Energy efficiency in industrial buildings

Impact of high efficiency radiant panels on energy consumption

Presentation of
FRENGER SYSTEMEN BV
by Dr.-Ing. Klaus Menge

Who is FRENGER?

FRENGER SYSTEMEN BV
An international leader in radiant heating

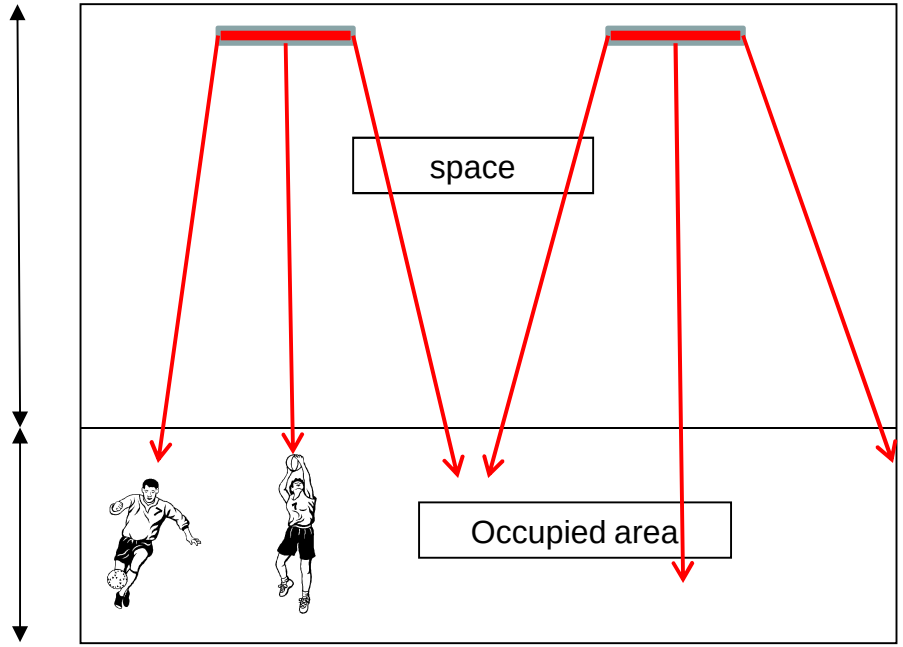
- Gunnar Frenger developed radiant heating systems in the 1940s
- FRENGER SYSTEMEN BV was founded 1953
- FRENGER`s core business = Energy efficiency by radiant heating systems
- Internationally recognized leader
- The company sells heated and chilled ceilings throughout Europe and other parts of the world
- FRENGER SYSTEMEN BV has installed more than 6,800,000 m² of heated and chilled ceilings since1953

Basics – working principle

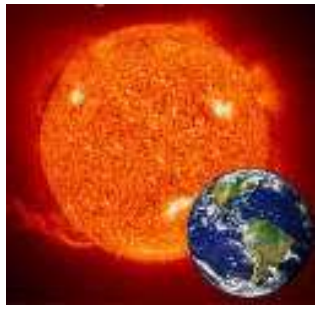
Where is heat required?

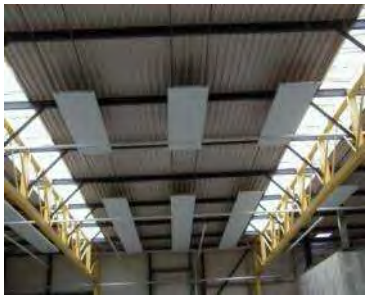
In the occupied area of a room!

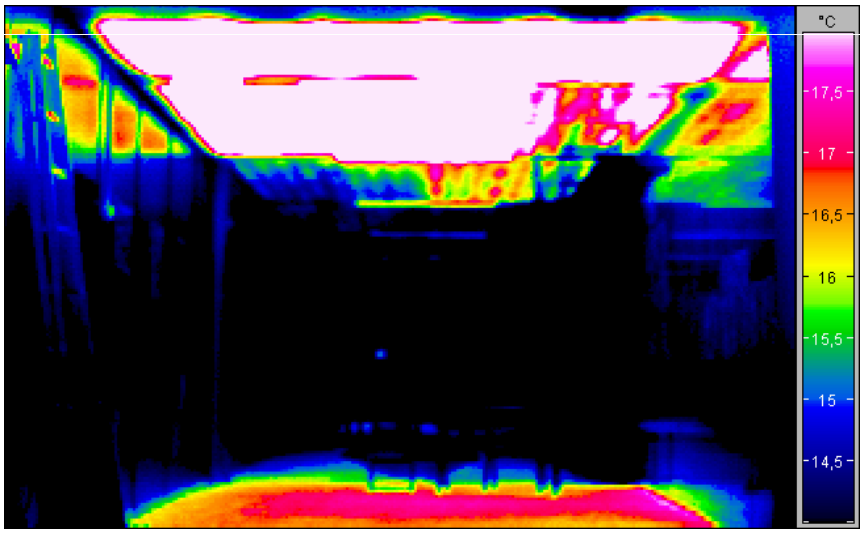
Radiant heat is reaching down!

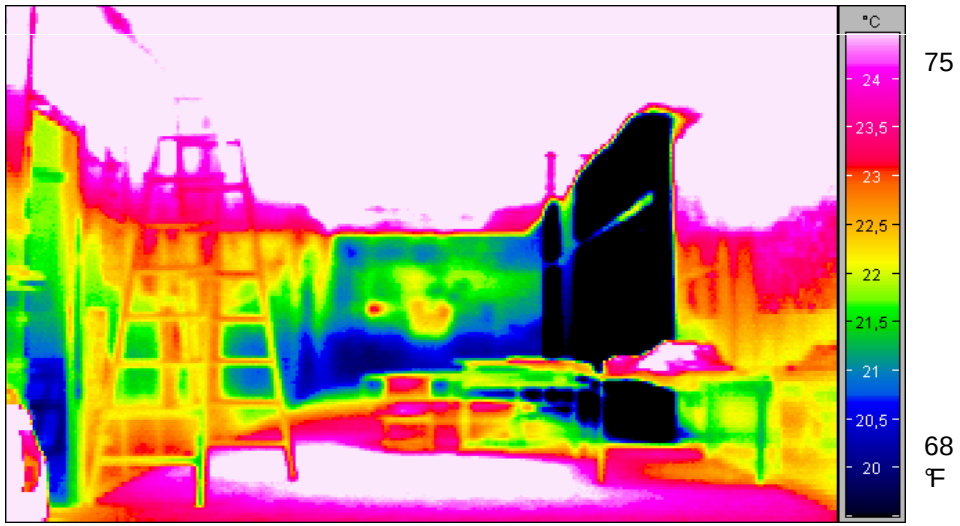


Basics – working principle



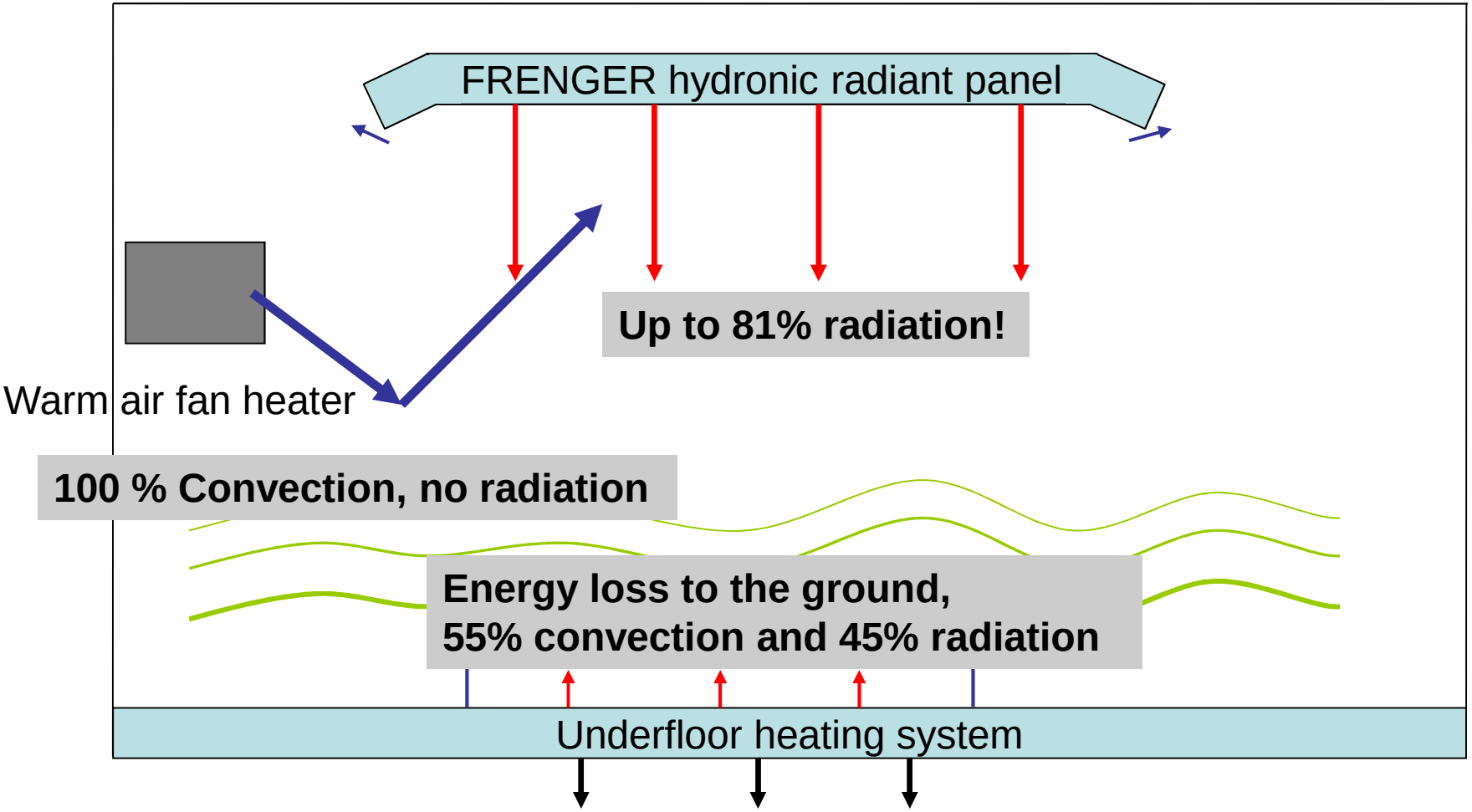






Thermographical images of warming-up-procedure of heated ceiling and room after 15 and 40 min

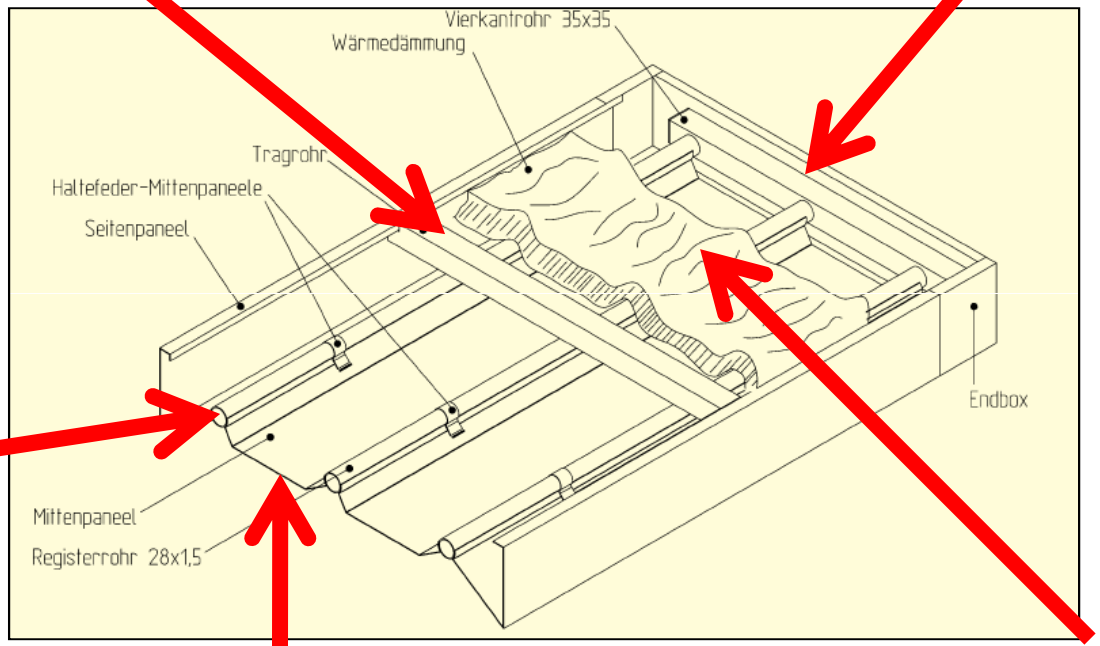
Basics – working principle



Basics – working principle

Stiffeners and mounting elements

Manifolds for flow and return connections



Tubes with heated water

Heated surface which emits infrared heat

Encapsulated backside insulation to prevent heat loss

You will find a sample of the hydronic radiant panel in the exhibition!

Product benefits

Advantages of FRENGER ceiling panels:

- ✓Energy savings of up to 50%
- ✓Rapid warming up
- ✓Maintenance free – no moving parts
- ✓Noiseless – no fans
- ✓Life expectancy > 30 years
- ✓Hygienic - no air movement
- ✓Easy to install - for new and existing buildings
- ✓Very lightweight
- ✓No replacement of concrete floor

Case Study

FRENGER SYSTEMEN BV

Gymnasium (building erected in1968):
Retrofit carried out in 2006:

Length: 42,75 m / 141 ft
Width: 21,68 m / 72 ft
Height 7,21 m / 24 ft
Ground floor area 927 m² / 10152 sq. ft.
Room temperature 20℃ / 62 ℉

Energy consumption before retrofit with forced air heating system:

Heating (average) 200.222 kWh / a = 683 MBTU
Electricity for heating (average) 25.648 kwh / a = 87 MBTU

Case Study

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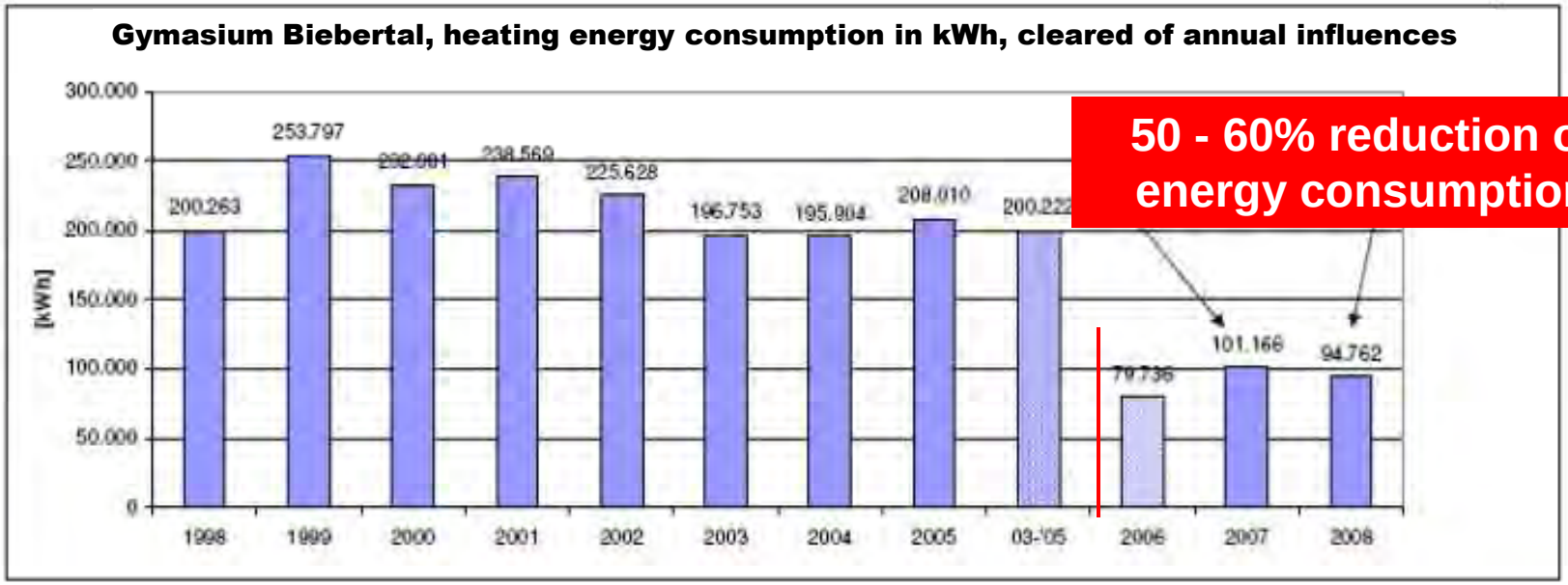
Gymasium Biebertal, energy consumption in kWh

Zähler	absoluter Verbrauch												absolut	witter.
FZ-SH-233	Januar	Februar	März	April	Mai	Juni	Juli	August	September	Oktober	November	Dezember	Summe	Summe
1998	37.690	29.632	21.540	13.036	3.918	3.974	3.478	3.330	5.671	12.063	29.044	21.137	184.513	200.263
1999	22.495	73.033	22.335	7.110	5.394	3.966	2.121	3.509	961	14.261	30.352	32.436	217.975	253.797
2000	33.754	30.331	26.194	11.955	3.974	3.408	4.729	0	6.056	13.297	26.448	34.708	194.856	232.881
2001	40.125												221.298	238.569
2002	36.367												197.963	225.628
2003	35.831												181.074	196.753
2004	34.317												186.619	195.904
2005	35.968	48.044	35.870	5.807	6.362	4.589	1.671	1.847	2.614	4.190	20.290	25.679	192.961	208.010
03-'05	35.372	36.172	25.514	7.878	6.196	3.546	2.888	1.841	3.609	10.141	22.314	31.410	186.881	200.222
2006	16.622	5.970	5.484	3.633	7.052	2.082	720	530	1.060	3.170	15.510	13.176	75.209	79.736
2007	14.974	15.000	11.898	2.692	2.020	1.727	1.203	930	2.206	6.735	16.015	14.857	90.259	101.166
2008	15.479	14.751	10.969	6.878	1.547	755	95	952	1.680	5.951	13.520	16.139	88.716	94.762

Energy consumption (heating) before(forced air system) and after retrofit (FRENGER high efficiency radiant heating system)

Gymasium Biebertal, heating energy consumption in kWh, cleared of annual influences



50 - 60% reduction of energy consumption

683 MBTU -> 270 MBTU/year

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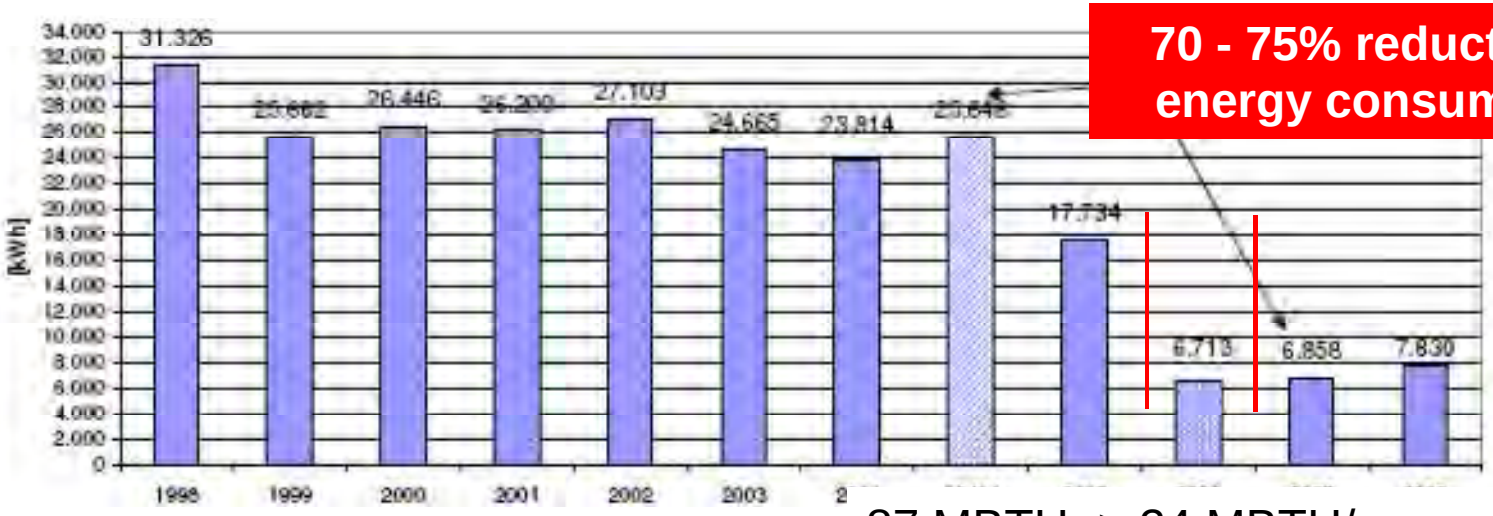
Gymasium Biebertal, energy consumption in kWh

SZ-SH-352	Jan	Feb	Mrz	Apr	Mai	Jun	Jul	Aug	Sep	Okt	Nov	Dez	Summe
1998	4.407	4.268	3.762	2.104	2.124	2.055	2.124	2.124	2.055	2.124	2.055	2.124	31.326
1999	2.291	4.157	3.072	1.367	1.558	727	488	881	1.850	2.053	3.959	3.259	25.662
2000	3.570	3.371	3.116	1.853	1.105	424	407	837	1.175	3.185	4.404	2.999	26.446
2001	3.527										3.761	3.542	26.200
2002	4.043										3.850	3.321	27.103
2003	3.788										3.812	3.697	24.665
2004	4.612										3.336	2.154	23.814
99-'04	3.639	3.607	3.166	1.587	1.288	573	504	506	1.295	2.289	3.854	3.162	25.648
2005	2.798	2.849	2.448	954	663	409	415	124	638	515	3.350	2.571	17.734
2006	911	205	732	839	264	357	249	167	445	528	1.141	875	6.713
2007	715	878	532	261	317	277	189	259	675	607	1326	822	6.858
2008	1.065	992	731	561	322	202	139	425	649	587	1177	980	7.830

Energy consumption (electricity for heating - fans) before (forced air system) and after retrofit (FRENGER high efficiency radiant heating system)

Gymasium Biebertal, electrical energy consumption in kWh of heating system



70 - 75% reduction of energy consumption

87 MBTU -> 24 MBTU/year

Case study

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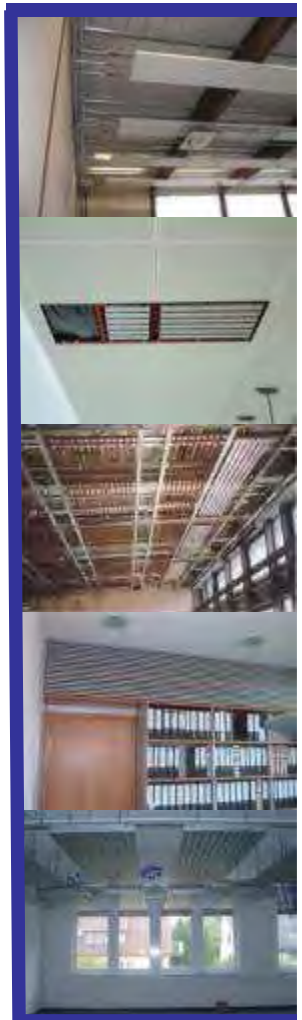
US ARMY GARRISON „WIESBADEN“
Wiesbaden Army Airfield Hangar 1035



Original situation – heated by forced air

Case study

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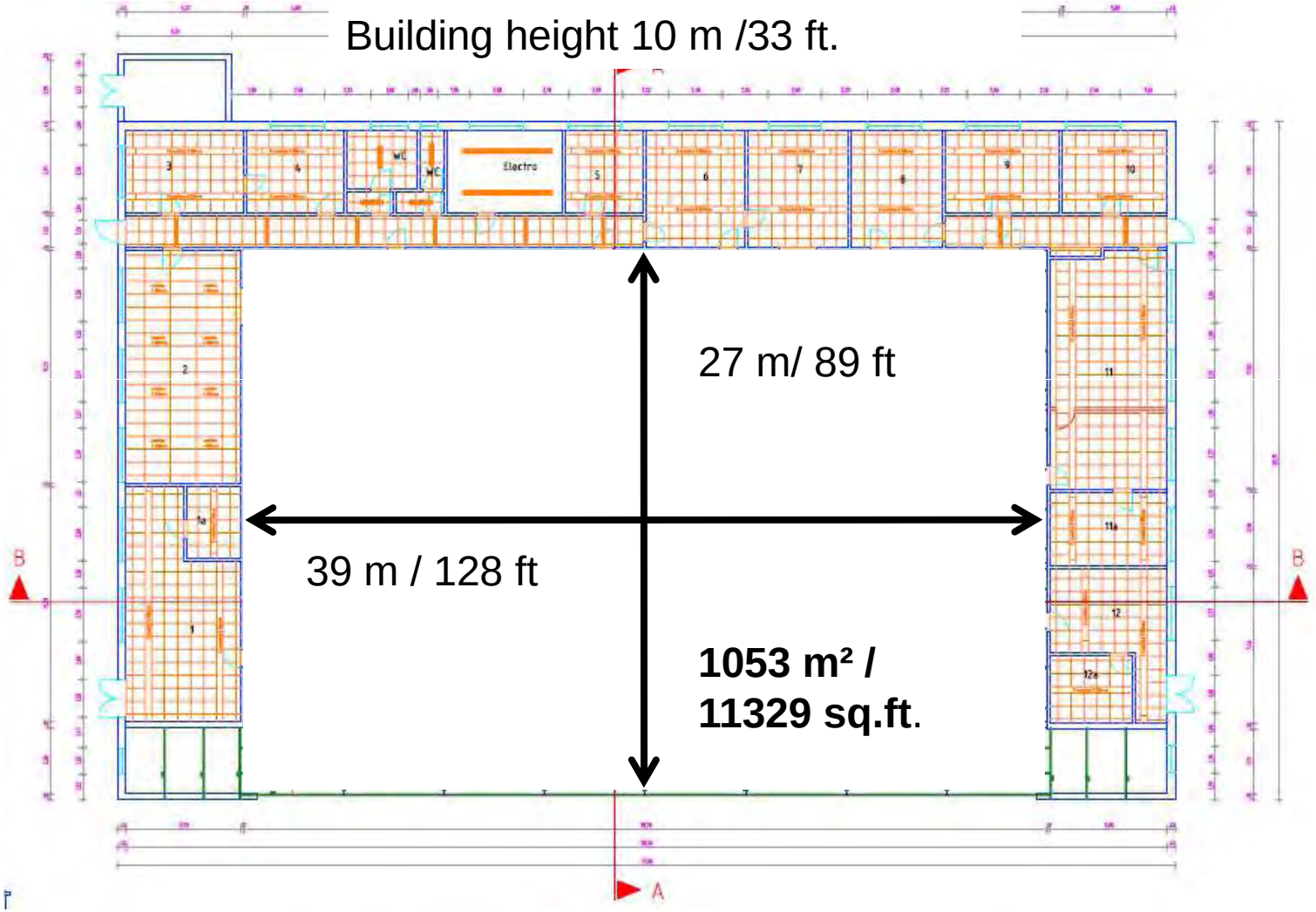
Building height 10 m /33 ft.



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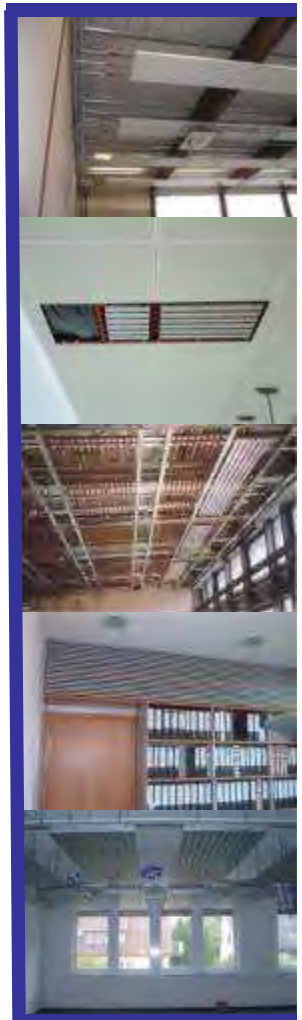


6 warm air fan heaters

38 kW/13,000 BTU/h heat capacity each
→ 228 kW /779,000 BTU/h in total

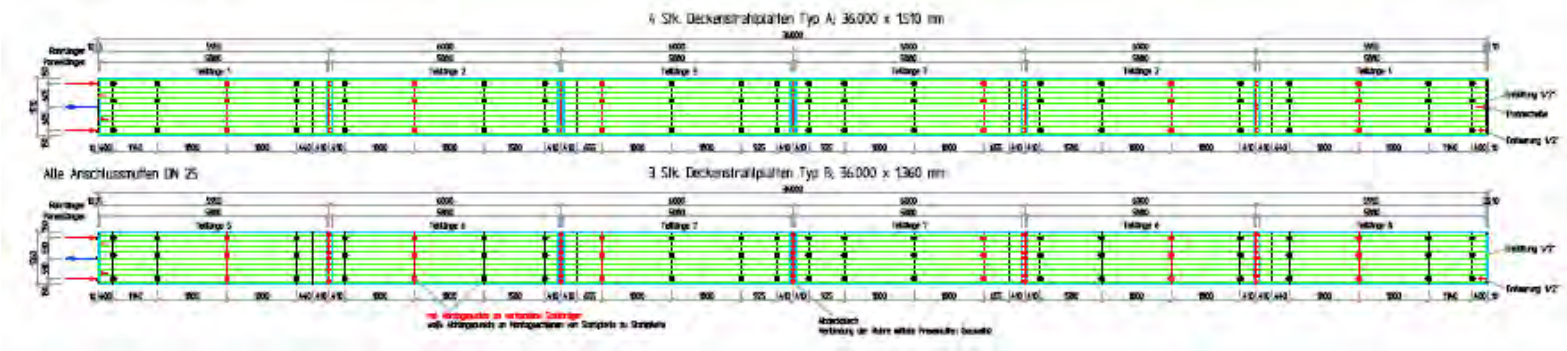
Fan power: 0,35 kW /1,20 BTU/h each
→ 2,1 kW/7,200 BTU/h in total

Waste of Energy!

WAAF – Hangar 1035
FRENGER high efficiency radiant panel

Case study

FRENGER SYSTEMEN BV



7 panel runs in total – 36 m/119 ft. Long

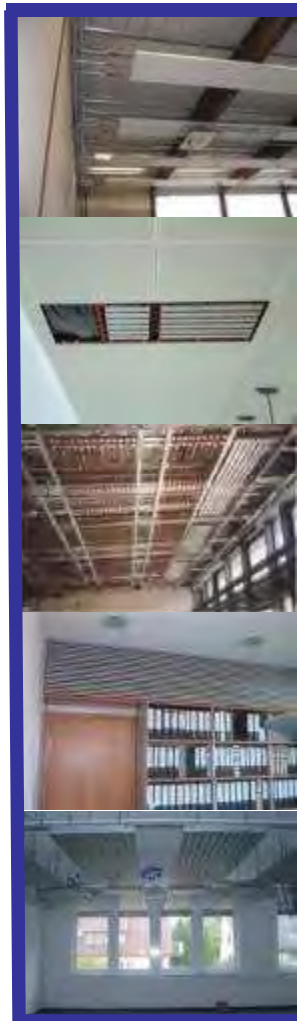
Installed heat capacity: 148 kW/505,000 BTU/h
forced air was 228 kW/778,500 BTU/h

FRENGER high efficiency radiant panels:
- **40% lower heat capacity!**
- **Indoor temperature of 20℃/68℉ (at -15℃/5℉ outside)**

WAAF – Hangar 1035
FRENGER high efficiency radiant panel

Case study

FRENGER SYSTEMEN BV



WAAF – Hangar 1035
FRENGER high efficiency radiant panel

Case study

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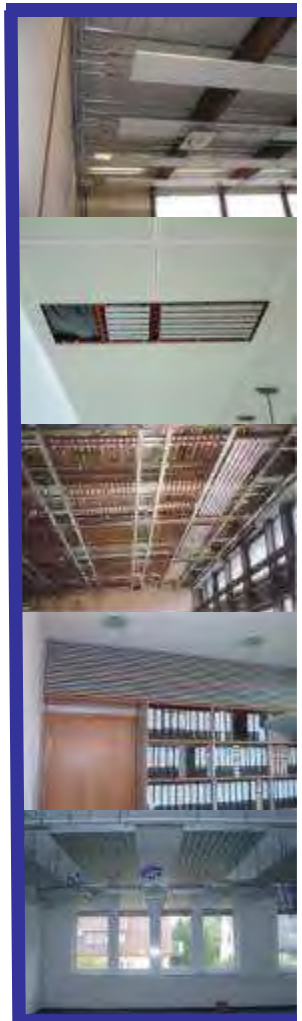
Results - costs

- FRENGER high efficiency radiant panels including supporting steel beams, modification of pipework, new controls

  90,000.00 € // 126,000 USD

- Replacement of forced air:

  20,000.00 € // 28,000 USD



Case study

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Results - savings

Savings of FRENGER radiant panels

- Heating: 15,087 €/year (21,122 USD/year)
- Electricity: 4,392 €/year (6,148 USD/year)
- Maintenance: 350 €/year (490 USD/year)

Total savings of FRENGER radiant panels:

19,829 €/year // 27,761 USD/year

Total reduction CO_2: 49,435 kg/year

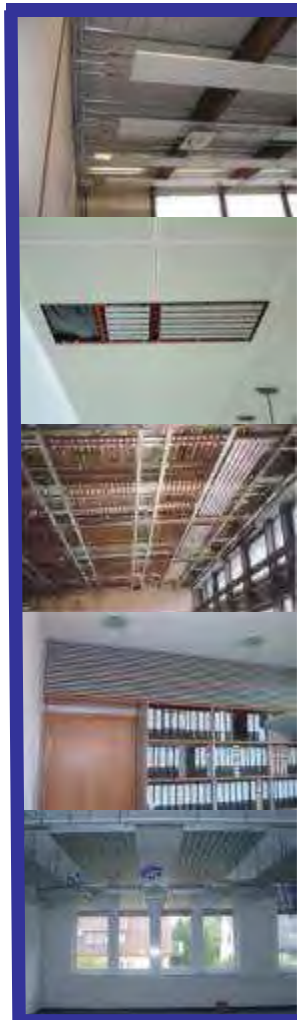
Payback period: 4.1 years

WAAF – Hangar 1035
FRENGER high efficiency radiant panel

Case study

FRENGER SYSTEMEN BV

US ARMY GARRISON „Ansbach“
Hangar 5807



Original situation – heated by forced air

Case study

FRENGER SYSTEMEN BV

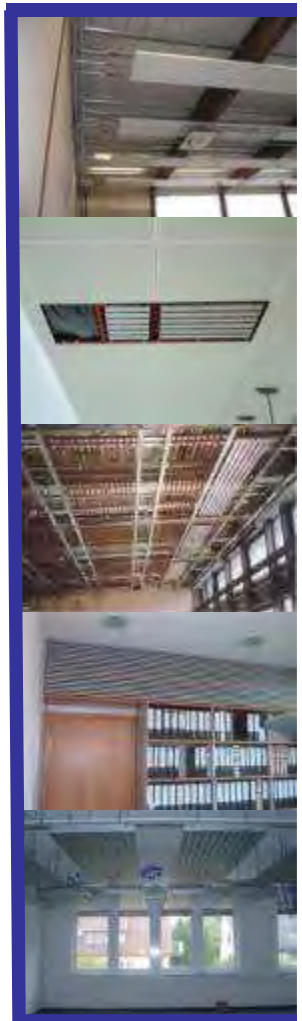
Tasks:

1. Increase energy effciency
   High energy consumption due to high air exchange rate

   →Reduce energy consumption

2. Increase thermal comfort
   Room was quite cold due to huge doors/ air exchange rate

   → Create 18 ℃/64.4℉ room temperature

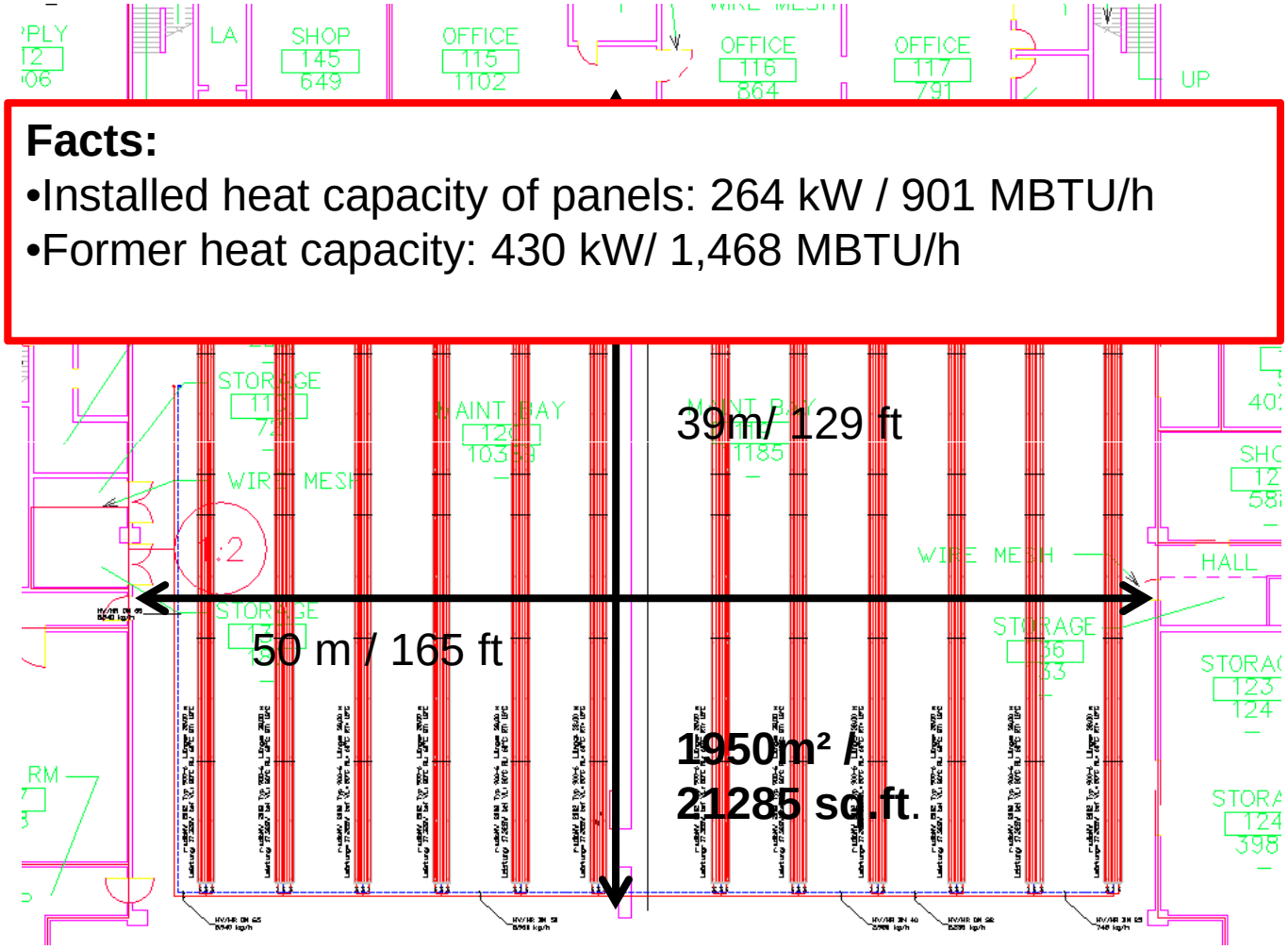


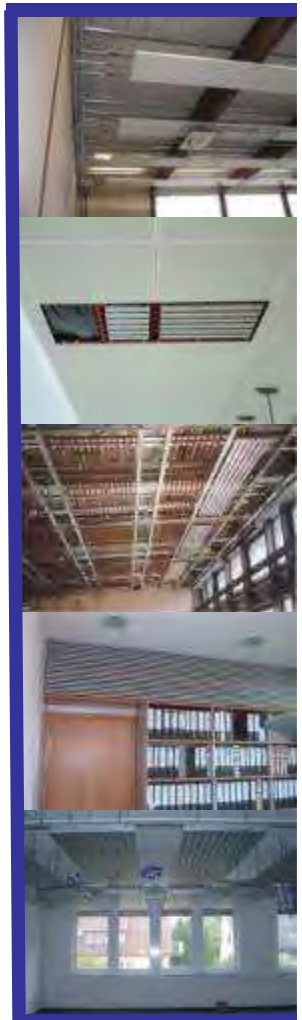
Case study

FRENGER SYSTEMEN BV

Facts:

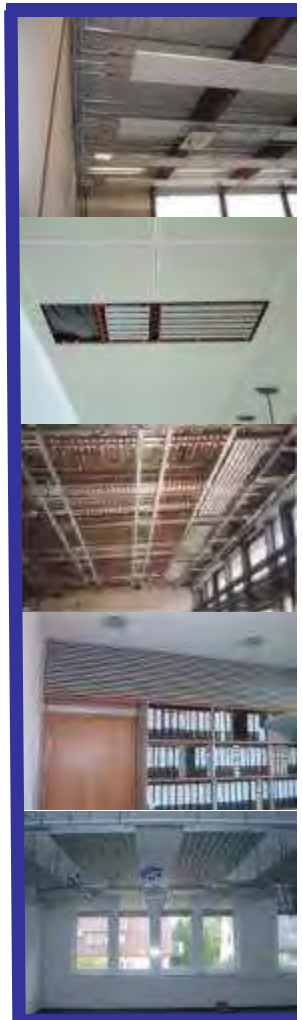
- Installed heat capacity of panels: 264 kW / 901 MBTU/h
- Former heat capacity: 430 kW/ 1,468 MBTU/h





Case study

FRENGER SYSTEMEN BV



After retrofit – heated by high efficiency radiant panels

Case study

FRENGER SYSTEMEN BV

Results - savings

Savings of FRENGER radiant panels

- Heating: 23,680 €/year (34,809 US
- Electricity: 7,602 €/year (11.1
- Maintenance: 750 €/yea

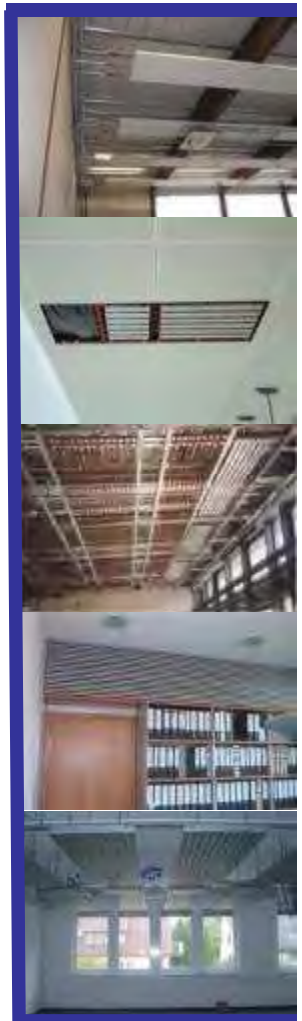
Total saving… …adiant panels:

… // 47,087 USD/year

Total …duction CO_2: 105,063 kg/year

Payback period: 4.4 years

These results have been awarded !



Ansbach/Katterbach Hangar 5807
FRENGER high efficiency radiant panel

Case study

FRENGER SYSTEMEN BV

Offical press release:
Our local DPW Utility Engineer and Energy manager **Regina Kranz recently earned the individual award for innovative new technology during FY 2010**.

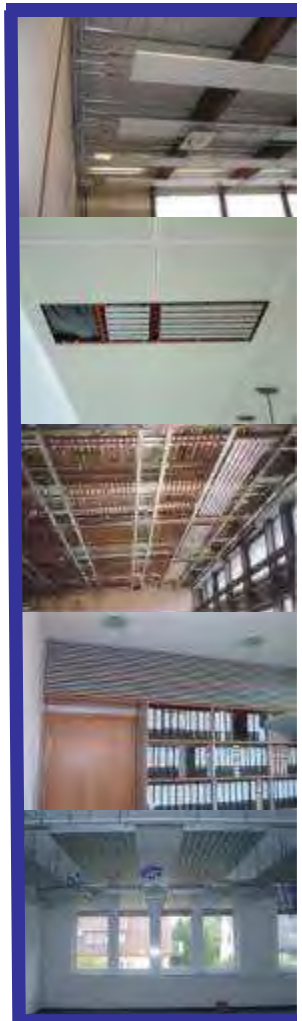
She received the award at the 33rd Annual Secretary of the Army, Energy and Water Management Awards Ceremony in Cincinnati, Ohio.

Her innovative idea is expected to save USAG Ansbach some $2.2 million over their life span of some 20 years.

Her idea: Replacing old blower heating systems with new water circulating, energy efficient and also maintenance-free radiant heating systems in four Hangars at the Katterbach Army Airfield.

The new heating system will help the Army to reinforce the importance of meeting the Army's energy reduction goal, as well as comply with federal U.S. and German energy and water conservation goals.

She is already working on her next project: A heating systems for three hangars on Storck Barracks, at Illesheim



Case study

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Building 144 Vilseck/Grafenwöhr

Jürgen Alex from USAG Grafenwöhr will talk about his success story!

FRENGER`s project

FRENGER SYSTEMEN BV

Factsheet

- Location: Heubach near Frankfurt
- Application: Development and production of radiant heating and cooling systems; chilled beams
- Size of Warehouse and manufacturing area: 6.000 m²/66,000 sq.ft.
  Size of office:
  1.500 m²/16,500 sq.ft.
- Radiant heating and cooling paired with chilled beams for heating, cooling and de-humidifing

- **Task: FRENGER`s building has to be a „PLUS BUILDING“**

FRENGER`s project

- Located in beautiful countryside
- Area is protected nature area
- No industrial zone

- Responsibility to people living around, to nature and landscape

FRENGER`s project

The new home of energy efficiency – where the future starts

General task:
-Compared to ENEV 2007 60% lower energy consumption
-Compared to ENEV 2009 30% lower energy consumption

- Another 25% lower when using heat pumps

Multiple ways for reducing energy consumption

- High efficiency radiant panels
- Perfect building envelope (insulation and air tightness)
- Multiple thermal zones
- Efficient way of generating heat
- Efficient lighting and computer technology
- **Task: FRENGER`s building has to be „PLUS BUILDING“**

FRENGER`s project

FRENGER SYSTEMEN BV

Energy concept

- High efficiency heat pumps
- Flow temperature 35℃/95℉
- Cooling shall be provided free of energy consumption
- Process heat for painting shall be provided by heat pump
- COP > 7 to meet environmental policy →**"Plus building"**
- Bore hole >= 800 m / 2640 ft deep

- Wood chip boiler as backup system
- Wood chip boiler to be fed with wood chips from waste only

FRENGER`s project

Energy savings start with right choice of heating system…

- Warehouse and manufacturing area are heated with high efficiency radiant panels
- Unique radiant output of 81%
- Offices heated, chilled and de-humidified by radiant ceiling and chilled beams

FRENGER`s project

Energy savings go on with the right choice of windows, rooflights and insulation…

Task: As much daylight as possible and lowest heat loss
Problem: Windows and rooflights have worst U-values of building envelope

→Triple-glazed windows in all parts of buildings (U-value 0.8)

→Transparent polycarbonate elements for much daylight (U-value 0.8)

→200 mm/8 inches of mineral wool as roof insulation

→100 mm /4 inches of insulation below concrete floor even in warehouse and production

FRENGER`s project

…and ends up with lighting, a building management system and clever IT choices

Task:

→Installation of modern dimmable light fittings with daylight and movement detectors connected to a BMS

→ Latest technologie of illuminant – T5-35 W technology with overhead mirrors

→BMS controls heating, cooling, lighting, roof lights

→Only green mode servers, online USV`s and no print/backup servers shall be used

FRENGER`s project

What about primary energy and water?

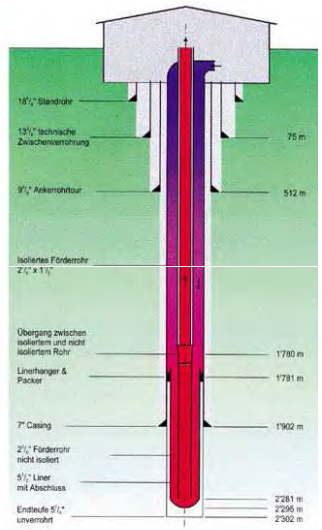
- PV-System: 55 kWp/19kBTU/h
- PV provides enough electricity to cover consumption of heating & cooling with heatpump and lighting
- Rainwater is collected and used as greywater for toilets

FRENGER`s project

FRENGER SYSTEMEN BV

Introduction: Ground source

- Deep ground source:
  - Bore hole: > 400 m/1320 Ft.
  - Application: Heating or generating electricity
  - Bore holes: coaxial heat exchangers
  - Generation of electricity: Steam turbines
    CHP (Flow > 90℃)



FRENGER`s project

FRENGER SYSTEMEN BV

Reasons for choosing a deep coaxial heat exchanger

- Compared to standard ground source (<100 m; 333 ft):
  - just one hole – minimizes land requirement
  - Estimated COP of 7-8 due to very high ground temperature
  - Water can be used as fluid (no anti-freeze required)

- Compared to very deep ground source
  - Mobile drilling machine
  - Moderate costs due to acceptable hole diameter

FRENGER`s project

FRENGER SYSTEMEN BV

Results:

- Successful energy concept
- Blower-Door test confirmed excellent air exchange rate
- Energy consumption 10 kWh/a m² (= 3410 BTU per sq ft.) and year for heating and cooling

- **Perfect combination of radiant panels, heat pump and building**
- **Perfect solution to be energy efficient and independent from energy suppliers**

FRENGER high efficiency radiant panels:

- 50% energy savings
- Perfect for retrofits and new buildings
- Quickest solution for saving energy
- Suitable for all kind of buildings