

EAST-GSR

Solar Thermal applications in Eastern Europe with Guaranteed Solar Results



Work package 3

"Adaptation of the GSR Charter to Bulgaria"

Bulgaria

April 2007

Sofia Energy Centre



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Part I

Description of National Conditions for Application of GSR Contract. General framework

1. Bulgaria – Introduction

The Republic of Bulgaria is located in the southeastern part of Europe on the Balkan Peninsula.

The climate is temperate continental with clearly marked four seasons. A Mediterranean influence is felt in the country's southern regions. The average annual temperature is 10.5°C. The average January temperature is around 0°C. Average summer temperatures rarely exceed 30°C.

In Bulgaria the average annual period of sunshine is about 2,100 hours, in some of its regions it may reach 2,500 hours. The solar monthly radiation changes during the year from 41-52 kWh/m² in January to 200-238 kWh/m² in July. Annually on horizontal surface, for different sites, the total solar radiation varies between 1,400 kWh/m² and 1674 kWh/m². The above data shows that the climatic conditions and the high rates of solar radiation in Bulgaria are ideal for the exploitation of solar energy for thermal energy production. Solar collectors for domestic hot water (DHW) production can be used almost everywhere in the villages and in the towns, in hotels, holiday houses, municipality buildings (hospitals, kinder-gardens, etc.), multi-storied buildings, etc.

2. Background of implementation of solar collectors

The first Bulgarian solar thermal collectors have been of panel type radiators with area of 2 m², next step of design was the flat plate collectors with area of 1,46 and 1,76 m². The first Bulgarian solar collector was designed and produced in 1977. The state enterprise “New Energy Sources” (NES) was in a position to solve technical problems related to research, design, testing, manufacturing and assembling of solar thermal installations. NES implemented a large – scale governmental programmed for designing, the manufacture and installation of 50,000 m² solar collectors. These collectors were installed during 1977 – 90 mainly in the tourist facilities for hot water supply at the Black sea coast. Solar collectors were also applied in industry for DHW and for drying agricultural products.

Most of the collectors installed comprise of steel absorbers, black coating, single glass cover and galvanized steel collector surrounding. The pipes for installations are 99% from steel.

However, the low quality of the equipment and the installations made in Bulgaria, and the lack of maintenance in many of the early installations resulted in a dissatisfaction, creating for a moment an additional barrier to further solar energy utilization.

For the last 15 years within different programs many solar thermal demo projects have been implemented. But it should be mentioned that the R&D activities, manufacturing and installation of solar collectors have almost stopped since 1990 because of the economy reformation and resulting difficult economic situation.

In 2002-2003 the market of solar thermal systems in Bulgaria started to develop again at good rates. Of great importance at this still early stage on this market are the correct and professional sizing, implementation and maintenance of the solar systems.

3. Products and suppliers of solar systems

In Bulgaria there are only a few factories, which produce flat solar collectors. Most of them import the absorbers and the rest is produced and assembled in Bulgaria. There is no production of vacuum tube collectors in the country. There is import of solar collectors from Greece, Germany, China, France, Turkey, etc.

In the following table are given the manufacturers and distributors of solar thermal equipment.

Manufacturers and distributors of solar thermal equipment

<p>1. ERATO 6300 Haskovo; 67 “Saedinenie” Boul. Tel. 00359 38 662012 Fax.00359 38 661356 E-mail: toplo@erato.bg www.erato.bg</p>	<p>2. EKOTEHPRODUCT 66, Dimitar Manov Str. 1408 Sofia Tel. +359 2 541267 Fax. +359 2 547206 Contact: Mrs. Rajna Zlatareva</p>
<p>3. ECOTHERMENGINEERING LTD. CO. 51, Varban Genchev Str. Students Town 1100 Sofia Tel. +359 2 688207 Fax. +359 2 689137 Contact: Mr. Venelin Stojnov</p>	<p>4. ECOTHERMENGINEERING LTD. CO. 51, Varban Genchev Str. Students Town 1100 Sofia phone: +359 2 623119, fax: +359 2 689137 Contact: Mr. Emil Stojanov</p>
<p>5. ZAVOD ZA NOVI ENERGIJNI IZTOCHNITSI Razgrad Tel. +359 84 29521 or 26845, Fax. +359 84 32252 Contact: Mr. Georgi Georgiev, Director</p>	<p>6. ENERGOCONSULT – SR Sofia “Strelbishte” bl. 100 en. B ap. 49 Tel/fax. 00359 2 859 57 91 E – mail: mirkov@mobikom.com</p>
<p>7. “TERMOKOMPLEKTENGINEERING” 1, Komi Str. 4000 Plovdiv Contact: Mr. Jordan Popov</p>	<p>8. SOLKAV BULGARIA LTD Sofia, 31A Dragan Tzankov Blvd. Tel. +359 2 9608130, Fax. +359 2 9608131</p>
<p>9. “TERMO PROMENERGO, BLAGOEVGRAD” STATE CO. 2700 Blagoevgrad, kv. Bjalo Pole Tel. +359 73 20800 or 20805 Contact: Mr. Aleksander Tunov, Director</p>	<p>10. BG THERM LTD 17, “Acad. St. Mladenov” Blvd. Tel. +359 2 9697122, Fax. +359 2 8625410 Pleven: Tel. +359 64 823037 www.bgtherm.com</p>
<p>11. PROMISHLENA ENERGETIKA (Industrial Energy) 5, Philip Koutev Str. 1407 Sofia Tel. +359 2 681235, Fax. +359 2 687401, 681135 Contact: Mr. Ivan Lambriev, General Manager</p>	<p>12. APEX MM Sofia 49. Bulgaria Boul. Tel. + 359 2 955 61 65 Cell. +359 888 62 95 22</p>

13. ECOTHERMAL Bourgas 8000 Slivnitza str. 47 Tel. + 359 56 814215; + 359 2 979 05 45 Fax. + 359 56 841522; + 359 2 979 19 38 E – mail: ecothermal@ecothermal-bg.com www.ecothermal-bg.com	14. KOVEX 1606 Sofia 34 Totleben Boul. Tel. + 359 2 952 1772 Fax. + 359 2 952 65 69 E – mail: kovex@omega.bg
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4. Test Procedures for Solar thermal equipment

There is no laboratory in Bulgaria for testing solar collectors, which is authorized to give the needed certificates. Therefore no quality certificate can be granted for collectors made in Bulgaria. At present, a test laboratory (one stand) is being constructed for experimental testing of solar collectors in real conditions, i.e. they carry out experimental testing (Stand for Solar Water Collector Testing: Central Laboratory of Solar Energy and New Energy Sources – BAS, 72, Tzarigradsko chaussee blvd., 1784 Sofia, tel.:+359 2 778 448, fax: +359 2 754 016).

The imported solar collectors, as well as the imported absorbers have the necessary certificates for the respective characteristics. In Bulgaria no additional testing for their qualities is made when they are imported.

5. Standards for Solar Thermal Systems and Components

List of Existing Bulgarian Standards for Thermal Solar Systems and Components

БДС EN 12975 – 1: 2006	Thermal solar systems and components – Solar collectors – Part 1: General Requirements
БДС EN 12975 – 2: 2006	Thermal solar systems and components – Solar collectors – Part 2: Test methods
БДС EN 12976 – 1: 2006	Thermal solar systems and components – Factory made systems – Part 1: General Requirements
БДС EN 12976 –2: 2006	Thermal solar systems and components – Factory made systems – Part 2: Test methods
БДС EN 61725: 2004	Analytical expression for daily solar profiles (IEC 61725: 1997)
БДС ENV 12977 – 1: 2002	Thermal solar systems and components – Custom built systems – Part 1: General Requirements
БДС ENV 12977 – 2: 2002	Thermal solar systems and components – Custom built systems – Part 2: Test methods
БДС ENV 12977 – 3: 2002	Thermal solar systems and components – Custom built systems – Part 3: Performance characterization of stores for solar heating systems

6. Dimensioning and calculation methods

In Bulgaria there is no accepted common method for calculation and sizing of solar collectors. The different importers and distributors of solar collectors have different software programs with which they work. The information about the climate required in order to design solar thermal engineering systems includes:

- Solar radiation;
- Atmosphere air temperature;
- Relative air humidity;
- Movement of atmosphere air (wind velocity).

The value of each one of these qualities is obtained statistically: the measurement in hours, days, months or years made for the considered period are average and are accepted as “representative” for the respective time period and region.

The most accurate is the definition of the “representative year” which includes values per hour of solar radiation, air temperature and humidity, barometric pressure and wind speed throughout the year (a total of 8760 values per hour). These values are used for practical purposes.

In Bulgaria the following inclinations for collector operation are recommended:

- 30° for the summer
- 42° for the whole year

In addition to the necessary data for the climate the following initial information is necessary:

- Selection of the basic solar system diagram;
- Hot water consumption (average per day) and selection of hot water temperature;
- Orientation and collector field tilt depending on the roof structure type and orientation;
- The necessary specific collector area;
- The area of the collector field (the number of collectors).

Based on the above mentioned necessary initial information and after the input of the necessary data in the software program which is different for the different suppliers of solar collectors the resulting solar thermal energy is calculated.

For being able to guarantee the solar thermal results, the dimensions of the solar installations must be determined by qualified experts. As it was stated above, Bulgaria is in the beginning of developing solar thermal systems market and there is a lack of good specialist for implementation of solar thermal systems.

7. Contract

The solar thermal systems market in Bulgaria is still in its initial stage of development. This determines the Contractor (a legal person or an organization) to sign a contract for implementation of a Solar system for domestic hot water. In this Contract the Contractor is responsible for the design, supplying the components, installation and putting the system into operation. For the maintenance of the system an additional contract is usually signed.

Until the present moment the result from the installation of a Solar system were calculated by comparing the energy consumed for the necessary DHW before and after the installation of the system. There was no guarantee for the solar energy that had to be supplied.

Guaranteeing the solar result at the present state of the market of solar systems can be applied in the contract for building the solar system itself.

The guaranteed solar result is a quality approach to the building of Solar thermal systems. The advantages of the GSR quality approach for the Client as well as for the Contractor are:

- There is no financial risk;
- The maintenance that the Contractor provides gives assurance for the quality implementation of the system;
- Easy access to bank loans as everything in the Contract is clear and it takes into account a compensation approach;
- Easy evaluation of the effect on the environment with a potential access to public subsidies.

These advantages are preconditions for the acceptance and application of the Guaranteed Solar Result, which is a part of the Contract for building the solar system.

In Part II is given an appropriate for Bulgaria contract.

8. Contract partners and their mission

The contract is signed by the Client on one side, and by the Contractor on the other, who undertakes the building of the Solar thermal energy and guarantees the supply of annual amount of thermal energy, i.e. Guaranteed Solar Result (GSR).

Who can be the client in Bulgaria?

The following main clients for big solar systems (> 50 m²) in Bulgaria have been defined:

- **Public** (state and municipality buildings)

This category includes buildings such as: hospitals, kinder-gardens, social houses, elderly people's homes, etc.

- **Private**

This category includes mainly:

- Hotels, holiday houses, campings, swimming pools;
- Multi-storied building (mainly new buildings);
- Industry – for wood processing and agricultural products.

The GSR Contracts are extremely important both for the public and the private clients. The GSR Contract guarantees that the contractual solar thermal energy will be supplied. This means a quality execution and transparency and gives the client assurance as well as the opportunity for a bank credit.

In the case of a public client, calls for tenders are obligatory.

Who can be guarantor for GSR?

In Bulgaria there are few companies that produce flat solar collectors with ordinary or selective absorber. The selective absorbers are not manufactured in Bulgaria; they are imported. The vacuum tube collectors are also imported.

The manufacturers and importers of solar collectors in Bulgaria act as technical consultants and Contractor, i.e. they design the solar thermal systems, they provide the equipment (solar collectors, boilers, etc.), and install it. For the installation of the solar thermal systems in some cases they have their own installers, and in other cases they use subcontractors. For maintenance of the installation a separate contract is usually signed.

Taking into account the above mentioned, it is most expedient for Bulgaria the guarantor to be the Contractor (technical consultant). A legal grouping of companies, responsible for the various missions of realization and with the ability to fulfill the financial obligations under the GSR contract is possible, but is not recommended. The Contractor (technical consultant) could be in charge of the follow up of the measurements. He should respond to exploitation problems of the Solar thermal system that may arise and especially in cases when the supplied quantities of hot water are less than the guaranteed.

9. Measurements

Up to now in Bulgaria the obtained solar thermal energy is usually not measured. The result of the implementation of a Solar thermal system is determined by comparing the bills of the energy carrier (electrical energy, liquid fuels or natural gas) for DHW production before and after the installation of the Solar thermal system. Until the present moment in the country the Guaranteed Solar Result (GSR) principle hasn't been applied and therefore there are no telecontrol units installed. The implementation of a telemonitoring pilot system in Bulgaria will be the first of its kind.

Part II – Contract for guaranteed solar results

The present contract is established between:

The Contractor:

Organisation: _____

Address: _____

Town/Region: _____

Country: _____

Telephone: _____

Fax: _____

Fiscal Identification Number: _____

and

The Client

Organisation: _____

Address: _____

Town/Region: _____

Country: _____

Telephone: _____

Fax: _____

Fiscal Identification Number: _____

Article 1 - Subject

1.1. The subject of the present Contract is **Guaranteed Solar Result (GSR)** from a Solar thermal system for domestic hot water (DHW). The Contract is for definite time period, in accordance with article 2.

The Contractor takes responsibility before the Client to build a Solar thermal system and to guarantee the supply of the contractual solar energy by ensuring the execution of the following:

- design;
- supply of solar collectors and the other components (boilers, etc.) for the system;
- installation and putting into operation the system;
- supply and installation of monitoring systems for reporting the received quantities of solar energy;
- data gathering and evaluation of solar performance;
- supply of maintenance service during the whole Contract period¹;
- management of the Contract and reporting.

1.2. the present Contract can consist of two parts, namely:

- for the purchase of Solar thermal system;
- for the providing GSR guarantee.

1.3. All technical issues of the Solar thermal system and the monitoring system are given in the Technical annex of this Contract, which is an integral part of the Contract.

1.4. The Contractor shall start the work following the date of signature of the Contract by the last of the duly authorised representative of the parties.

Article 2 – Guaranteed solar result

2.1. The guaranteed solar result (GSR) is a guarantee, with which the Contractor guarantees a contractual amount of solar energy, that the Solar thermal system will provide to the Client annually. This amount is set by the Client and depends on the domestic hot water consumption, defined in paragraph 2.3 of the Technical Annex.

Guaranteed solar result (GSR) = kWh/year.

2.2. The measurements of the supplied solar energy and the consumed domestic hot water are done in accordance with the measurement scheme provided in Chapter 4 of the Technical annex.

2.3. The result calculation is verified in two phases:

a) verification phase;

¹ In the case the maintenance is provided by a separate (existing) contract with a third party, the Contractor must decide whether to accept the existing maintenance or demand for it a new contractual agreement.

b) confirmation phase.

- 2.4. The 1st phase (verification) shall start after the start of operation of the Solar thermal system. This phase shall last for a continuous period of 12 months².
- 2.5. During the verification phase the Contractor may make whatever modifications it believes necessary to the Solar thermal system, in order to optimise the installation and to ensure that the Guaranteed Solar Results will be fulfilled.
- 2.6. In case that art. 2.5. is applied, the Contractor shall send to the Client a description of the modifications. If there is no objection from the Client within working days, the Client is supposed to have agreed to such modifications. Any such modifications shall be entirely at charge of the Contractor.
- 2.7. The second phase (confirmation) shall start at the end of the verification phase, unless a delay interval is agreed between the parties with written communication.
- 2.8. The confirmation phase shall have a duration of.....(3 years³).

Article 3 – Installation price and payments

- 3.1. The reference total price paid by the Client for the complete Solar thermal system is taken to be:

(TSP) Total System Price = _____ leva (BGN)

It includes:

- system design and supply of all materials and components;
- plant installation;
- supply and installation of (tele-)monitoring systems;
- data gathering, processing and evaluation of solar performance;
- supply of maintenance service during the whole contract period;
- contract management and reporting.

Part of the Total System Price, amounting to 10% (ten per cent), the Client can withheld for a period up to 30 days after the date of acceptance of the Final report to be delivered by the Tenderer at the end of the confirmation phase.

- 3.2. The Contractor expressly renounces to any change of the system price, due to the increase of the labour cost, to unforeseen difficulties in the execution of the work and to design changes (except those changes that may be imposed by the Client). **In particular, the Total System Price is fixed and not subject to any escalation clause.**

² One year is recommended because it covers the variation in insolation and hot water consumption throughout four seasons. A shorter period may be used if a agreed in writing between the parties.

³ Three years are recommended in order to take into account the seasonal variability.

- 3.3. In case the Guarantee for the Solar Results is not fulfilled and a compensation has to be paid by the Contractor to the Client, the payment will be made at the end of the confirmation phase after the acceptance by the Client of the Final report. The 10% of the Contract price withheld by the Client will be taken into account for the compensation.

Article 4 – Terms of guarantee

- 4.1. The period of validity of the Guarantee shall cover all the phases,(verification phase and confirmation phase), as described in the preceding article 2. The Guarantee period ends at the end of the confirmation phase, after the Client has accepted the Final report.
- 4.2. The Contractor guarantees that the Solar thermal system shall supply, on average kWh/year⁴ of solar energy for the period of the confirmation phase, conditional upon the reference monthly hot water consumption levels, listed in the Technical Annex at paragraph 2.3.
- 4.3. The total quantity of solar energy guaranteed during the confirmation phase is taken as the sum over the whole confirmation period of the individual monthly figures, as specified in the Technical Annex, paragraph 2.5.
- 4.4. The method used to calculate the level of guaranteed solar energy and reference data to be used in the calculation are specified, respectively, in Chapter 3 of the Technical Annex.
- 4.5. If, at the end of the confirmation phase, the contractual energy amount to be guaranteed is not attained, a compensation value for the Client will be calculated according to the procedure outlined in the following articles 5.1 to 5.6.

Article 5 – Compensation

- 5.1. The amount of solar energy to be guaranteed is confirmed if the total level of hot water consumption attained is equal or greater than the amount foreseen.
- 5.2. In the case the hot water consumption level for any month during the confirmation phase is lower than the reference level for that month, the guaranteed solar energy amount for that month has to be recalculated according to the accepted method, using the actual, measured hot water consumption.
- 5.3. According to the provisions of art. 5.1 and 5.2, compensation is due whenever the solar energy production level measured during the confirmation phase is lower than the guaranteed target. In this case, the Contractor will compensate the Client.
- 5.4. The compensation value (CV) is expressed as follows:

⁴ The annual average guarantee of solar energy supply, given in art. 4.2, is the sum of the guaranteed monthly figures for one year, from January to December.

$$CV = (1 - L) \times TSP$$

Where:

$$L = \frac{\text{Solar energy supplied (SES) during the confirmation phase period}}{\text{Solar energy guaranteed (SEG)}}$$

TSP – Total System Price

- 5.5. The compensation amount will be paid at the end of the confirmation phase according to the compensation value given in article 5.4. The Client is entitled to also receive interest over the compensation amount for the duration of the confirmation phase.
- 5.6. If the level of fulfilment of the Guarantee 'L' is equal to or higher than one, neither compensation nor additional payment is due.

Article 6 – Acceptance of the work

- 6.1. The acceptance of the system, made by comparing the in-situ installed components with those described in the Technical Annex and by checking the working performance of the whole system.
- 6.2. The Client shall release to the Contractor a provisional acceptance of the Solar thermal system withindays from its completion. Such provisional acceptance authorises the beginning of the verification phase.
- 6.3. The Contractor shall supply means and tools in order to allow the Client to check the system working performance.
- 6.4. At the end of the confirmation phase the Contractor shall deliver to the Client a Final report in which the results of the performance of the Solar thermal system and the eventual compensation value are duly described.
- 6.5. Within 30 days from the delivery of the Final report, mentioned in article 6.4, the Client shall sign a acceptance of the Solar thermal system results. If a compensation is due, the Contractor will pay to the Client the compensation, calculated according to the art. 5.4 above within.....days from the acceptance.
- 6.6. In case the Client disagrees with the results described in the Final report he shall, within 30 days from the receipt of the Final report, inform the Contractor by a written communication to be sent by registered mail.

Such communication entitles the Client to retain the last 10% of the Contract price still due to the Contractor until a final agreement is reached.

Article 7 – Monitoring system

- 7.1. The Contractor shall ensure that a suitable monitoring equipment is installed and that the level of monitoring are sufficient to obtain, at least, the following figures needed to the check of the GSR:

- the level of hot water consumption,
 - the solar energy supplied,
 - the auxiliary energy consumption for heating the DHW to the agreed temperature.
- 7.2. The Contractor shall be responsible of the regular collection and analysis of the data related to the Solar thermal system and of periodical (annual) reporting of system performance to the Client.
- 7.3. The Client, at his own expenses, may request an independent third party to verify the monitoring procedures and results..
- 7.4. Testing and maintenance of the monitoring equipment shall be the responsibility of the Contractor.
- 7.5. The Contractor shall supply, at least every year, and at the end of the confirmation phase, a written documentation of monthly energy performance of the system. The data will be delivered in an official report prepared by the Contractor and co-signed by the contracting parties.
- 7.6. The telemonitoring system should be connected to the telephone network. The telephone line with simple connection is at the client expense.

Article 8 – Maintenance of the installation

- 8.1. The Contractor shall be responsible for the maintenance of the solar thermal system during the whole period of validity of the present Contract.
- 8.2. During the period of validity of the Contract, any necessary interventions required for ensuring a proper operation of the system shall be undertaken by the Contractor at its own expenses.

Article 9 – Damages to the Solar thermal system

- 9.1. Throughout the period of validity of the present Contract, the Client is responsible for any theft or damage to the solar thermal system. The existence of this GSR Contract should in no way represent an insurance against the risks the system may incur.
- 9.2. If the Solar thermal system is damaged due to a force majeure event, the necessary repairs will be carried out by the Client in agreement with the Contractor. The costs incurred for such repairs shall be at charge of the Client.
- 9.3. If the Solar thermal system is damaged due to a force majeure event and the Client does not undertake satisfactory repairs within..... days, then the Contractor is relieved of its remaining obligations deriving from the present Contract.
- 9.4. If the Solar thermal system is damaged due to a force majeure event, the time during which the system was not working shall not be considered part of the period of the guarantee. Instead, the appropriate phase and the whole guarantee

period will be extended by the time that the Solar thermal system and/or monitoring systems were not working.

Article 10 – Additional issues

- 10.1. In case the Contractor intends to subcontract part of the work to other companies, he shall first ask a written authorisation of the Client. In any case the Contractor obligations remain fixed and firm towards the Client.
- 10.2. Under no circumstance may the Contractor transfer its obligations deriving from the present Contract to a third body such as a subcontractor or a supplier of goods.
- 10.3. Any modification to the present Contract and its annexes shall be the subject of a written agreement duly signed by the authorised representatives of the Contractor and the Client.
- 10.4. The present Contract shall be governed by the law of Republic of Bulgaria.
- 10.5. In case of a dispute or a disagreement between the Parties arising in connection with this Agreement, the Parties shall first endeavour to settle it by amicable discussions. If such effort fails, then the dispute shall be brought before a Bulgarian Court.
- 10.6. In the case of legal proceedings between the parties involved concerning the results, calculations of the GSR or the compensation, the Client can propose a procedure of arbitration.
 - The arbitrator will be chosen by the demander and proposed for acceptance by the opposite party.
 - The expenses for the arbitration established by the arbitrator will be provided in equal amounts by the parties involved. After the arbitration, the expenses will be covered by the losing party.
 - In order to carry out the required verifications, the arbitrator will be obliged to use the data and the calculation methods specified in the Contract documents.
- 10.7. The following annexes form an integral part of the present Contract and they are accepted by both parties by signing the contract.
 - 1) Technical Annex;
 - 2) Calculation Model Description;
 - 3) Technical documentation of the Solar thermal system

SIGNATURES:



For the Contractor:

For the Client

Name:.....

Name:

Date:.....

Date:.....

Technical Annex

1. SOLAR THERMAL SYSTEM FOR DOMESTIC HOT WATER (DHW)

- 1.1. The Solar thermal system starts at the connection point of the cold water and ends at the connection point of the DHW distribution network.
- 1.2. It is composed of all the elements needed to obtain a GSR.
- 1.3. Its situation and the disposition needed for its installation is specified in the Contractor specifications (Description of the works and plans)

2. CALCULATION BASIS FOR THE SOLAR THERMAL SYSTEM AND ITS PERFORMANCE

2.1. Calculation method

The Solar thermal system performance will be calculated by the Contractor according to the program and methods used by him.

2.2. Meteorological data

Outdoor temperatures: the conventional reference figures will be the average daily temperatures issued by the National Meteorological office; they are shown below:

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
...

Solar radiation: This is based on the global solar radiation on a horizontal plane or, if these figures are not available, on the hours of sunshine measured in the reference station. These figures in kWh/m².month, for a Southern orientation and a slant of°, are as follows:

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
...

2.3. Domestic hot water consumption data

Cold water temperature for the different months is as follows:

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
...

Temperature of the domestic hot water, The conventional reference temperature of the domestic hot water entering the distribution circuit for use is fixed at..... ° C.

which the system operates (meteorological, situation, etc.) and the characteristics of the solar collectors and the solar system.

This amount will be more than or equal to $f = \dots\dots\dots/10$ of the calculated estimation of the solar energy supply, shown in the table below:

$$\text{GSE} = f \times \text{EES} = \dots\dots\dots \times \dots\dots\dots = \dots\dots\dots \text{kWh/year}$$

3.2 Verification of the results calculations

The guaranteed results are partially based on the meteorological data and on the behavior of the client (for the hot water consumption), both of which are beyond the control of the Contractor.

The measured solar energy supply will not necessarily reach the forecast results during the first year of operation and this can be the case in spite of the application of the reduction ratio provided for the previous paragraph.

3.2.1. Verification at the end of the first year

The energy supply, recorded by the monitoring system during the verification period, is compared with the calculated estimation obtained by the method using the real meteorological data and the hot water consumption measured by the meter on the cold water inlet pipe as specified, the consumption is compared with the reference figures stated in paragraph 2.3.

If, during a given month, the average daily domestic hot water consumption is less than 50% of the reference figure stated in paragraph 2.3, the energetic performance for the month is neutralized.

When this work has been completed, at the end of the first year, a verification contract is established, the results obtained are recorded.

If the energy supply is less than $f\%$ of the newly calculated estimate the Contractor is responsible for making the improvements needed to attain the guaranteed results during the following years.

3.2.2. Verification at the end of the GSR period

During the confirmation phase the meteorological hazards are considered to be nonexistent; there is just the measured hot water consumption that can affect the guarantee, as the contractual temperature for the hot water supply is displayed and cannot be changed.

If, during a given month, the average daily hot water consumption is less than 50% of the reference amount stated in paragraph 2.3, the energetic performance for that month is neutralized; however, this neutralization has no effect on the duration of the confirmation phase.

The estimated hot water supply for the confirmation phase is re-calculated for every month during the period in which the energetic performance has not been neutralized, using the measured monthly hot water consumption figures, leveled off at the reference figures stated in paragraph 2.3.

If the measured amount of energy supplied, since the system was put into operation (minimum duration 3 years) is more than or equal to the estimated energy supply, the Contractor has no contractual obligation in relation to the client.

4. PERFORMANCE VERIFICATION OF THE SOLAR THERMAL SYSTEM

The need to attain a given result makes it necessary to survey the good working order of the installation all the time and measure the performance of the installation throughout the period of the Contract.

For this reason, the system must be equipped with a telemonitoring apparatus connected to the telephone network

4.1 Functions of the telemonitor

The function of a telemonitoring apparatus that can be questioned at a distance by telephone is twofold:

- ensure a permanent control of the solar thermal system performance and the working order of the different components,
- inform the system manager immediately in the case of a breakdown or a failure of one of the components.

For these reasons, it is an essential tool needed to obtain “guaranteed” results.

4.2 Description of the measurements

The functions proposed for this installation are as follows:

- Measurement of the “useful” solar hot water energy by means of an impulse flow meter installed on the cold water inlet pipe to the solar hot water storage, a temperature sensor on the cold water inlet to the first solar storage tank (T1) and a solar hot water temperature sensor on the outlet pipe from the last solar storage tank (T2).
- Measurement of the “useful” hot water back-up energy supply by means of the same flow meter, a back-up hot water temperature sensor on the back-up outlet pipe (T3).
- Measurement, in the technical premises, of the temperature of the fluid coming from the collectors.
- Control of the duration of the primary and secondary pump operation.

The data logging station can be a NAPAC Solar TBC version MUC 5 or similar. It will be installed in an electricity box independent of the main electricity controls.

It will be supplied in monophasic 220 V current with a protection fuse. The telephone connection will be equipped with a lightning conductor. Furthermore, it will be connected to:

- the flow meter impulse emitter with 2 x 1 mm wiring or 1,5 mm² screened cable;
- four temperature sensors, type Pt 1000, fixed on the steel or copper pipes with Rilsan ring clamps and 2 x 1 or 1,5 mm² cable.

The sensors should be NAPAC type or Heraeus reference P12 DZR0, they will be applied to a straight stretch of pipe with a clean surface. They will have a perfect thermal insulation.

The sensors include:

- a cold water sensor (T1) to be installed on the main cold water inlet pipe at a distance of at least 3 meters from the hot water storage tank inlet.
- a solar hot water sensor (T2) to be installed on the solar storage tank outlet pipe leading to the back-up heat exchanger, at a distance of at least 2 meters upstream of the cold water inlet.
- a back-up hot water sensor (T3) to be installed on the domestic hot water outlet pipe of the back-up storage tank.
- a collector outlet sensor (T4) to be fixed on the main pipe connecting the collectors to the heat exchanger, as close as possible to the heat exchanger.

Furthermore, the telemonitoring equipment will be connected to the auxiliary contacts of the primary and secondary command switch.

The connection of the auxiliary contacts will be made with screened wires 2 x 1 or 1,5mm².

The connections to existing wiring or any additions should be exclusively soldered with tin. These connections will be protected by a thermo-retractable sleeve. The wiring will be fixed to existing cable tracks.

4.3 Monitoring

The monitoring will be conducted by

The “guaranteed” energy corresponds to the solar hot water energy supply.

The datalogger will be questioned every week, the collected data will be stocked and processed.

The processed data will be published at the end of each month in the form of a statement that will be sent to all the partners.

The purpose of this “solar statement” is to materialize the energetic performance and the conventional energy savings.

5. MAINTENANCE

The Contractor is expected to ensure the good working order of the Solare thermal system during the whole period of validity of the Contract.

The Contractor ensures the replacement at his expense of all the equipment that he has supplied that does not carry out its function during the guarantee period and he remains the only person responsible for breakdowns and the resulting energy loss, with respect to the client.

His obligations are not binding if he can prove that the damage was caused by outside circumstances or an act of God.

Maintenance contract

Over and above the contractual guarantee year, the Contractor will ensure the maintenance of the installation throughout the period covered by the GSR, that is years more than the normal contractual guarantee.

This Contract will be limited to the maintenance of the Solar thermal system + the back-up, from the cold water inlet to the hot water outlet in the technical premises, the hot water distribution network is excluded.

It will cover:

- replacement (supply and work time) of all the small consumable components (watertight joints, fuses, display lights),
- replacement of spare parts (collector connectors),
- carrying out tasks such as topping up the primary circuit (work time),
- eventual cleaning of the collector glazing,
- carrying out checks, other than the normal verifications described below, requested by the Contractor or the Client within the limits of the planned annual maintenance time.

Important equipment can only be replaced after the client has accepted an estimate.

There will be at least four annual maintenance interventions, that is every three months, the average length of time will be 4 hours or 16 hours per annum.

Interventions can be called for by the Client or the Contractor with confirmation by fax. In this case, the delay should never be greater than 48 hours and the intervention will replace one or more obligatory visits depending on its duration, except when it is the object of a separate invoice.

For each maintenance visit, the company must fill in an official register, that it has supplied:

- the date, the time, the weather (sunny, cloudy passages, cloudy),
- the flow meter readings (main cold water meter, solar storage tank inlet meter equipped with an impulse emitter),
- the primary circuit pressure marked on the manometer situated close to the expansion chamber,
- check which of the motors or pumps (1 or 2) primary and secondary is operating,
- the state of the primary and secondary pumps (operating or stopped) and their intake suction and compression (in forced operation if necessary),
- the temperatures of the primary and secondary circuits entering the heat exchanger when the pumps are operating.

Twice a year, the company should also carry out a quick verification of the outdoor installation (collectors, pipes, valves, flexible connectors).

Any anomaly, including the state of cleanliness of the collector glazing, should be recorded in the maintenance register and should be included in a report to the contractor who will decide if the client should be informed.

SIGNATURES:

For the Contractor:

For the Client

Name:.....

Name:

Date:.....

Date:.....