New Generation of Solar Thermal Systems

# WP1.E8 / THEORETICAL EVALUATION OF PROMISING SYSTEM: Integrated collector storage

Author: Bart van der Ree, Anton Schaap

Ecofys, Kanaalweg 16 G, 3526 KL Utrecht, The Netherlands

Reviewers: Claudius Wilhelms, Dagmar Jaehnig, Klaus Vajen

## CONTENTS



## SUMMARY

The new system (working name used here: 'Ecofys ICS') is an ICS (Integrated Collector Storage) type solar water heater. The system is characterised by a cylindrical tank under a transparent dome and with an involute reflector behind the tank. Compared to the reference system (a thermosyphon solar water heater) the system is easy to install because it consists of a single unit. It is also maintenance free, because there is no glycol circuit and has no anode. It is designed to have a better price/performance ratio (about 25%) than the reference system because of reduced material use, ease of installation and a design allowing efficient mass production of its parts. A further important aspect is an attractive design of the system which allows advantageous building integration. Overheating and frost protection are given much attention with a combination of passive and active safety measures.
The system is planned to be marketed in Southern European countries, as a competitor to the thermosyphon systems commonly applied there. In comparison to these thermosyphon systems, advantages of the ICS are lower cost price, less installation effort and no maintenance. The system is designed to be used with auxiliary heating in the house (natural gas, propane or electric).

For confidentiality reasons, not all technical details can be revealed in this evaluation.

## 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 state of the art of system technology used for (solar) water heating in Europe. 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

Primary purpose: solar domestic hot water pre-heating

Description: The reference system is a small thermosyphon solar water heater as commonly used in South Europe. Because the ICS is designed to be frost-resistant, the reference system has a glycol antifreeze fluid in its collector loop. It consists of a flat-plate collector with a horizontal tank on top of it. External piping connects the collector to the store. Such systems are commonly placed on flat roof using metal brackets.

Cost (retail sales price of the reference system without installation): Depends on brand, quality and country.

Collector area and store volume of the reference system: about 2 $m^2$, 150 l

*Figure 1: Reference system: thermosyphon solar water heaters*

Market: The reference system represents the state of the technology in most of the world except for the North-Western European countries where pumped systems are state of the art.

Reference: The reference system is described in more detail in NEGST WP1.D1 / SURVEY ON THE STATE OF THE TECHNOLOGY OF SOLAR THERMAL SYSTEMS.

## Evaluation

### Description of the evaluated system

Application: Primary purpose: solar domestic hot water pre-heating

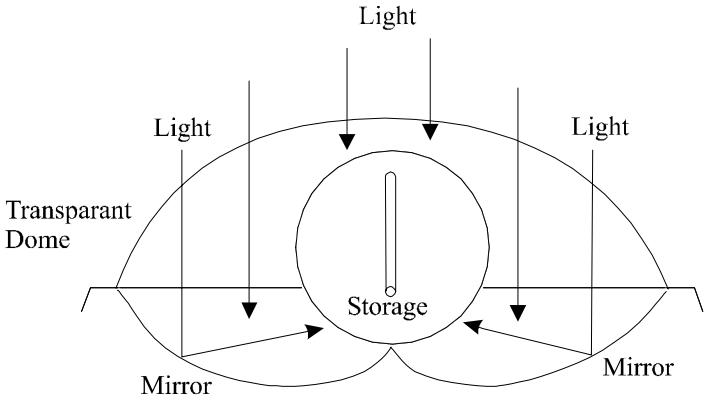
Description: The new system is an Integrated Collector Storage (ICS) system, with a cylindrical storage tank covered with a highly spectral selective layer, and an involute reflector behind the storage. The system is directly connected to the cold water line and delivers preheated water to an auxiliary heater. The aperture area is about 1.9 $m^2$ and the store volume about 150 liter per unit. Several units may be used together to cover high demands.

The system has several protection mechanisms:

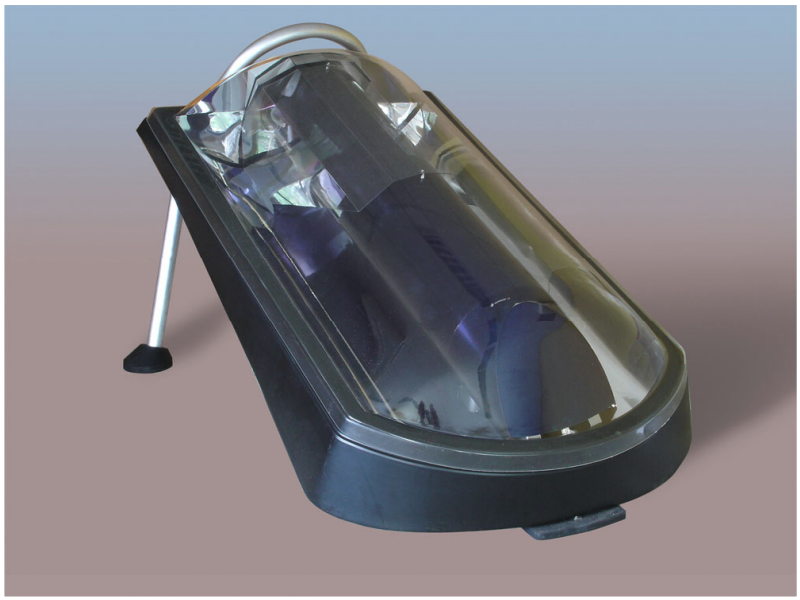
- against freezing: passive (using heat from the house on which it is mounted) and active (draining some water).
- Against overheating: passive (thermostatic mixing valve) and active (draining some water).

The total amount of water drained is limited, e.g. for a Spanish climate it is estimated to be about 100 liter per year. Water is not drained onto the roof but into the sewage.

Performance is targeted to be comparable to that of the reference system. Store losses during the night will be slightly higher than the reference system, but this will be partly compensated because the ICS can use the irradiation at very low levels. During the day, the ICS is more efficient than the reference system because the heat loss (about 2 $W/m^2K$) will be lower than that of the flat plate collectors.




Principle of the new ICS Solar water heater.



Picture of the new ICS solar water heater (with flat roof support)

*Figure 2: ICS solar water heater with cylindrical tank*

## Cost and savings

Material and manufacturing: The new ICS solar water heater is an extremely simple construction with a low material use. There is no separate circuit between collector and storage. This means that there is no need for a heat exchanger or double walled tank. In comparison with the reference the installation costs are lower because there is only one unit to be placed on the roof, no interconnections of collector and storage and no filling with glycol. The whole ICS is made out of a handful of large components (transparent dome, tank, bottom plate and frame), which can easily be mass produced, and some connecting elements. The ICS is designed to be maintenance free: it has no glycol antifreeze fluid and no sacrificial anode. A cost reduction of 25 % is anticipated compared to the reference system for the system costs including installation, but dependant on local circumstances. Based on first tests, the energy yield will be comparable to that of the reference system with similar collector area.

### Additional benefits

Safety and health: No difference to reference system, or better because a thermostatic mixing valve is integrated into the system reducing the chance of omission or installation errors.

Range of application: Solar water pre-heating or solar-only application.

Environmental friendliness: At disposal the system can easily be taken apart in a few big parts and some smaller parts. There are no parts which are made from a mix of materials, except for the stainless steel tank, which can be recycled as stainless steel. All materials can be recycled.

Aesthetics, building integration and space requirement: Because of the highly aesthetical design the system is designed to be more attractive for buyers than the reference system.

Technical integration: The system can easily be integrated as pre-heater into an existing water heating system. A thermostatic valve keeps the temperature below a set value.

### Markets and marketing considerations

Opening-up of new and niche markets: Because of the highly aesthetical design the system is much more attractive for buyers than the reference system. This system is also attractive just because of the design. This can open up a more mainstream market in which consumer goods are sold merely on emotions rather than on economics.

Expansion of existing market: The better price performance ratio can also broaden the market for this ICS, especially because of the simple installation.

## Special considerations and limitations

## Acknowledgements

The work on this ICS solar water heater started at ZEN in The Netherlands some ten years ago. After ZEN was taken over by ITHO the industrial property was transfered to Ecofys. At Ecofys the system was redesigned by Anton Schaap and Iwan van Bochove. The system will be tested in practice at ten locations in The Netherlands in the autumn of 2005 (with financial aid of the EOS-DEMO programme in The Netherlands).