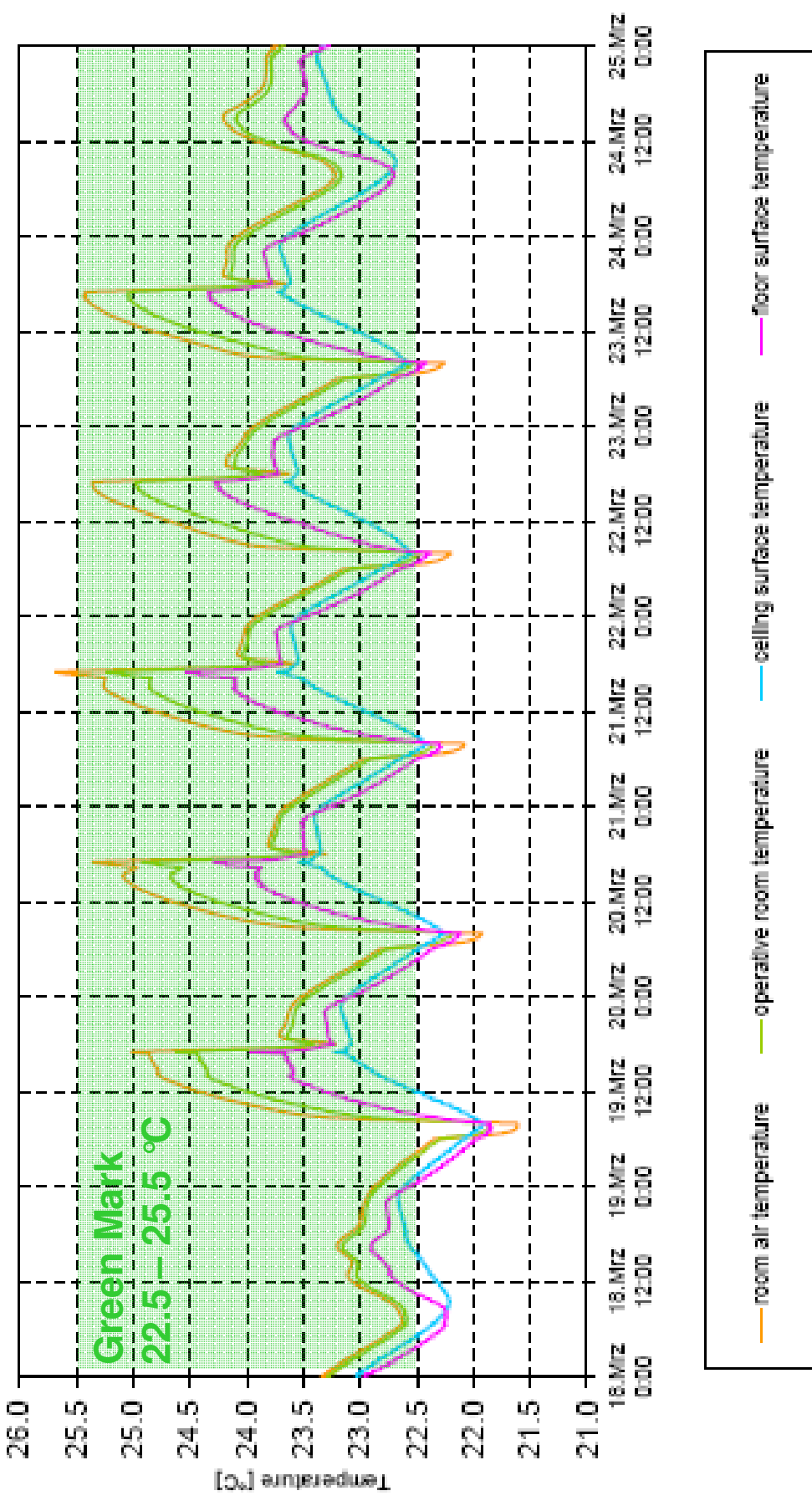


# ZEO: Floor Slab Cooling

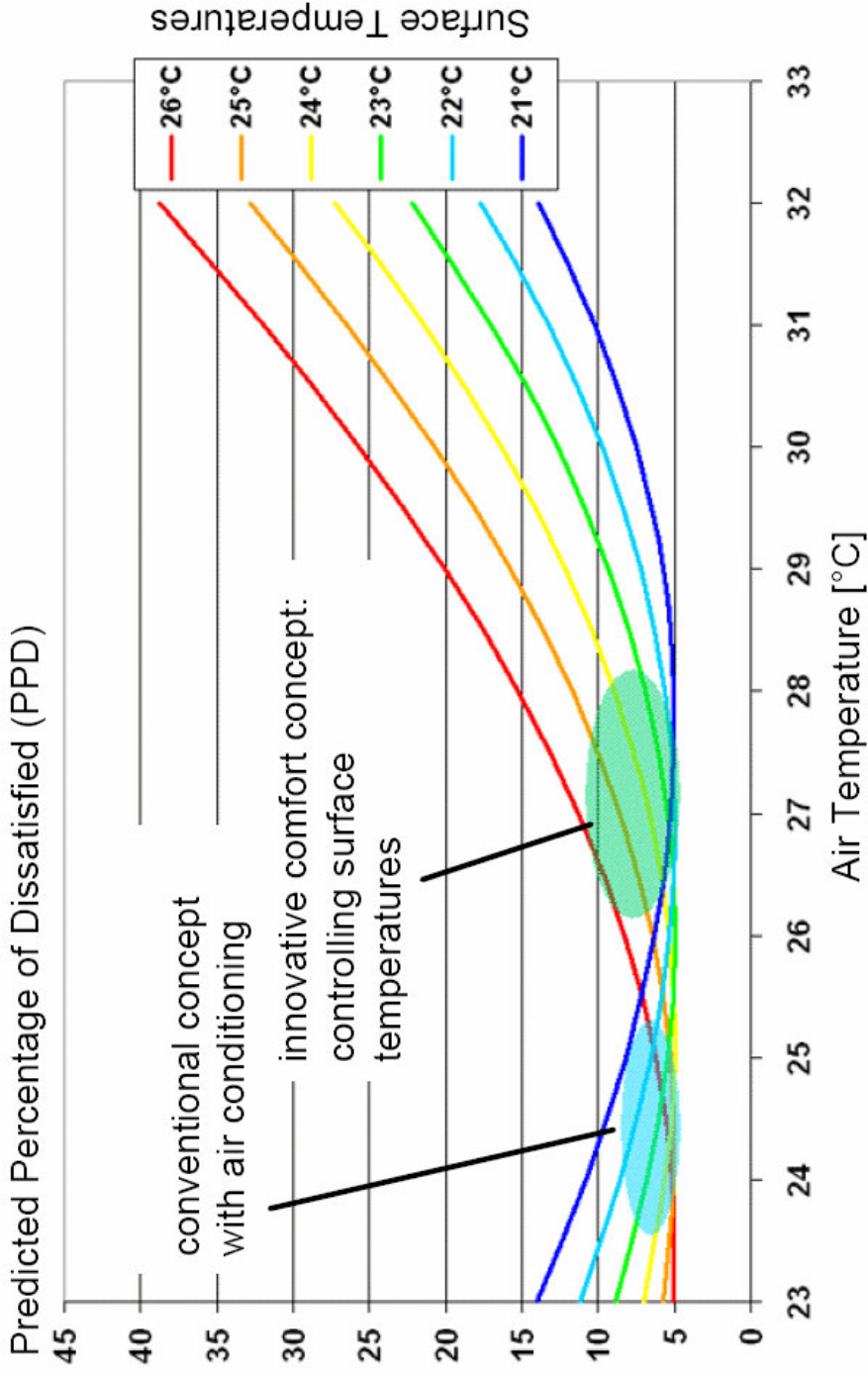
- PEX pipes
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# ZEO: Floor Slab Cooling Simulations



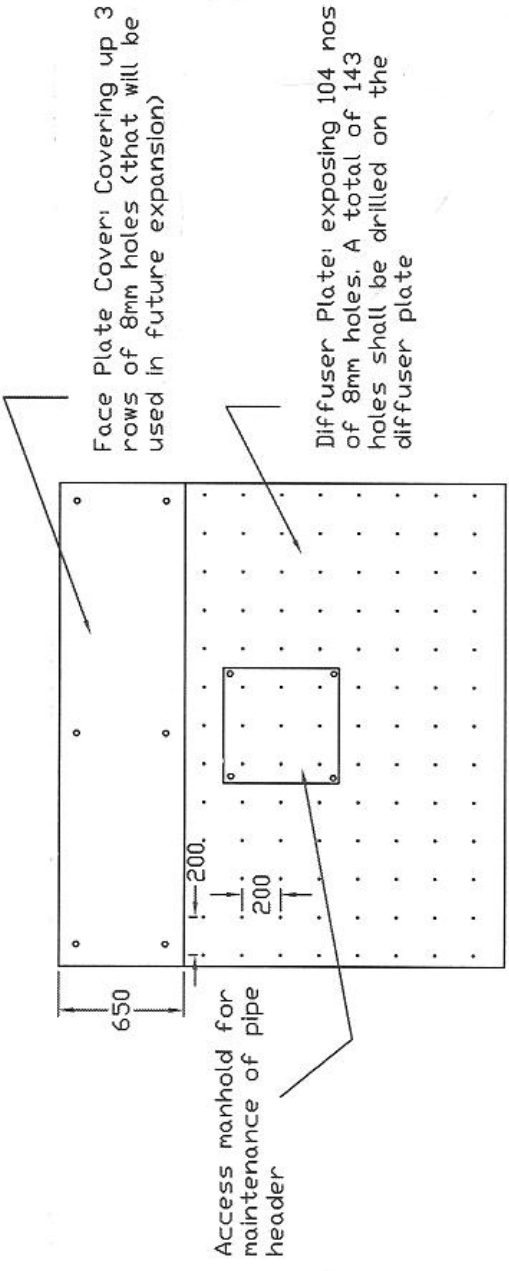
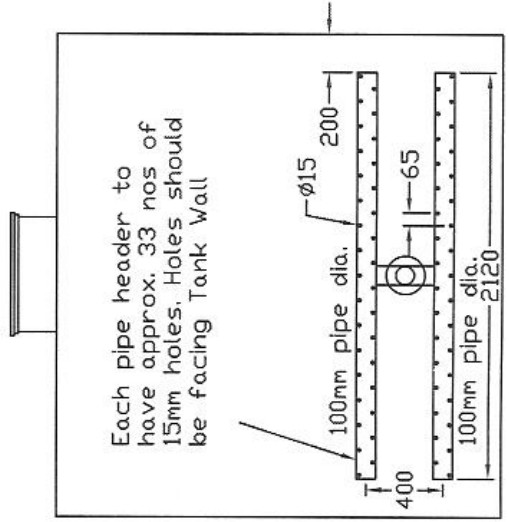
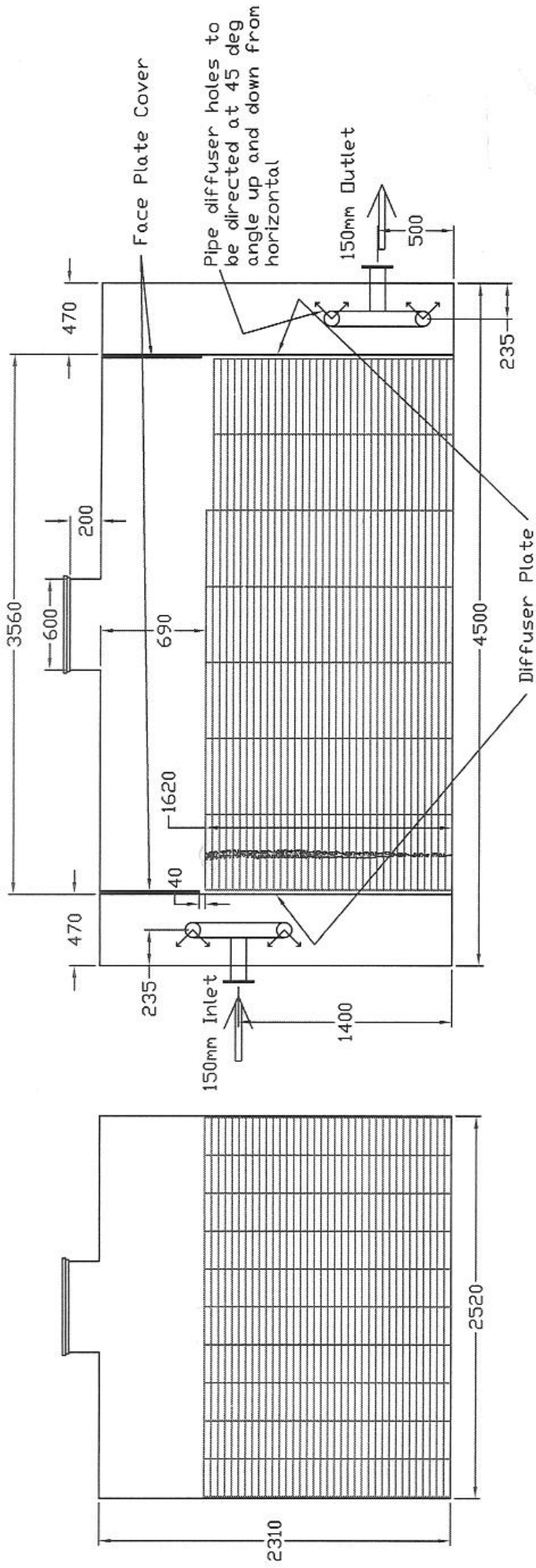
# Floor Slab Cooling allows Higher Air Temperature



Predicted percentage of dissatisfied (PPD) according to Prof. O. Fanger  
 different surface temperatures; no direct radiation  
 office work, light clothing air velocity 0.15 m/s; humidity 11 g/kg



# Existing Setup



# Phase Change Material Tank

- Melting point: 10 °C
- Total storage capacity: 580 kWh
- Charged with 7 °C water (night time)
- Used for dehumidification of air: 19 → 8 g/kg



Dimensions: ~ 3 x 3 x 2.5 meters

# Phase Change Material Tank



By: Gregers Reimann

IEN Consultants



[www.ien.dk](http://www.ien.dk)

7 June 2007

# Water Short Circuiting Issues Inside PCM Tank

- Along the two sides



- Along the top

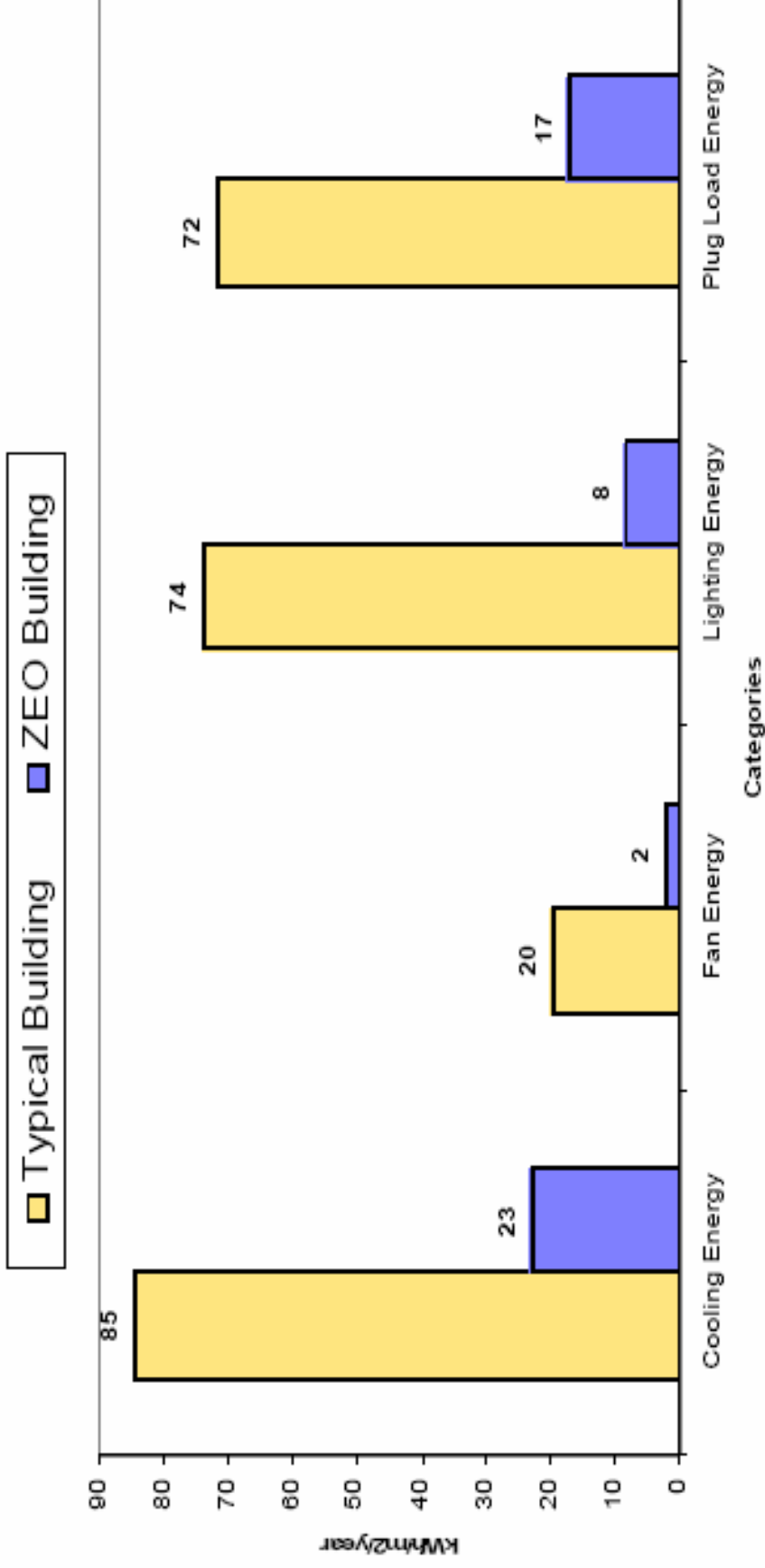


# PCM Tank



# ZEO: Energy Study

Building Energy Index



# ZEO: Energy Study

## Building Cooling Load

