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Sustainable Geothermal Heat-Cold-Composite Energy Concept for Supermarkets – EDEKA Aktiv-Markt, Schömberg

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Dipl.-Ing. Ralf Gasper, Dipl.-Ing. Stephan Oehlert

Zent-Frenger Gesellschaft für Gebäudetechnik mbH, Center of Excellence for Geothermal Energy, Schwarzwaldstraße 2, 64646 Heppenheim

Ralf.Gasper@zent-frenger.de , Stephan.Oehlert@zent-frenger.de

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1. INTRODUCTION

Supermarkets are the most energy intensive buildings in the commercial sector. It has been estimated that 3-5 % of the total use of electricity stems from supermarkets in industrialized countries. The energy systems are complex and large efficiency improvements are possible if a better understanding of design and operation of these systems can be acquired.

2. CONVENTIONAL (CLASSIC) SYSTEM

Since the outstanding hot summer in 2003 licensees of supermarkets are more and more into the conception of cooling plants and air conditioning systems. Cooling devices were often run on the peak performance level or shut down automatically because of excessive condensation temperature. Especially supermarkets in the city centres were affected by the tremendous ambient temperature which even in the night didn't allow cooling down the market. Room temperature over 28 °C was not a curiosity.

Records of the German Meteorological Service show that the outdoor temperature is more than 25 °C for 500 hours p.a. in average while common store opening hours (up to date 2001). The medium- and long-term trend forecast of meteorologists assume a further increase of summer outdoor temperatures.

Because of high scrap rates many food store chains exchanged their stores partly with Split AC and partly with Multisplit-VRF-AC-Systems. Often with questionable success: In the summer the surrounding of the buildings are extremely heated up by the sun. Therefore outdoor units of the clime devices on the roof cause high condensation temperatures and as a consequence enormous energy costs. Due to the high ambient temperature the units are frequently overburden and therefore susceptible for malfunctions. Especially precarious is the situation in supermarkets with plug-in refrigerators. These units emit their waste heat into the sale room and stress the clime devices additionally.

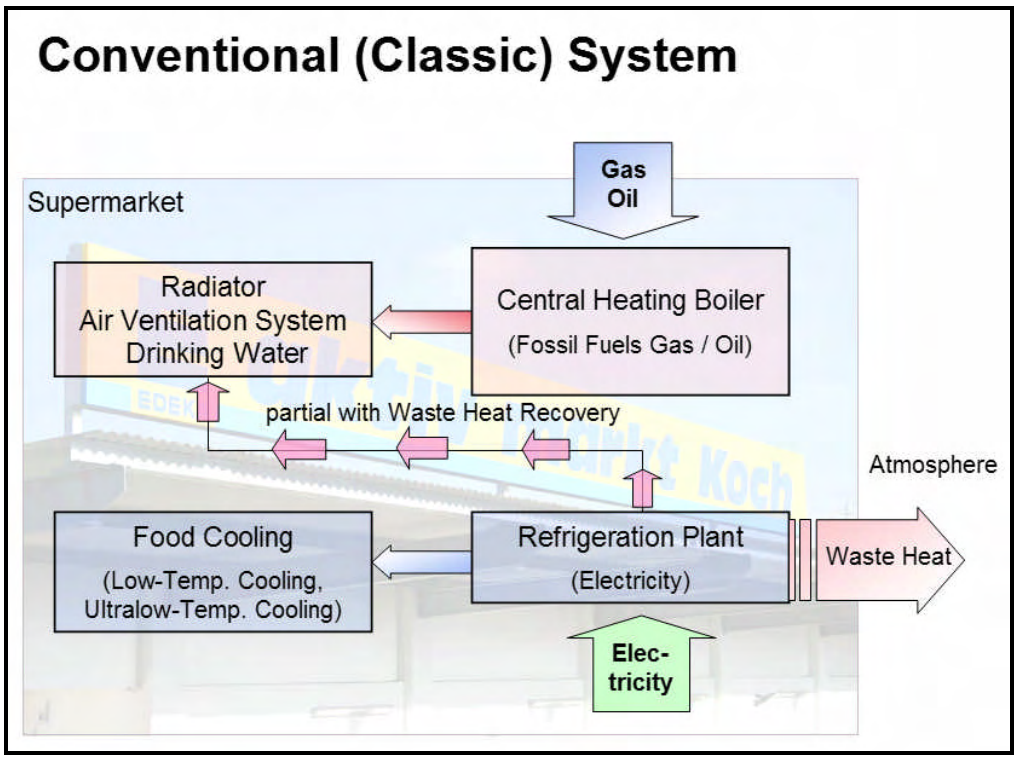

Figure 1: Conventional (Classic) System

3. GEOTHERMAL HEAT-COLD-COMPOSITE ENERGY CONCEPT

Traditional installations of supermarkets are usually separated systems for freezing temperature, cooling temperature as well as floor heating and cooling. But the Geothermal Heat-Cold-Composite Energy Concept uses a factory prefabricated geothermal energy plant “GEOZENT market” which merges and controls all functions of traditional installations. Following energy fluxes are released out of the cold/heat pump plant:

- Thermal heat for the compartment air system (40/35 °C)
- Thermal heat for the radiators (40/35 °C)
- AC cold for the compartment air system (14/18 °C)
- Cold for cooling temperature (-14 °C)
- Cold for freezing temperature (-38 °C)
- Thermal heat of 65 °C to heat up the drinking water (optional)

This process oriented network concept delivering energy fluxes with different temperature levels and driven by a refrigerating machine/heat pump plant-composite-system offers following advantages:

- Optimized cooling process technology ensures great efficiency
- All functions integrated in one control centre
- Use of a “Geothermal Energy” (Borehole Heat Exchangers)
- Waste heat of the cooling process is provided without loss to heat up the building
- Surplus energy in the summer is partly conducted into the geothermal sink/source, partly blown off through a free cooling system to the ambient air
- Cooling energy of the borehole heat exchangers improves the coolant efficiency ratio of the integrated cold production
- Indoor AC limits the increase of the summer indoor air temperature in the store to a max. of 26 °C
- A integrated software assisted energy management provides a economic energy consumption by thermal movement and process optimisation.

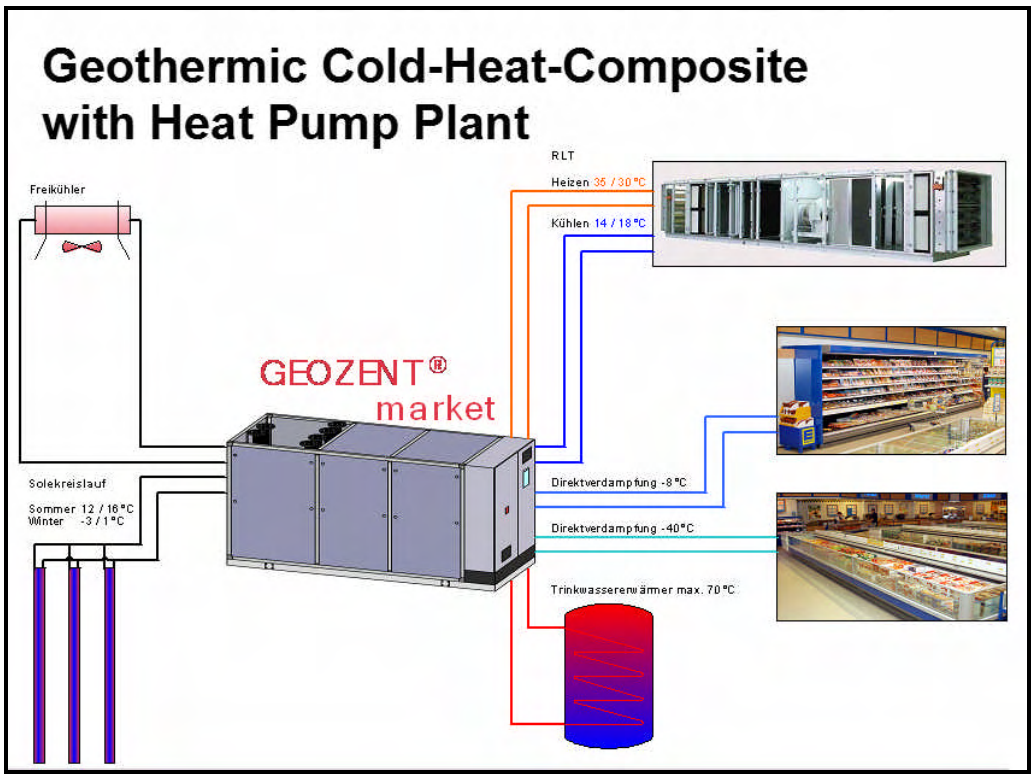

Figure 2: Geothermic Cold-Heat-Composite with Heat Pump Plant

3.1 Geothermic Heat-Cold-Composite - summer

To obtain an annual equated heat balance in the seasonal thermal energy storage (STES) the waste heat of the cooling process is partly conducted into the borehole heat exchangers and the rest is blown off through a free cooling system into the environment. This concept does not need any additional oil- or gas-burning central-heating boiler anymore.

The Borehole heat exchangers (BHE) improve the coefficient of performance of the refrigeration cycle.

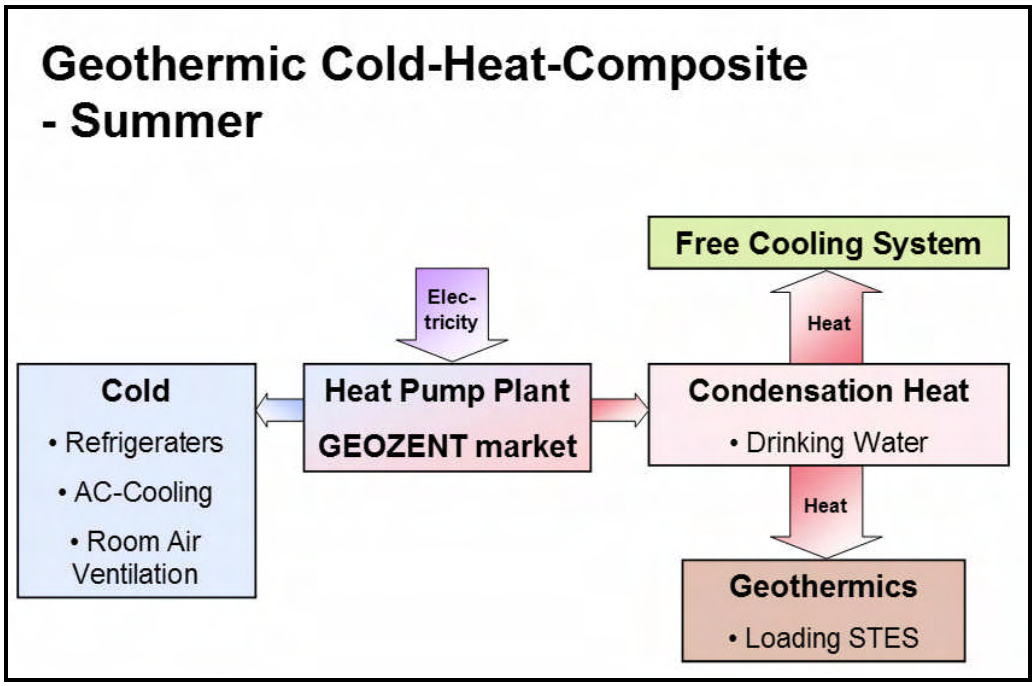

Figure 3: Geothermic Cold-Heat-Composite System - summer

3.2 Geothermic Heat-Cold-Composite – winter

The Balance of the internal heat and the waste heat of the cold production on the one side and the heating load for the building on the other side shows that for sales area and 0 °C ambient temperature there's no additional heat demand , if the energy offer and demand is managed by an energy composite system. If the heat demand increases because of decreasing ambient temperatures, seven borehole heat exchangers in the depth of 140 m are coupled into the circle for additional heat extraction.

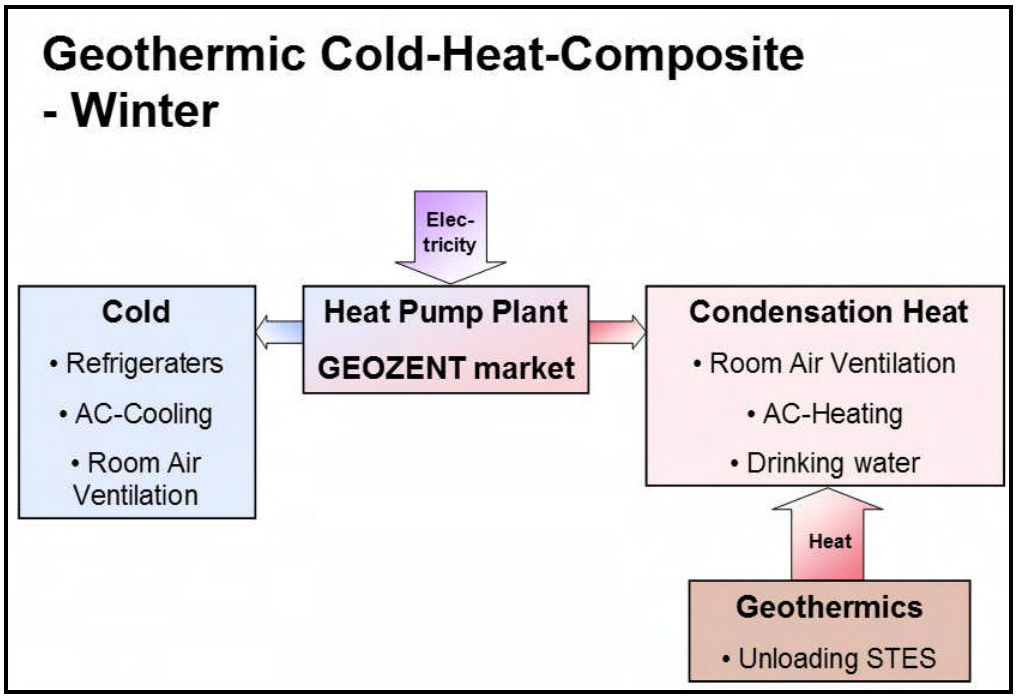

Figure 4: Geothermic Cold-Heat-Composite System - winter

4. EDEKA AKTIV-MARKT, SCHÖMBERG

The new "EDEKA Aktiv-Markt" in the business park "ImGrund 2" of Schömberg near Balingen was planned classical, thus separate according to sections. Intended was a oil-burning heating boiler to supply the radiators, the ventilation system and to heat the drinking water. The cooling plant to cool the foods was planned - as usual - separately. During the construction period the future licensees of the "EDAKA Aktiv-Markt", the Koch Handelsgesellschaft mbH with the managing directors Gerd and Klaus Koch, thought about how to transfuse the ecological understanding of the company into the building and how to visualize it for the customers.

Although the decision was made only in the middle of the construction period and therefore not all saving and efficiency increasing potentials couldn't be implemented, the realised solution is financially very profitable for the supermarket licensees. About 20.000 EUR investment costs were saved by passing the 150 kW heating boiler, the 17.000 ltr. oil tank as well as the flue gas system. Opposed to the cost savings there are additional costs of about 100.000 EUR for the geothermal control centre and the borehole heat exchangers. Additional costs for the cooling function of the anyway planned air ventilation system are put into perspective by better storage conditions and greater customer frequency, even while having high summer outdoor temperatures. In opposition to the additional investments there are projected cost savings of round about 10 000 EUR/a.

Picture 1: EDEKA Aktiv-Markt Koch, Schömberg

EDEKA aktiv markt Schömberg - Data Sheet

Sales Area:	1700 m²
Absolute Altitude:	800 m
Reference Outdoor Temperatur:	-15 °C
Heat Demand Market and Additional Areas:	150 kW
Overall Amount of Supply Air:	11200 m³/h
Indoor Cooling Demand Market:	85 kW
Cooling Capacity Refrigerator (Low.-Temp. Cooling):	70 kW
Cooling Capacity Refrigerator (Ultralow.-Temp. Cooling):	22 kW
Waste Heat Benefit of Refrigerators for Heating Purpose Max.:	123 kW

Geothermics

Winter „Heat Source“:	49 kW
Sommer „Heat Sink“:	49 kW

Borehole Heat Exchangers

spez. Entzugsleistung:	50 W/m
Bohrtiefe:	140 m
Anzahl Sonden:	7 Stück

Figure 4: EDEKE-Aktiv-Markt, Schömberg – Data Sheet

Picture 2: EDEKA Aktiv-Markt Koch, Schömberg – Geothermal Manifold

Picture 3: EDEKA Aktiv-Markt Koch, Schömberg – Energy Plant GEOZENT Market

Picture 4: EDEKA Aktiv-Markt Koch, Schömberg - Freezer

Picture 5: EDEKA Aktiv-Markt Koch, Schömberg – Multideck Cabinet

Picture 6: EDEKA Aktiv-Markt Koch, Schömberg – Cooling Tower

4. SUMMARY

The plant concept - a geothermal supported cold-heat-composite - implemented near Balingen is groundbreaking for a efficient and a permanent low energy consumption. The introduced technology allows to heat the supermarket with the waste heat of the food cooling system about 84 % of the annual utilisation time. Surplus heat is stored in the ground, if necessary; a energy management system ensures seasonal equated temperature proportions in the ground. If experts of geothermics are involved early it is possible to improve the whole energy efficiency of such solutions and to reduce investment costs.

Installation and operation of such innovative systems are perfect to implement and to run within a holistic marketing concept. The “EDEKA Aktiv-Markt“ is going to inform his customers about the amount of CO2 savings as well as the total ecological concept of the supermarket by displaying all on an info column. So a high identification with the customers should be created and new ecologic oriented customer groups should be attracted.

REFERENCES

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