Report on Solar Combisystems Modelled in Task 26 (System Description, Modelling, Sensitivity, Optimisation)

A Report of IEA SHC - Task 26
Solar Combisystems
April 2003

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INTERNATIONAL ENERGY AGENCY
Solar Heating & Cooling Programme
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A technical report of Subtask C

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System #3a Philippe Papillon, David Chèze, Clipsol, Aix-les-Bains, France
System #4 Louise Jivan Shah, Technical University of Denmark
System #8 Jacques Bony, Thierry Pittet, EIVD, Yverdon-les-Bains, Switzerland
System #9b Markus Peter, University Oslo, Norway
System #11 oil, gas Chris Bales, SERC, Borlänge, Sweden
System #12 base Chris Bales, SERC, Borlänge, Sweden
System #15 Dagmar Jaehnig, SOLVIS, Braunschweig, Germany
System #19 Richard Heimrath, IWT, Graz University of Technology, Austria
### Nomenclature

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Q_{\text{SH}}$</td>
<td>space heating demand</td>
</tr>
<tr>
<td>$Q_{\text{DHW}}$</td>
<td>domestic hot water demand</td>
</tr>
<tr>
<td>$Q_{\text{loss,ref}}$</td>
<td>reference system losses</td>
</tr>
</tbody>
</table>

\[
E_{\text{ref,month}} = \frac{Q_{\text{SH}} + Q_{\text{DHW}} + Q_{\text{loss,ref}}}{\eta_{\text{boiler,ref}}} 
\]

\[
E_{\text{ref}} = \frac{Q_{\text{SH}} + Q_{\text{DHW}} + Q_{\text{loss,ref}}}{\eta_{\text{boiler,ref}}} 
\]

- Monthly final energy demand of reference system boiler
- Annual final energy demand of reference system boiler
- Thermal energy load of auxiliary boiler
- Mean annual efficiency of auxiliary boiler

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Q_{\text{boiler}}$</td>
<td>final energy consumption of auxiliary boiler</td>
</tr>
<tr>
<td>$\eta_{\text{boiler}}$</td>
<td>primary energy consumption of auxiliary boiler</td>
</tr>
</tbody>
</table>

\[
E_{\text{boiler}} = \frac{Q_{\text{boiler}}}{\eta_{\text{boiler}}} 
\]

- Thermal energy load of el. heating element
- Mean annual efficiency of el. heating element

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$W_{\text{el.heater}}$</td>
<td>primary energy consumption of el. heating element</td>
</tr>
<tr>
<td>$\eta_{\text{el.heater}}$</td>
<td>parasitic energy consumption of solar combisystem</td>
</tr>
</tbody>
</table>

\[
E_{\text{el.heater}} = \frac{W_{\text{el.heater}}}{\eta_{\text{el.heater}}} 
\]

- Parasitic energy consumption of solar combisystem electricity generation efficiency
- Primary parasitic energy consumption of solar combisystem

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$W_{\text{par}}$</td>
<td>primary parasitic energy consumption of solar combisystem</td>
</tr>
<tr>
<td>$\eta_{\text{el}}$</td>
<td>parasitic energy consumption of reference system electricity generation efficiency</td>
</tr>
</tbody>
</table>

\[
E_{\text{par}} = \frac{W_{\text{par}}}{\eta_{\text{el}}} 
\]

- Parasitic energy consumption of reference system
- Primary parasitic energy consumption of reference system

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$W_{\text{par,ref}}$</td>
<td>combined auxiliary energy consumption of solar combisystem</td>
</tr>
<tr>
<td>$\eta_{\text{el}}$</td>
<td>combined total energy consumption of solar combisystem</td>
</tr>
</tbody>
</table>

\[
E_{\text{par,ref}} = \frac{W_{\text{par,ref}}}{\eta_{\text{el}}} 
\]

- Combined auxiliary energy consumption of solar combisystem
- Combined total energy consumption of solar combisystem

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$E_{\text{aux}} = E_{\text{boiler}} + E_{\text{el.heater}}$</td>
<td>combined total(^1) energy consumption of solar combisystem</td>
</tr>
<tr>
<td>$E_{\text{total}} = E_{\text{aux}} + E_{\text{par}}$</td>
<td>combined total energy consumption of reference system</td>
</tr>
<tr>
<td>$E_{\text{total,ref}} = E_{\text{ref}} + E_{\text{par,ref}}$</td>
<td>collector area (m(^2))</td>
</tr>
<tr>
<td>$A$</td>
<td>storage volume (l)</td>
</tr>
<tr>
<td>$V$</td>
<td>usable solar energy</td>
</tr>
</tbody>
</table>
| $Q_{\text{solar,usable}}$ | \(^1\) The losses from refining and transportation of the fuels were neglected.
1 Introduction

One of the targets of Task 26 was to compare different combisystem designs by means of annual system simulations. The following report summarises the simulation methodology and the results for nine systems following the guidelines presented in [1] and [2].

To describe the performance of solar combisystems and to carry out an adequate comparison with detailed simulation models, it needs to be recognized that the result of a comparison depends on:

1.) the chosen reference conditions concerning energy demands, energy sources, parameter settings, and standard components,
2.) the output or target function of the annual system simulation that serves as a measure of the combisystem performance (e.g. the saved gas consumption of a combisystem compared to the gas consumption of a non-solar reference heating system), and
3.) the mathematical accuracy of the system simulation and the choice of the same simulation models for identical parts of the systems

In order to carry out a comparison between combisystems that do not correspond to the reference conditions defined in [1], these non-complying combisystems were additionally characterised in a way that allows comparisons of different system designs for various climates and system sizes. A description of a characterisation method developed in the framework of Task 26 is given in [1] and [2].

2 Methodology of Modelling

2.1 Reference Conditions

The reference conditions are given in detail in [1]. They are summarised in the following:

- **Climate**: In order to cover the geographical range for the main markets of solar combisystems it was decided to choose a northern European (Stockholm, Sweden), a middle European (Zurich, Switzerland) and a southern European (Carpentras, France) climate for all further investigations and simulations. The hourly weather data was calculated with Meteonorm 3 [3] using long term average monthly values. Additionally the yearly temperature fluctuation of the mains water was taken into account.

- **Heat demand of buildings**: The heat demand of the buildings was defined by reference buildings with reference conditions for user behaviour, occupation, etc. These building models were also part of the TRNSYS model of each solar combisystems. Three single-family houses (SFH) with the same geometry but different building physics data were defined in a way that the specific annual space heating demand for the Zurich climate amounts to 30, 60 and 100 kWh/m²a. Additionally, a multi-family house (MFH) with five apartments and a specific annual space heating demand for Zurich of 45 kWh/m²a was defined. The room temperature was allowed to vary between 19.5 and 24°C during the heating season. In the reference case the heat was delivered via radiators (Non-standard TRNSYS type 162 radiator). The flow temperature was controlled via the ambient temperature and internal loads were accounted for by thermostatic valves (Non-standard TRNSYS type 120 PID-controller). Two systems used floor heating systems with additional reference values.
• **Domestic hot water (DHW):** The DHW demand was fixed with 200 litres/day per house or apartment. The daily distribution was calculated with a software tool developed by [4]. It is based on a statistical distribution of the occurrence of taking a bath, taking showers, washing hands, etc. coupled with weekday/weekend differences and vacation periods. Figure 1 show an example of the domestic hot water demand over a period of seven days.

![Figure 1: Domestic hot water demand for 72 hours and 200 litres/day](image)

• **Auxiliary heating device:** Two burner models, a gas and a biomass burner model, were defined by specific characteristics such as range of modulation, convective and radiation losses, standby temperature etc. as standard burner models. If burners were an integrated part of the solar combisystems, the burner model was adapted to its specific values. Non-standard TRNSYS Type 170 was used for the burner calculations, the controller for the burner was non-standard TRNSYS type 123.

• **Solar collector:** A typical flat plate collector with optically selective coated absorbers was used for the comparisons. The collector parameters are shown in [1]. The Non-standard TRNSYS type 132 was used as collector model. Additionally the connecting tubes of the collector loop were defined.

• **Electricity consumption:** The parasitic electricity demand of a combisystem, \( W_{\text{par}} \), and of a reference heating system (see chapter 2.2), \( W_{\text{par,ref}} \), was defined as the sum of the annual electricity consumption, other than for heating, of all electrical system components (pumps, burner devices, valves and controllers).

### 2.2 Target Functions

The target function for the optimisation is based on fractional energy savings \( f_{\text{sav}} \) of the solar Combsystem compared to a reference system. According to CEN/TC 312, ISO/TC 180, \( f_{\text{sav}} \) is related to the purchased auxiliary energy. The reference systems were defined with the reference buildings for each climate coupled with a gas-boiler driven radiator heating system. No space heating water storage was used, the volume of the DHW store was set to 150 litres. Three different indicators were used.

**Fractional thermal energy savings (\( f_{\text{sav,therm}} \))**

This definition gives fractional energy savings based on the saved fuel input of the solar combisystem compared to the reference heating system.
equ.1: \[ f_{\text{sav, therm}} = 1 - \frac{Q_{\text{boiler}} + Q_{\text{el heater}}}{\eta_{\text{boiler, ref}}} = 1 - \frac{E_{\text{aux}}}{E_{\text{ref}}} \]

with:
\[ \eta_{\text{el heater}} = 40\% \text{ for systems that do not apply solely renewable energy sources} \]
\[ \eta_{\text{el heater}} = 90\% \text{ for systems that apply solely renewable electrical energy sources} \]

**Extended fractional energy savings (f_{\text{av,ext}})**

In this definition, the above value takes into account the parasitic electricity \( W_{\text{par}} \) used by the system.

\[ f_{\text{sav, ext}} = 1 - \frac{Q_{\text{boiler}} + Q_{\text{el heater}} + W_{\text{par}}}{\eta_{\text{boiler, ref}}} = 1 - \frac{E_{\text{total}}}{E_{\text{total, ref}}} \]

with:
\[ \eta_{\text{el heater}} = 40\% \text{ for systems that do not apply solely renewable energy sources} \]
\[ \eta_{\text{el heater}} = 90\% \text{ for systems that apply solely renewable electrical energy sources} \]
\[ \eta_{\text{el}} = 40\% \text{ for all systems} \]

**Fractional savings indicator (f_{\text{ui}})**

This last definition includes also a penalty \( Q_{\text{penalty, red}} \) for not fulfilling the comfort criteria of domestic hot water (DHW) and room temperatures as described in [1].

\[ f_{\text{ui}} = 1 - \frac{E_{\text{total}} + Q_{\text{penalty, red}}}{E_{\text{total, ref}}} \]

### 2.3 Model calibration, optimisation, sensitivity analysis

All TRNSYS models of Task 26 had to be adjusted to reach the same mathematical simulation accuracy. Otherwise the simulation results would not have been comparable. This adjustment was performed in the following steps:

1) All TRNSYS types are the same for all participants (all current TYPE versions were collected at a specific website that was accessible for Task 26 workers) and the reference system has the same results on each computer and TRNSYS library used.

2) Simulation time step and the parameters for convergence and integration accuracy had to be adjusted in order to reach a given relative and absolute accuracy. The accuracy was defined as the relative difference of the \( f_{\text{sav, therm}} \) – values between two iterative simulation runs.

Figure 2 illustrates this procedure:
Most of the systems had to be modelled with small time steps in order to achieve the defined accuracy (see chapter 2.3). In the course of Task 26 it was found, that there were mistakes in the standard TRNSYS types 16 (radiation processor) and proc.for (a basic routine for TRNSYS) when small time steps not equal 1/(2^n) hours were used (TRNSYS Version 14.2). Both subroutines were improved by participants of Subtask C. The revised modules can be ordered from the author.
The **optimisation procedure** for the different systems was defined by a two step approach: In the first step the systems were optimised in itself as they are produced starting from a 'base case' with their typical collector areas and store volumes.

In the second step values for the FSC method (see [1] and [2]) are calculated for each system. The comparison of the systems based on these values are presented in [1] and [2].

The following steps are performed during the system optimisation:

- Model the system in TRNSYS for the relevant climate (preferably Zurich) and the 60 kWh/m²a building with collector area and store volumes set by the participant.

- The target functions for the analysis are based on fractional energy savings. Three functions (ref. to chapter 2.2) are defined.

- Do a sensitivity analysis (and maybe optimisation) with this model. The parameters that should be varied are given in Table 1. Of course participants were free to perform a sensitivity analysis with more than the mandatory parameters. The model could also be changed, if it was found, that it is in the present form far away from the optimum.

- Optimise the system using the specified target function in chapter 2.2 (by hand and automatically). If available, cost functions can be included in the optimisation. The results of this last step are presented in [6]

- Besides: country or company specific calculations could be performed

It should be mentioned that each participant of Subtask C of Task 26 did as much as possible within the optimisation, but of course, was restricted by funding available for the Task.

The parameters to be generally included in the optimisation are defined as shown in Table 1. Table 2 shows as an example the actual parameters and the resulting $f_{\text{sav,ext}}$ values for the optimisation runs performed with System #19.

All results for the different systems are shown in the description of each system. The optimisation led to several changes in the lay-outs of the system during the Task. These changes are described in [5].
### Table 1: Parameters for optimisation (values, boundaries and fixed parameters see [1])

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Ref.-Cond.</th>
<th>Analysis/optimisation</th>
<th>Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ref. Climate</td>
<td>Analysis/optimisation</td>
<td>Comparison</td>
<td></td>
</tr>
<tr>
<td>Four climates</td>
<td>*</td>
<td>one</td>
<td>all</td>
</tr>
<tr>
<td>Climates:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stockholm (northern Europe)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zürich (middle Europe)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carpentras (southern Europe)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space heating system</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Single-family house</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 kWh/m²a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60 kWh/m²a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 kWh/m²a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Multi-family house (45 kWh/m²a)</td>
<td></td>
<td>only #19</td>
<td></td>
</tr>
<tr>
<td>c) Lay-Out temp. of heating system °C</td>
<td></td>
<td>if possible</td>
<td>fixed</td>
</tr>
<tr>
<td>System</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collector</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type (η₀, a₁, a₂)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2 types in ref. cond.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area [m²]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Azimuth (-90 - +90°)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tilt angle (0 – 90°)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specific flow rate (kg/m²h) (8 - 50 l/m²h)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed/matched flow</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipe system (collector – storage unit)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>electricity consumption (pump) [W]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage unit(s)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume [m³]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume/diameter [m³/m]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Position of heat exchangers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Position of in/outlets</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed position of in/outlets – stratification unit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Position of sensors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal insulation [W/m²K]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DHW – preparation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Load</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Circulation loop (if necessary)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of circul. loop [m]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat loss (thermal insulation) [W/K]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electricity consumption (pump) [W]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat exchangers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U*A [W/K]</td>
<td></td>
<td>variable</td>
<td>opt. fixed</td>
</tr>
<tr>
<td>Control strategy</td>
<td></td>
<td>variable</td>
<td>opt. fixed</td>
</tr>
<tr>
<td>Auxiliary heating</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range of modulation (if possible)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel consumption (e.g. wood, gas)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electricity consumption (pump, control-unit)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

opt. fixed: optimum from system analysis/optimisation taken.
Table 2: Parameters variation done for System #19 (base-case see annex of #19 system description)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Variation</th>
<th>Variation in $f_{sav,ext}$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base Case (BC)</strong></td>
<td>-</td>
<td>38.97%</td>
</tr>
<tr>
<td>Collector size [m²] (fixed store size 5.5 m³)</td>
<td>25 – 250</td>
<td>16.85 – 50.91%</td>
</tr>
<tr>
<td>Collector Size [m²] (fixed store spec. vol. 0.05 m³/m²)</td>
<td>25 – 250</td>
<td>18.01 – 55.49%</td>
</tr>
<tr>
<td>Store Size [m³] (fixed collector area of 100 m³)</td>
<td>1.75 – 13.00</td>
<td>31.77 - 39.64%</td>
</tr>
<tr>
<td>Collector Azimuth [°] (fixed tilt of 60°)</td>
<td>-90 - 90</td>
<td>26.73 – 39.06%</td>
</tr>
<tr>
<td>Collector Tilt [°] (fixed azimuth of 0°)</td>
<td>15 – 90</td>
<td>29.46 – 39.45%</td>
</tr>
<tr>
<td>Specific Collector flow rate [kg/m²-h]</td>
<td>10 - 22</td>
<td>38.70 -39.22%</td>
</tr>
<tr>
<td>Climate (45 kWh MFH – Base Case (BC))</td>
<td>Carp. / Zur. / Stock.</td>
<td>67.0% / 39.0% / 34.4%</td>
</tr>
<tr>
<td>Boiler Inlet Rel. Height [-]</td>
<td>0.940 – 0.999</td>
<td>38.97 – 39.10%</td>
</tr>
<tr>
<td>Boiler Outlet Rel. Height [-]</td>
<td>0.87 – 0.98</td>
<td>38.48 – 40.37%</td>
</tr>
<tr>
<td>Heating System Inlet Rel. Height [-]</td>
<td>0.00 – 0.60</td>
<td>31.04 – 38.97%</td>
</tr>
<tr>
<td>Collector Heat Exchanger UA [%] (variation from identified value)</td>
<td>-50 - +100</td>
<td>37.94 – 39.63%</td>
</tr>
<tr>
<td>DHW Heat Exch. UA [%] (variation from BC value)</td>
<td>-50 - +100</td>
<td>38.83 – 39.15%</td>
</tr>
<tr>
<td>Store Insulation: top [cm]</td>
<td>4 – 34</td>
<td>36.84 – 39.45%</td>
</tr>
<tr>
<td>Store Insulation: sides [cm]</td>
<td>4 – 34</td>
<td>28.69 - 41.21%</td>
</tr>
<tr>
<td>Store Insulation: bottom [cm]</td>
<td>4 – 34</td>
<td>38.84 – 39.02%</td>
</tr>
<tr>
<td>Collector Controller dTstart [K] (constant dTstart/dTstop)</td>
<td>4 – 12</td>
<td>38.94 – 39.06%</td>
</tr>
<tr>
<td>Boiler Outlet Temperature [°C]</td>
<td>61 - 80</td>
<td>35.88 – 41.39%</td>
</tr>
<tr>
<td>Store Charge Thermostat (off) [K]</td>
<td>0 - 2</td>
<td>38.80 – 39.87%</td>
</tr>
<tr>
<td>Store Charge Flow Rate [kg/h]</td>
<td>1500 - 5500</td>
<td>37.57 – 39.13%</td>
</tr>
<tr>
<td>Store Charge Controller Sensor Rel. Height [-]</td>
<td>0.85 – 0.96</td>
<td>36.85 – 38.97%</td>
</tr>
<tr>
<td>Collector Controller Sensor Rel. Height [-]</td>
<td>0.050 – 0.500</td>
<td>38.14 – 39.11%</td>
</tr>
<tr>
<td>DHW charge flow rate [kg/h]</td>
<td>100 - 200</td>
<td>38.24 – 42.00%</td>
</tr>
<tr>
<td>DHW Storage charging time (Day) [h]</td>
<td>9:00 – 13:00</td>
<td>38.90 – 39.14%</td>
</tr>
<tr>
<td>DHW Storage charging time (Night) [h]</td>
<td>0:00 – 4:00</td>
<td>38.80 – 38.97%</td>
</tr>
<tr>
<td>DHW Storage charging temperature [°C]</td>
<td>53 - 63</td>
<td>37.61 – 41.96%</td>
</tr>
<tr>
<td>DHW Storage Volume [m³]</td>
<td>0.15 – 0.30</td>
<td>38.65 – 40.29%</td>
</tr>
</tbody>
</table>

1 The variation if fractional savings indicated in the table does not represent the values for the extremes of the range, rather the minimum and maximum values for the range indicated.
2 The thermostat settings for store charging and electrical heater were NOT changed for these variations. Adjusting the setting to just meet the demand of the period with the highest load would probably lead to different results.

3 The insulation has a conductivity of 0.04 W/m-K and has a correction factor for “imperfection” of $C_{corr} = MAX(1.2,(-0.1815*LN(V_{maiST})+1.6875))*2.5$.

4 The settings for the controller for the charging of the store from boiler were kept constant for all variations (62°C start, 70°C stop).

5 The boiler standby and supply set temperature were set to be 5K higher than the thermostat (off) setting. The thermostat had a constant hysteresis of 8K.

### 2.4 Common Report Structure

A common report structure for the system simulation reports was defined in Subtask C in Task 26. It consists of the following parts:

1. General description of the system
2. Modelling of the system
   2.1 TRNSYS model
   2.2 Definition of the components included in the system and standard inputs data
   2.3 Validation of the system model
3. Simulations for testing the library and the accuracy
   3.1 Result of the TRNLIB.DLL check
   3.2 Results of the accuracy and the time step check
4. Sensitivity Analysis and Optimisation
   4.1 Presentation of results
   4.2 Definition of the optimised system
5. Analysis using FSC
6. Lessons learned
7. References
8. Appendix 1: Description of components specific to this system
3 Systems Modelled

The following 9 Systems were modelled within Subtask C of Task 26 and are described in detail the following appendices to this report. A comparison using the FSC-method is given in [1] and [2]. A more detailed analysis of the simulations can be found in [6].

Systems:

System #2 Klaus Ellehauge, Denmark
System #3a Philippe Papillon, David Chèze,,Clipsol, Aix-les-Bains, France
System #4 Louise Jivan Shah, Denmark
System #8 Jacques Bony, Thierry Pittet, EIVD, Yverdon-les-Bains, Switzerland
System #9b Markus Peter, University Oslo, Norway
System #11 oil, gas Chris Bales, SERC, Borlänge, Sweden
System #12 base Chris Bales, SERC, Borlänge, Sweden
System #15 Dagmar Jaehnig, SOLVIS, Braunschweig, Germany
System #19 Richard Heimrath, IWT Graz, University of Technology, Austria

4 References


