Green Building features

Ministry of Energy, Water and Communication

ZEO - Zero Energy Office Building

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
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)

Source of chart: EAEF Project 64
Project leader: Energy Sustainability Unit, Singapore, 2006
Zero Energy Office (ZEO) in Malaysia

**Key data:**
- Gross Floor Area: 4,000 m²
- Energy Index: 35 kWh/m²/year (excl. PV)
- Energy Index: 0 kWh/m²/year (incl. PV)
- Additional construction cost: 21% (excl. PV)
- Additional construction cost: 45% (incl. PV)

**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

Malaysian Energy Centre, Bangi, Malaysia (completion July 2007)
ZEO: Photovoltaics

- **A**: 47 kW\textsubscript{p} (poly-crystalline)
- **B**: 6 kW\textsubscript{p} (amorphous silicon)
- **C**: 11.7 kW\textsubscript{p} (mono-crystalline, see-through)
- **D**: 27 kW\textsubscript{p} (mono-crystalline)
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ZEO: Shifting Load to Night Time

Daily Load Curves

Daily Electric Load Curves
Peninsula Malaysia 1997 - 2001

ZEO Thermal storages:
- Floor slab cooling (18°C)
- Phase Change Material tank (10°C)

ZEO photovoltaics
- Area A, B, C and D (91 kWp)
Step-in Design (Self-Shading)
Typical Section

- 20°C (concrete slab cooling)
- 22-23°C (ceiling surface)
- 22-23°C (floor surface)
- 24-26°C (air temperature)
- 23 - 24°C (Window surface)

Thermal Comfort: 23°C (operative temperature)

No Glare

Low Noise Level from ventilation

Typical Section

- Direct sun light
- Diffuse light
- Mirror lightshelf
Schematic of ZEO building Chiller System

- Trickling Water on PV Roof
- Condenser
- Chiller
- AHU
- Floor Slab
- HEX 1
- HEX 2
- HEX 3
- PCM
Cooling Storage in Floor Slabs and PCM Tank

Chiller

21°C

High COP

Cool Floor Slab

Embedded water pipes

22°C

19°C

Phase Change Material (PCM) Tank

10°C

Small AHU with heat pipe

17 – 19°C

Cool Dry air

AHU

15°C

11°C

ISEAS, Singapore
22nd June 2007

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

IEN Consultants
www.ien.com.my
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
- Embedded in concrete slab
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ZEO: Floor Slab Cooling Simulations

Green Mark
22.5 – 25.5 °C

Temperature [°C]

room air temperature
operative room temperature
ceiling surface temperature
floor surface temperature
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

- Face Plate Cover: Covering up 3 rows of 8mm holes (that will be used in future expansion)
- Access manhole for maintenance of pipe header
- Diffuser Plate: exposing 104 nos of 8mm holes. A total of 143 holes shall be drilled on the diffuser plate

Each pipe header to have approx. 33 nos of 15mm holes. Holes should be facing Tank Wall.
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.iен.dk
7 June 2007
Water Short Circuiting Issues Inside PCM Tank

- Along the two sides

- Along the top
ZEO: Energy Study

Building Energy Index

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KWh/m²/yr
ZEO: Energy Study

Building Cooling Load

- Heat Gain from Façade (kW):
  - Typical Building: 61
  - ZEO Building: 31

- Heat Gain from Roof:
  - Typical Building: 20
  - ZEO Building: 10

- Q sensible air intake (AC Hours):
  - Typical Building: 25
  - ZEO Building: 7

- Q latent air intake (AC Hours):
  - Typical Building: 75
  - ZEO Building: 18

- People Sensible Heat Gain:
  - Typical Building: 11
  - ZEO Building: 11

- People Latent Heat Gain:
  - Typical Building: 7
  - ZEO Building: 7

- Equip Sensible Heat Gain:
  - Typical Building: 79
  - ZEO Building: 9

- Lighting Sensible Heat Gain:
  - Typical Building: 77
  - ZEO Building: 18

- Fan Sensible Heat Gain:
  - Typical Building: 9
  - ZEO Building: 2