

## WP1.E4 / THEORETICAL EVALUATION OF PROMISING SYSTEM: Compact Heating Unit for Solar Domestic Hot Water (SDHW) Preparation

Authors: Marc Imann, Vaillant Group, Germany  
Harald Drück, Elke Streicher, Institut für Thermodynamik und Wärmetechnik (ITW), Universität Stuttgart, Germany  
Reviewers: Dagmar Jähmig, Claudius Wilhelms

### CONTENTS

#### REFERENCE SYSTEM WHICH SERVES AS A BASELINE

Choice and use (of the reference system)  
Description (of the reference system)

#### SYSTEM EVALUATION

Description of the evaluated system  
Cost and savings  
Additional benefits  
Markets and market considerations  
Special considerations and limitations

#### FURTHER INFORMATION

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### SUMMARY

Today most solar thermal systems in Germany are used for domestic hot water production in single-family or small multi-family houses. These systems are designed to cover approximately 60 % of the annual hot water demand by means of solar thermal energy under the average German climate conditions.

In general a typical solar domestic hot water system shows the following configuration: The collector on the roof heats up a heat transfer medium, which usually is a mixture of water and glycol (anti-freeze). The electronic control unit monitors the temperature difference between the collector and the lower part of the hot water store. When these temperatures are appropriate, a pump is activated to circulate the heat transfer fluid through the collector loop. Through a heat exchanger, the solar heat is transferred into the water in the hot water store. For auxiliary heating, a second heat exchanger, which is connected to the oil or gas boiler, is located in the upper part of the hot water store.

This system type is taken as the reference system in the present report, as it represents the state of technology of solar domestic hot water preparation in Germany. The evaluation of the promising system type introduced in the second part of this report is based on a comparison with this reference system.

The promising system type is a compact heating unit for solar domestic hot water (SDHW) preparation. The compact heating unit combines all functions that are needed to supply heat for space heating and domestic hot water for a whole house. It includes a condensing boiler with a thermal power of up to 20 kW, a 150 litre solar store combined with a so-called shift load storage providing a thermal power of up to 24 kW and all necessary hydraulics. All these features are integrated within one single casing. One major advantage of this concept is the possibility to install the unit nearly everywhere in the house - from the cellar to the attic.

With a required space of approximately 0.6 m<sup>3</sup> the system thus provides a high comfort regarding domestic hot water supply. At present (beginning of 2006) such compact heating units for solar domestic hot water preparation are offered in Germany by three different manufacturers.

## Reference system

### Choice and use of the reference system

In this report, the system evaluation is based on a comparison with a reference system. The reference system matches the current state-of-the-art of system technology used for solar domestic water heating in Germany.

All statements in the *evaluation* section below are relative to (or in comparison with) the properties of the reference system.

### Description of the reference system

Application: Primary purpose: solar domestic hot water heating

Description: Most common systems for solar domestic hot water heating consist of a store with two integrated heat exchangers, one for the solar loop and one for the auxiliary heating loop, as can be seen from the hydraulic scheme below. In general the heat transfer medium consists of a mixture of water and antifreezing fluid in order to avoid freezing of the collector during the winter season. Therefore the collector circuit has to be hydraulically separated from the water in the store.

A boiler is not regarded as being part of the reference system and therefore it is not included in the cost indicated below. The costs of an appropriate gas or oil boiler will be approximately EURO 3000 (including VAT).

Cost (retail sales price of the reference system without installation, including VAT): Euro 4000.

Dimensioning of the reference system:

Collector aperture area: 5 m<sup>2</sup>  
Store volume: 300 l

The schematic set-up of the reference system is shown in Figure 1:

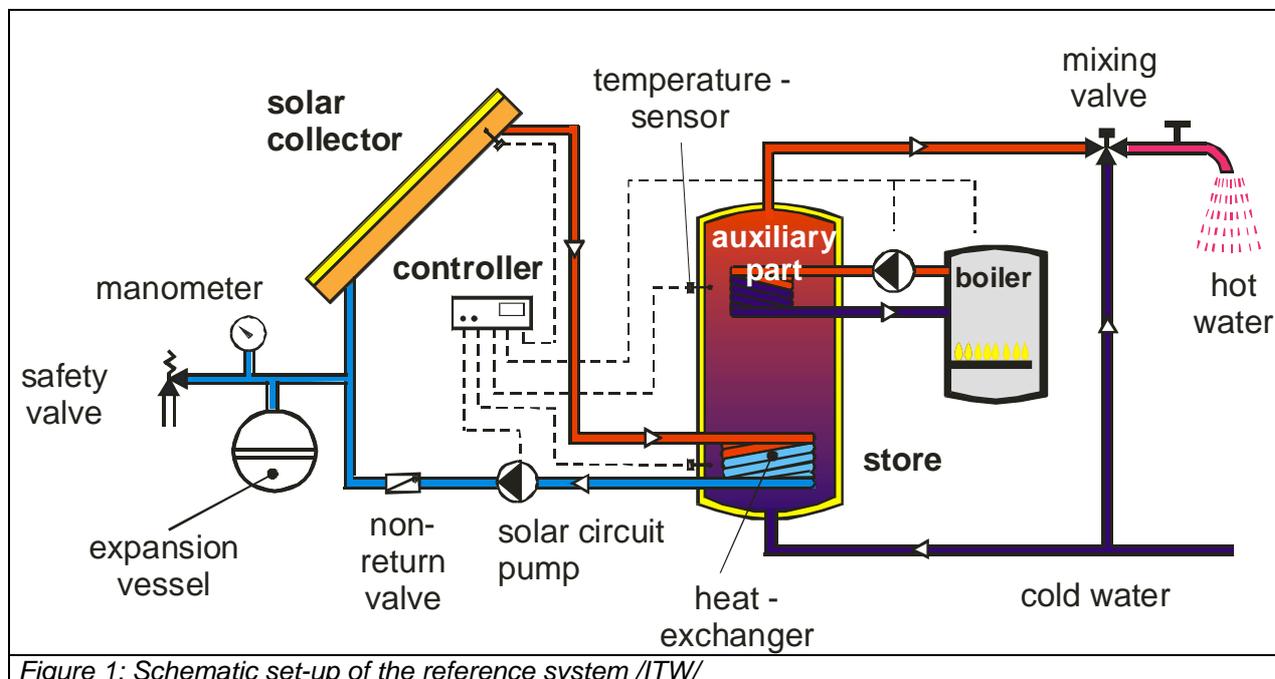


Figure 1: Schematic set-up of the reference system /ITW/

Market: The reference system represents the current state of technology in Germany in the year 2005.

Reference: The reference system is described in more detail in NEGST WP1.D1 / SUMMARY REPORT ON TODAY'S SYSTEM TECHNOLOGY, Appendix Germany

## Evaluation

### Description of the evaluated system

Application: Solar domestic hot water heating

Description: The evaluated compact heating unit for solar domestic hot water preparation combines a highly efficient condensing central heating system with a solar domestic hot water (DHW) system for comfortable warm water supply and space heating for one or two family houses. All necessary components with the exception of the solar expansion vessel are integrated in one casing with a size of (167 x 60 x 57) cm.

Depending on the weather conditions, the integrated store with a total volume of 150 litres is used as a 150 litre solar store, a 75 litre stratified store or a combination of both. The basic principle of a stratified store concept is illustrated in figure 2. The stratification in the store leads nearly to the same amount of usable hot water as a conventional 200 l store with a low level of stratification.

With the thermostatic mixing valve integrated in the compact heating unit, the maximum outlet temperature can be adjusted in the range from 35°C up to 65°C while the store temperature can rise up to 85°C. In case the store is nearly completely discharged, the so-called shift load system starts. During shift-load operation, the compact heating unit will mainly operate as an instantaneous water heater, however a minor ratio of the domestic hot water is prepared by discharging the store in parallel. Due to this concept hot water can still be withdrawn if the domestic hot water store is completely discharged.

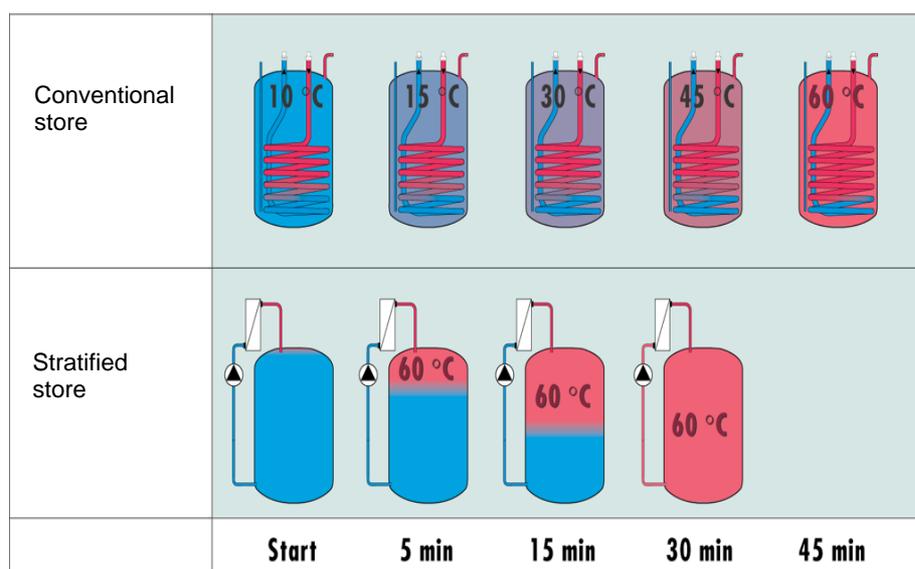
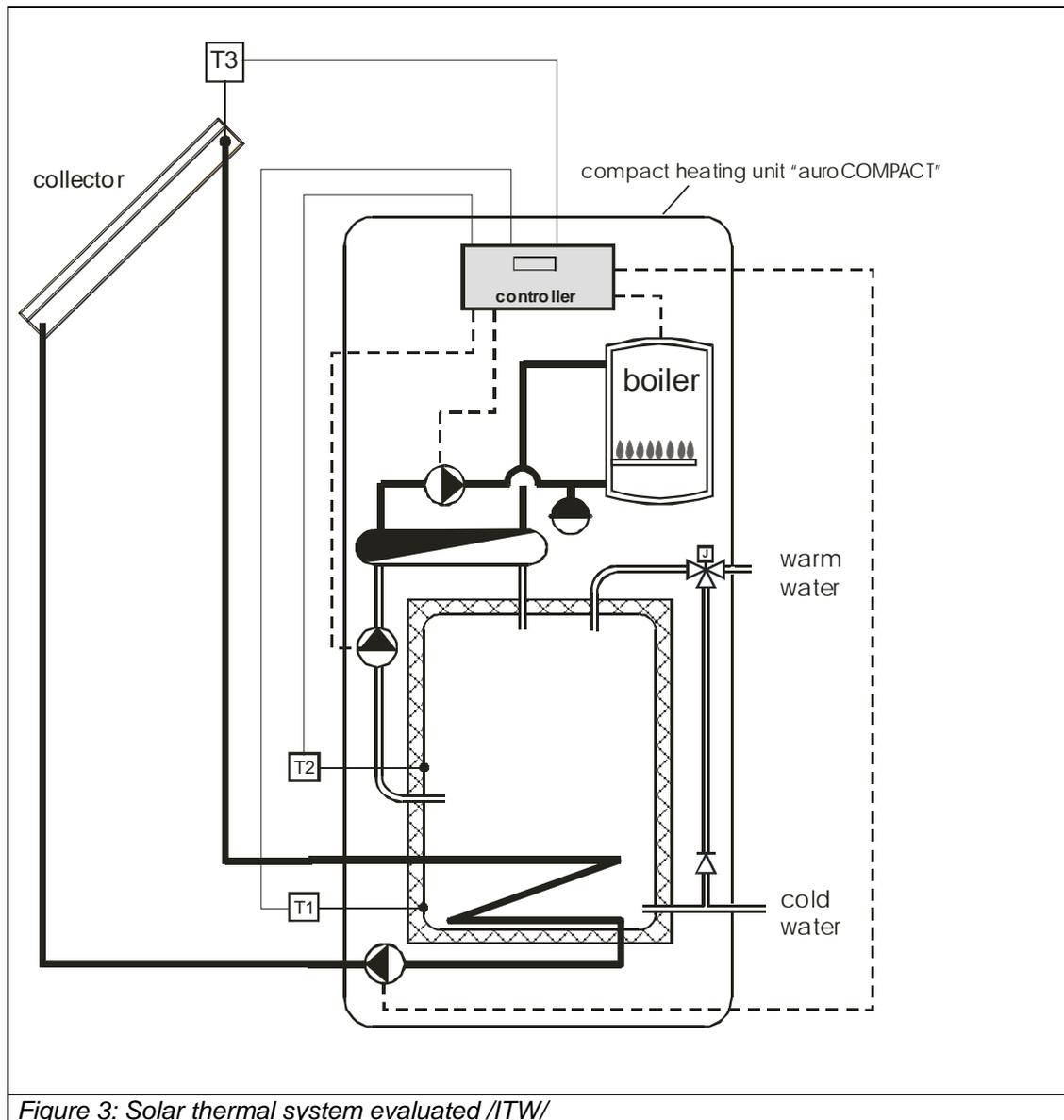


Figure 2: Thermal stratification of two different store concepts /Vaillant/

The whole set will be delivered with two flat plate collectors with a collector area of 2.2 m<sup>2</sup>. Hence the total collector area is  $2 * 2.2 \text{ m}^2 = 4.4 \text{ m}^2$ .

The costs for the whole system including the compact heating unit, two collectors, collector loop twin tubing, solar fluid and expansion vessel are less than 5000 € (without installation, including VAT).

Figure 3 shows the detailed set-up of the compact heating unit discussed in this report.



The photographs in figure 4 of the compact heating unit shall give an additional impression of the evaluated system.



## Cost and savings

### Material and manufacturing:

In comparison to the reference system, the compact heating unit requires less installation material. Furthermore less material is embodied in the system due to the compactness of the heating unit. The manufacturing process is material-optimized and the components are well adjusted to each other.

### Installation:

Due to the easy installation process concerning the connection of the collectors to the compact heating unit, the simple installation of the collectors, the well prepared connections for central heating, DHW and flue pipes, time and material savings are an important advantage of the compact heating (in comparison to the reference system). All connections for installation are easily accessible and clearly marked.

The relatively light weight of 140 kg and the mounted carrying handles as well as the low noise emissions make it possible to install the system nearly everywhere in the building.

### Maintenance:

All components are placed in the way that they can be easily accessed from the front in case of service or maintenance. Most of the components are fixed with brackets, so that they can be replaced quickly and easily. The gas burner is maintenance-free.

A diagnosis of electronics and sensors is easy to manage with the on-board PC-interface.

### Combined cost:

The costs for the entire system hardware are approximately 1000 € -1500 € less than for buying single components with the same nominal data and quality.

The installation costs are lower as the time needed to install the system is shorter.

### Performance and energy savings, including embodied energy:

As the reference system has a store with twice the volume and one additional square metre collector area the energy savings achieved by the reference system are higher.

However, the hot water comfort of the evaluated system is much better because in the compact heating unit a special approach based on a combination of thermally stratified store and an instantaneous hot water preparation unit is implemented (the so-called shift store concept).

### Cost performance ratio:

The cost performance ratio is expected to be better than the one of the reference system, especially if the comparison is based on the costs of a complete system consisting of a solar domestic hot water part and a gas or oil boiler.

### **Additional benefits**

Range of application, extra service, extra comfort, extra function:

The preventive service system can be connected via internet, mobile phone card or phone line. The appliance is detecting failures and calls the installer independently on its own.

Environmental friendliness:

The gas part of the system fulfils all European emission requirements.

Aesthetics, building integration and space requirement:

Due to its design, the compact heating unit looks like furniture and not like a central heating system. Due to the installation space the systems could be installed in principle everywhere in the house. Any kind of collector installation (roof, facade, etc.) is also possible.

Technical integration:

The compact heating unit is developed for one or two family houses. It can be used for new buildings or in case of a complete renovation of the central heating system, but it is not suitable as addition to already existing systems.

### **Markets and marketing considerations**

Opening-up of new and niche markets:

According to the manufacturer this system is expected to be the first choice for house builders all over Europe who want to save space and money. The reasons therefore are easy installation, reduced installation space, flexibility of where to install the system, attractive design, attractive price as well as the hot water comfort provided by the system. For this reasons the system is interesting for new buildings and in case that an already existing heating system should be replaced.

Expansion of existing market:

Same reasons as mentioned above.

### **Special considerations and limitations**

The system and its components is approved and certified nearly for all of Europe.

It is suitable especially for markets in Central Europe, where the combination of a condensing boiler with a solar domestic hot water system is rewarded by national subsidy programs.

This system is sold as auroCOMPACT system VSC S 196 –C 200 from Vaillant GmbH, Germany. Up to now (end of 2005), nearly 3000 systems are in operation.