Solar Thermal Systems

Design and Applications in the UAE

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Dubai Knowledge Village Congress Centre, Dubai 20.4.2009
Viessmann Werke

<table>
<thead>
<tr>
<th>Founded:</th>
<th>1917</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headquarters:</td>
<td>Allendorf (Eder) GER</td>
</tr>
<tr>
<td>Products:</td>
<td>Comprehensive product range heating- and climate-technology</td>
</tr>
<tr>
<td>Employees:</td>
<td>8,600</td>
</tr>
<tr>
<td>Turn-over:</td>
<td>1,7 Bil. Euro</td>
</tr>
<tr>
<td>Export Share:</td>
<td>60 %</td>
</tr>
</tbody>
</table>

- Third generation family-owned enterprise
- Among the Top 3 of industry
- www.viessmann.com
Viessmann Headquarter
Allendorf (Eder), Germany 130 km North of Frankfurt
### Comprehensive product range
For all energy sources and all output ranges - 1.5 kW to 20 MW in three program levels

<table>
<thead>
<tr>
<th>Energy sources:</th>
<th>Oil, natural gas, solar, bio energy (wood, biogas), natural heat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output range:</td>
<td>1.5 kW to 20.000 kW</td>
</tr>
<tr>
<td>Range categories:</td>
<td>100 Plus, 200 Comfort, 300 Excellence</td>
</tr>
<tr>
<td>System solutions:</td>
<td>Integrated system components</td>
</tr>
</tbody>
</table>
Viessmann has system solutions for heating, hot water, steam and solar energy applications in housing and commercial projects.
Solar Energy – The power source of the earth

In less than four hours the sun radiates the annual energy demand of the world’s population to the earth.
Solar radiation on the Earth

1360 W/m²

Atmosphere

1000 W/m²
## Solar energy

### Annual energy amount (global radiation)

<table>
<thead>
<tr>
<th>Country</th>
<th>City</th>
<th>Annual energy amount kWh / m² x year</th>
</tr>
</thead>
<tbody>
<tr>
<td>UAE</td>
<td>Dubai</td>
<td>2027</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>Riyadh</td>
<td>1873</td>
</tr>
<tr>
<td>Jordan</td>
<td>Amman</td>
<td>1870</td>
</tr>
<tr>
<td>Syria</td>
<td>Damascus</td>
<td>1862</td>
</tr>
<tr>
<td>Lebanon</td>
<td>Beirut</td>
<td>1734</td>
</tr>
<tr>
<td>Italy</td>
<td>Milano</td>
<td>1241</td>
</tr>
<tr>
<td>France</td>
<td>Paris</td>
<td>1127</td>
</tr>
<tr>
<td>Germany</td>
<td>Frankfurt</td>
<td>1087</td>
</tr>
<tr>
<td>UK</td>
<td>London</td>
<td>899</td>
</tr>
</tbody>
</table>
Solar radiation on the Earth
Utilisation of solar energy in the collectors Output / losses

A  diffused radiation
B  direct solar radiation
C  wind, rain, snow, convection
D  convection losses
E  thermal conduction losses
F  heat radiated by the absorber
G  heat radiated by the glass cover
H  useful collector output
K  reflection

-Diffuse radiation of UAE is more than 40 %

Daily energy values irradiated onto the horizontal plane over a 12 month period
Solar Energy related to buildings

→ Heat

→ Electricity (direct with PV)

→ Solar lighting

→ Concentrated Solar Power

→ Bio Fuels
Solar energy related to buildings
What can we do with the heat? → Heat

- Domestic hot water >80%
- Pool heating
- Heating support in cold climates
- Process heat
- Solar cooling with absorption chillers
- Solar desalination
Solar-thermal: Heat through sunshine

- Vitosol 100/200-F Flat
- Vitosol 200-T tube
- Vitosol 300-T tube-heat pipe
Vitosol 200-F
Flat collector

All round folded aluminium frame
Stable, highly transparent cover made from special glass
“S” patterned copper absorber
Highly effective thermal insulation
Vitosol 200-T
Evacuated tube collector with copper absorber, direct flow

Highly effective thermal insulation
Coaxial distributor pipe
Header
Direct flow Sol-titanium coated absorber
High grade, low ferrous glass
Vitosol 300-T
Evacuated tube collector with copper absorber, heat pipe technology

- Highly effective thermal insulation
- "Dry" connection, no direct contact between carrier and heat transfer medium
- High grade, low ferrous glass
- Duotec twin-pipe heat exchanger with integral overheating protection
- Heat pipe
- Sol-titanium coated absorber
Solar Thermal Collector efficiency

Solar heating system for DHW
Solar heating system for DHW and central heating back-up
Solar heating system for generating process heat / solar air conditioning
Life expectations of solar collectors

20 years +
Life expectations of solar collectors

30 years

35 years
Certificates of solar collectors
Performance & Reliability Test reports according to EN 12975

Report of Performance Test according to EN 12975-2 for a Glazed Solar Collector

Test Centre
Address: Institut für Solarenergieforschung GmbH, Hameln/Emerthaler, Am Ohrberg 1, 31880 Emerthaler, Germany
Contact person: Dipl.-Ing. C. Lampe
Tel.: +49 (0)5151/950-522
Fax.: -500
E-Mail: Pruefstelle@isfh.de

Test Basis
Test according to
EN 12975-2:2006
Section 5

Test Report
Number: 03-06D
Date: 21.06.2006
Number of pages: 20
Date of translation: 25.10.2007

Customer
Address: Viessmann Werke GmbH & Co. KG
Vieisennangasse 1
D-35107 Allendorf
Germany
Contact person: Mr. Sigurd Wenzler
Tel.: +49 (0)6452/2862, Fax.: -5862

Test Collector
Type: Vitosol 200-F
Manufacturer: Viessmann Werke GmbH & Co. KG
Serial- or Prototype: Serial type
Year of production: 2006
Serial number: 718338313499109

Report of Reliability Test according to EN 12975-2 for a Glazed Solar Collector

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Test Basis
Test according to
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Section 5

Test Report
Number: 04-06D
Date: 28.09.2006
Number of pages: 18
Date of translation: 31.10.2007

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Serial number: 7183383613498102
Solar Modernisation of a Hotel Project
MAGIC LIFE
Sarigerme
Güneş Enerjisi
Sistemi
Viessmann'ın
katkılarıyla
Solar thermal hot water generation
Design of a solar thermal system for DHW

1 – Solar collectors, Vitosol
2 – pumping station – Divicon and accessories
3 – Dual mode or multi mode DHW cylinder
4 – Control unit – Vitosolic
5 – Back-up system – oil/gas boiler, electrical or heat pump
Design of a solar thermal system for DHW

- Planning data
- Basic information
- DHW cylinder volume
- Absorber surface area
- Pipe sizing
- Circulation pump (Solar Divicon) sizing
- Expansion vessel sizing
- Vitosol control unit
Design of a solar thermal system for DHW
Basic information for a single house 120 m²

Consumption
A – Room heating requirement of a building
B – Room heating requirement of a low-energy house
C – Hot water required

Gain
D – Solar energy yield with 5 m² of absorber surface area
E – Solar energy yield with 15 m² of absorber surface area
Design of a solar thermal system for DHW

Basic information

The solar system has to be selected for the maximum energy level.

The solar system cannot cover 100% of the consumption.

Realistic value is 60-70% of annual energy demand.
Design of a solar thermal system for DHW
Sample: Buffer tank for solar thermal system – 10000 l/pers/day

Energy needs to be stored => Daily buffer
Design of a solar thermal system for DHW
Hot water demand calculation

<table>
<thead>
<tr>
<th>In domestic homes</th>
<th>DHW consumption $V_p$ in l/(d·person) at a DHW temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>45 °C</td>
</tr>
<tr>
<td>High demand</td>
<td>50 to 80</td>
</tr>
<tr>
<td>Average demand</td>
<td>30 to 50</td>
</tr>
<tr>
<td>Low demand</td>
<td>15 to 30</td>
</tr>
</tbody>
</table>

Max 50 l/pers/day at 60°C  
or  
70 l/pers/day at 45°C

Sample:  
4 pers x 50 l/pers/day = 200 l/day at 60°C or 280 l/day at 45°C
Design of a solar thermal system for DHW
Absorber surface area

Solar radiation ~1000 W/m²
If sun is shining for 6 – 7 hours/day =>
Daily maximum gain 6 – 7 kWh/m²
The DHW temperature 60°C/10°C
The DHW flow: 6/50 = 0.12 m³/(h x m²)

100 l of DHW at 60°C per m² of collector

In our case:
400 l/day / 100 l/m² = 4 m² => 2 collectors Vitosol 200F
Thumb rules

DHW demand: 50 l/pers/day at 60°C

Collector area: 1 m² at 100 l of DHW at 60°C

Buffer tank: 50 l/m² of absorber area
Solar simulation

Solar simulation software
Large scale solar thermal, Example for a 10000 liter/day hot water system
Large scale solar thermal, Example for a 10000 liter/day hot water system

Results of Annual Simulation

<table>
<thead>
<tr>
<th>Description</th>
<th>Value 1</th>
<th>Value 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installed Collector Power:</td>
<td>70,22 kW</td>
<td></td>
</tr>
<tr>
<td>Collector Surface Area Irradiation:</td>
<td>193,60 MWh</td>
<td>2.079,88 kWh/m²</td>
</tr>
<tr>
<td>Energy Produced by Collectors:</td>
<td>124,05 MWh</td>
<td>1.332,75 kWh/m²</td>
</tr>
<tr>
<td>Energy Produced by Collector Loop:</td>
<td>121,10 MWh</td>
<td>1.301,07 kWh/m²</td>
</tr>
<tr>
<td>DHW Heating Energy Supply:</td>
<td>212,38 MWh</td>
<td></td>
</tr>
<tr>
<td>Solar Contribution to DHW:</td>
<td>119 MWh</td>
<td></td>
</tr>
<tr>
<td>Energy from Auxiliary Heating:</td>
<td>110,39 MWh</td>
<td></td>
</tr>
</tbody>
</table>

Electricity Savings: 140,0 MWh
CO2 Emissions Avoided: 93,243,48 kg
DHW Solar Fraction: 51,9 %
Fractional Energy Savings (prEN 12976): 48,9 %
System Efficiency: 61,5 %
Large scale solar thermal, Example for a 10000 liter/day hot water system
Solar hot water generation
closed loop- open loop differences

Closed loop

Thermosiphon

Thermosiphon is the easiest solution:
No power supply, no pump, no control, works everywhere

Advantages of closed loop system:
No tank on collector, architecturally better installation
Hot water resirculation possible, less water losses, no problems with low water quality
Better control, higher efficiency, no over night cooling losses
Best for large scale solar systems
Example: Selection of a Solar cooling system in UAE

**Hot water (Solar panel):**
- Flow rate: 32.5 l/sec
- Temperature: 115 / 103 C
- Capacity: 1590 kW

**Cooling water:**
- Flow rate: 110.0 l/sec
- Temperature: 38 / 43.6 C
- Capacity: 2578 kW

**Chilled water:**
- Flow rate: 48.0 l/sec
- Temperature: 12 / 7 deg C
- Capacity: 1000 kW
Installation examples

Case study –
Green Building, Manchester
Installation examples
Installation examples

Vacuum tube collectors on a vertical surface
Installation examples
Solar panels as shading elements for the building
Installation examples in UAE
Jebel Ali Process heating system

Solar Absorber gross surface area: 300 m²
Energy produced by collectors: 376,4 MWh/year
Diesel savings: 48 100 liters/year.
CO₂ emissions avoided: 132 500 kg
Application: Process heat for hot water loop at manufacturing plant

Installed by Value Addition FZE
Installation examples in UAE
Jebel Ali Process heating system
Installation examples in UAE
Palm Jumeirah Residential buildings solar hot water system

Solar Absorber gross surface area:
14 x 200 m² (2800 m²)
Energy produced by collectors: 3805 MWh/year
Natural gas savings: 471000 m³/year.
CO₂ emissions avoided: 1 070 000 kg
Backup system Gas fired wall hung condensing boilers

Installed by Value Addition FZE
Installation examples in UAE
Palm Jumeirah Solar Energy System

Viessmann Flat Solar Thermal Panels with original support system and connection pipes
Installation examples in UAE
Palm Jumeirah Solar Energy System

Viessmann Domestic Hot Water cylinders

Viessmann Gas condensing boilers for the backup of the system (109 % efficiency)
Installation examples in UAE
Solar Energy System for villa’s in Jumeirah

Solar hot water system with electric backup
Installation examples in UAE
Al Quoz Solar Energy System labour camp

Operational since 2000
Solar energy needs good engineering design and installation to reach the goal!

Together with the design of renewables check the energy saving potential!

Saving + renewable = Target
Vitocal 160-A
Air source heat pump for DHW heating 1,52 kW, 285 liters

Sample Calculation: 300 liters/day hot water

1. Electrical heater
Q = 300 x (60-10)/860 = 17,5 kW
Daily loss 1 kW
Electric consumption: 18,5 kW

2. Vitocal cylinder with heat pump
Q = 18,44 kW required electricity 5,2 kW
Cooling inside approx 17 kW
Saving at the AC of housing 5,7 kW
Electric consumption:
5,7-5,2 = - 0,5 kW

SAVING = 18,5 +0,5 = 19 kW
Annual expected saving 6840 kWh

(Max connected electrical load 500 W)
Vitocal 160-A in combination with solar energy

Max electrical load 500 W for a villa instead of 5-6 kW of electrical heaters
Questions ?