

MULTISOLAR

Development of an integrated solar system for buildings



COOP-CT-2004-508439

FINAL ACTIVITY REPORT

Preparation date: 14th of March 2008

Start date: 6th of September 2005

End date: 7th of January 2008

CONTENTS

Publishable executive summary	4
Section 1 – Project objectives and major achievements during the reporting period..	5
Section 2 – Work package progress	5
1. Workpackage A: Review of the concept / Energy analysis / Architectural analysis	5
1.1. Objectives and starting point of work at the beginning of the period.....	5
1.2. Progress towards objectives	5
1.3. Deviations from the work programme and corrective actions	6
1.4. List of deliverables	6
1.5. List of milestones	6
2. Workpackage B: Design of the system components.....	7
2.1. Objectives and starting point of work at the beginning of the period.....	7
2.2. Progress towards objectives	7
2.3. Deviations from the work programme and corrective actions	8
2.4. List of deliverables	8
2.5. List of milestones	8
3. Workpackage C: Manufacturing of the components	8
3.1. Objectives and starting point of work at the beginning of the period.....	8
3.2. Progress towards objectives	8
3.3. Deviations from the work programme and corrective actions	9
3.4. List of deliverables	9
3.5. List of milestones	9
4. Workpackage D: Development of Field tests	9
4.1. Objectives and starting point of work at the beginning of the period.....	9
4.2. Progress towards objectives	9
4.3. Deviations from the work programme and corrective actions	10
4.4. List of deliverables	10
4.5. List of milestones	10
5. Section 3 – Consortium management.....	10
6. Section 4 – Other issues.....	11
6.1. Contribution of the RTD performer to assist the SME in solving their problems.....	11
6.2. Balance of work/resources	11
7. Annex I – Plan for Using and Dissemination of Knowledge	13

7.1.	Section 1 – Exploitable Knowledge and Use	13
7.2.	Section 2 – Dissemination of Knowledge.....	13
7.3.	Section 3 – Publishable Results	13
8.	Annex II – Deliverable and Milestone List	14

PUBLISHABLE EXECUTIVE SUMMARY

The European Union is the largest energy importer and the second energy consumer in the world. The EU demand for energy has been growing at a rate of between 1 and 2 % a year since 1986. Internal resources are inadequate to meet this demand, as Europe is using far more energy than it can produce. Despite the considerable progress made in tapping conventional energy reserves in Europe, their levels remain low and they are expensive to extract. Even though the Candidate States are currently behind the Member States in terms of energy consumption, the long-term evolution of their energy demand will doubtless track that of the Union. While industrial needs has been relatively stable, as a result of the transition to service oriented economy, the increased demand for electricity and heat from households and the tertiary sector has more than compensated this decline.

The objective of the MULTISOLAR project consists in the study, development and integration of a new generation of solar panels in a building, capable of replacing the energy demands, be it electric power, hot water or hot air for heating. This will lead to improvements of these facilities regarding the individualised systems in use. The purpose of this type of panels is to serve as structural element of the building, forming part of the structure and covering walls and roof, giving it a good aesthetic impression together with the glass surfaces that form the panels.

The idea arises from the need to palliate the low performance of the photovoltaic generators that does not usually go beyond 10 or 15%, because in this type of facilities the heat is not taken advantage of in an appropriate way, leading to a loss of approximately 34% of the incident energy and the performance of the apparatus diminish quickly according the temperature of the collector increases, having important losses as soon as the temperature of the cells are between 40-45°C for modern solar panels.

SECTION 1 – PROJECT OBJECTIVES AND MAJOR ACHIEVEMENTS DURING THE REPORTING PERIOD

The major objective of the MULTISOLAR project is the study and development of a new generation of solar panels, capable of replacing the demands, for any type of building, be it electric power, hot water or hot air.

During the project work will focus on:

1. Review of the concept. Energy analysis. Architectural analysis.
2. Design of the system components
3. Manufacturing of the components
4. Installation and integration of the components in an existing building
5. Development of field tests

The project partners accomplished workpackages A and B and workpackage C partially.

SECTION 2 – WORK PACKAGE PROGRESS

1. Workpackage A: Review of the concept / Energy analysis / Architectural analysis

1.1. Objectives and starting point of work at the beginning of the period

Objectives of this workpackage were the adaptation of the standalone design and the integration of the solar collectors in the roof and façade of the Ad Fontes building.

1.2. Progress towards objectives

1.2.1 Task A1: Review of the concept

The concept was reviewed on the basis of literature research and the existing work on the Multisolar collectors as well as the experiences gained in previous tests and applications. It combines both the technical requirements and architectural demands for integration into the facade and roof of a building. A technical description of the Multisolar System will show the rising opportunities for applications with the Multisolar in buildings. Detailed information on the Multisolar concept can be found in deliverable D01.

1.2.2 Task A2: Solar peripheral facility concept

The preliminary concept of the peripheral solar facility was defined by DTU with contribution from the other partners and is described in detail in deliverable D02. This work includes the definition of the concept for the integration into the building in Bad Bederkesa and the preliminary definition of components used in the test building. Moreover DTU carried out simulations in TRNSYS and calculations of the ventilation potential. On the basis of the simulations a conclusion of the preliminary concept is formulated.

1.2.3 Task A3: Energy analysis

The energy analysis of the building where the Multisolar system will be implemented was performed by UMWELT with consulting by APEX and definition of data as well as allocation of plans and technical information by Ad Fontes. This work was one of the first steps to define the required information for the planning of the system. For the understanding of the description of the building service installations it is helpful to know deliverable 02.

The energy analysis provided the building's demands for domestic hot water generation (DHW) and heating (DH). These two energy demands were calculated separately and include all heat losses of pipes, heat generation, stand-by, etc. The sum minus the recovered energy, which is e.g. provided by the heat exchanger of the ventilation system, represents the total annual energy demand of the building. The results were sent to DTU and used for the further simulations regarding the system performance and for the detailed planning of the system.

Additionally, UMWELT made measurements of temperatures of the existing heating installation to achieve information on the system and the user's influence, which were helpful for the following calculations and will be required again for the acquisition of adequate measurement equipment.

1.3. Deviations from the work programme and corrective actions

Some delay occurred in the achievement of the first deliverables due to a delay in obtaining the relevant information.

1.4. List of deliverables

No.	Title	Scheduled month	Status	Date
D1	Requirements of the MULTISOLAR panel to form part of the building	Month 3	✓	30.09.2005
D2	Preliminary concept of the peripheral solar facility	Month 4	✓	23.09.2005
D3	Energy analysis of the building executed	Month 5	✓	15.01.2005

1.5. List of milestones

No.	Title	Scheduled month	Status	Date
M1	MULTISOLAR panels' requirements established	Month 5	✓	30.09.2005
M2	Concept of the peripheral facility decided	Month 5	✓	23.09.2005
M3	Energy analysis of the building executed	Month 5	✓	15.01.2005

2. Workpackage B: Design of the system components

2.1. Objectives and starting point of work at the beginning of the period

Objectives of this workpackage are the design of the Multisolar collectors for integration in buildings, the peripheral solar facility and the bench for the field tests.

2.2. Progress towards objectives

2.2.1 *Task B1: Design of the MULTISOLAR collectors*

The Multisolar collectors were designed by Millennium. Detailed description and technical drawings can be found in the deliverables D04 and D05.

2.2.2 *Task B2.: Design of the peripheral facility*

The design of the solar facility has been a joint effort by the Technical University of Denmark, University of Sevilla, Ceramica Vereva and Maniero Elettronica. A detailed description of the work carried out can be found in deliverable 6. The design of the solar facility has been laid out, with details of the peripheral system, the layout of the laboratory and the implementation in the roof and façade.

After investigating the simulations in deliverable D02, it has been decided to lower the number of collectors to 8, which is about 20 m². It has been done to achieve a higher efficiency on the collectors and for the whole system. To further make efficient experiments possible the free cooling option suggested in deliverable D02 has been implemented.

The 8 collectors are placed in 3 arrays, with 2 arrays on the roof with 3 collectors in each array individually. Details of the control are described in deliverable D07 (Design of the control unit).

2.2.3 *Task B3: Design of the test bench for the field tests*

The implementation of a measurement programme for the detailed measurement of the Multisolar collectors, which will be integrated in a building's roof and façade, has several advantages:

1. Documentation of the system's performance
2. Evaluation of different operational modes
3. Investigation of the interaction of components
4. Definition of the total energy output of the collectors
5. Validation of the control system
6. Definition of optimisation potentials

The measurements will help to improve the Multisolar collectors and the entire system due to the visualisation of the results. Special tests will be performed to test the component's compatibility, the system's performance and the suitability for the domestic hot water generation and indoor heating support.

Since the Multisolar collectors produce three types of energy providing media (electricity, hot water and hot air) at the same time, the test bench for the measurements

has to be equipped with different sensors and meters like heat meters (hot water), mean temperature sensors and flow meters (hot air) as well as power meters (electricity). Beside these measurements for the system output additional measurement of the ambient (weather station and collector temperatures) and the system's inputs as well as the consumption will be considered.

To achieve reliable data a measurement period of at least two heating (winter) and cooling seasons (summer) should be measured. Since the project duration is limited to two years, the measurement period will be reduced. However, it should be possible to measure at least some month of a heating period and of a cooling period.

Thus the performance of the system for both, the indoor heating support and the hot water generation can be evaluated.

2.3. Deviations from the work programme and corrective actions

Some deviations occurred within this work package.

2.4. List of deliverables

No.	Title	Scheduled month	Status	Date
D4	Drawings of MULTISOLAR collectors	Month 7	✓	30.09.2005
D5	Description of MULTISOLAR collectors	Month 7	✓	30.09.2005
D6	Design of the peripheral solar facility	Month 9	✓	28.09.2005
D7	Design of the control system	Month 9	✓	23.09.2005
D8	Design of the test bench for the field tests	Month 9	✓	28.08.2005

2.5. List of milestones

No.	Title	Scheduled month	Status	Date
M4	MULTISOLAR collectors designed	Month 9	✓	30.09.2005
M5	Solar facility and control system designed	Month 9	✓	28.09.2005
M6	Test bench designed	Month 9	✓	Draft available

3. **Workpackage C: Manufacturing of the components**

3.1. Objectives and starting point of work at the beginning of the period

Within this work package the designed collectors will be manufactured at Millennium facilities. Moreover the Multisolar collectors will be integrated in the building of Ad Fontes together with the peripheral system.

3.2. Progress towards objectives

3.2.1 *Task C1: Manufacturing of the MULTISOLAR collectors*

Millennium started to manufacture the collectors for the integration into the building of Ad Fontes. A detailed description of the manufacturing process can be found in deliverable D09.

3.3. Deviations from the work programme and corrective actions

The manufacturing of the collectors started facing a delay of 2 months. This caused a delay for the integration of the collectors on the roof and in the façade of the building.

3.4. List of deliverables

No.	Title	Scheduled month	Status	Date
D9	Report on the manufacturing of the MULTISOLAR collectors	Month 12	✓	30.09.2005
D10	Report on the installation of the facility components and test bench	Month 15	Not completed	-

3.5. List of milestones

No.	Title	Scheduled month	Status	Date
M7	MULTISOLAR collectors manufactured, only 3		✓	30.09.2005
M8	Facility components and test bench installed		pending	-

4. **Workpackage D: Development of Field tests**

4.1. Objectives and starting point of work at the beginning of the period

The aim of this work package is to carry out the field tests necessary to assess and evaluate the performance of the MULTISOLAR system. The required improvements will be recommended after the conclusion of these tests.

4.2. Progress towards objectives

After the Mid-term meeting the project activities stopped totally. The coordinator Millennium did not send the panels, which were necessary for this workpackage. And because of the missing payment all partners stopped their work in the project. After Millennium delivered 3 panels the case studies were accomplished by Umwelt.

4.2.1 *Task D1: Preparation of the case studies*

When Millennium agreed to send some MSS panels a design for a test bench was developed. After three panels were delivered several tests under different conditions were accomplished in the facilities of Umwelt. A report of the case studies was written after a decision about the future execution of the project was made.

4.2.2 *Task D2: Execution of the field tests*

The field test, which was planned at Ad Fontes in Bad Bederkesa were not completed. After the missing payment all work on the necessary components for the tests, like the control system or the installing frames for the panels, were cancelled.

4.3. Deviations from the work programme and corrective actions

The case studies were done with a delay of 12 months, because the panels were sent with this delay by Millenium. The field tests were not started at all.

4.4. List of deliverables

No.	Title	Scheduled month	Status	Date
D11	Report on the case studies considered for the field tests.	Month 15	pending	-
D12	Report on the field tests.	Month 24	Not completed	-

4.5. List of milestones

No.	Title	Scheduled month	Status	Date
M9	Field tests accomplished.	Month 24	Not completed	-

5. Section 3 – Consortium management

The project coordination was performed by Mr. Ami Elazari from Millennium supported by Umwelt. The information flow between the partners was performed by use of usual media systems.

To strengthen the personal contact and to guarantee the transfer of project data and knowledge, several meetings were held at the sites of the partners. The projects' progress and the potentials of every single partner were reviewed on a regular basis (partner visits at the site of the SME and RTD performers).

The kick-off meeting was held in Herzalia (Israel) at the site of Millennium on the 6th of September 2004 where all partners presented themselves and the orientation of the project work was fixed.

On the 26th of November 2004 a work meeting was held at Ad Fontes and on 30th of May 2005 another work meeting took place at Umwelt to present and discuss past and future work.

The mid-term meeting was held in October 2005 in Bremerhaven at the site of UMWELT, where the partners presented their work achieved and discussed the work to be carried out in the second half of the project.

The coordinator did not transfer the advance payment to the partners, which caused several delays and problems in the project activities. Therefore, the Commission requested a trouble shooting meeting. The meeting took place in Raanana, Israel on 05/10/2006, the financial and scientific officers from the Commission attended together with MILLENNIUM, and TTZ who was taking part representing the rest of the consortium.

By a letter dated 23/10/2006 (D/544341), the Commission suspended the project on its own initiative in accordance with Article II.5. Due to the fact that no remedy acceptable to the Commission for the outstanding financial obligations of Millennium was proposed, the Commission notified on a letter dated 09/11/2007 the change of

coordination to TTZ Bremerhaven (Umweltinstitut-Umwelt) and the decision to terminate the contract. The termination became effective on the 07/01/2008. Umwelt was in charge of requesting the information to the partners for the preparation of the final reports.

6. Section 4 – Other issues

6.1. Contribution of the RTD performer to assist the SME in solving their problems

The table below will give a summarised overview about the work of the RTD performer done for the SME. Detailed information can be found in the deliverables.

	Umwelt	US	DTU
Millennium	Scientific project management Development of the test bench	Architectural integration of the collectors	Peripheral design and simulation of the Multisolar system Development of the control unit
Ad Fontes	Energy analysis of the building	Preparation of drawings for the construction work	Peripheral design of the Multisolar system
Verea	Acquisition of the dimensions of the existing building	Architectural design of the roof integration	-
Maniero	-	-	Cooperation for the design of the inverters
APEX	Preparation of the energy analysis	-	-

6.2. Balance of work/resources

The following tables will give a summarised overview about the balance of work and resources done by each partner.

	Work carried out	Resources made available
Millennium	Requirements of the MULTISOLAR panel	<i>Personnel:</i> Engineers, technicians
	Drawings of the MULTISOLAR collectors	
	Description of the MULTISOLAR collectors	
	Manufacturing of the MULTISOLAR collectors	
	Project management	
Ad Fontes	Requirements for the integration of MULTISOLAR collectors in the roof and façade	<i>Personnel:</i> Engineers and technical staff <i>Materials:</i> electric installation for the grid connection
	Preparation of the building adaptation	
Verea	Development of the integration of the MULTISOLAR panels in the roof	<i>Personnel:</i> Engineers, technicians
Maniero	Development of the inverters to be used for the MULTISOLAR panels	<i>Personnel:</i> Engineers, technicians

	Work carried out	Resources made available
Apex	Support of the peripheral MULTISOLAR design	<i>Personnel:</i> Engineers and technicians
Umwelt	Energy analysis of the Ad Fontes building	<i>Personnel:</i> Engineers and technicians
	Design of the test bench for field tests	
	Accomplishment of the case studies	<i>Materials:</i> Weather station, data logger, etc.
	Project management	
US	Architectural design of the roof and façade integration	<i>Personnel:</i> Architects and engineers <i>Materials:</i> licence, etc.
DTU	Preliminary concept of the peripheral solar facility	<i>Personnel:</i> Engineers
	Design of the solar facility	
	Design of the control system	

7. Annex I – Plan for Using and Dissemination of Knowledge

7.1. Section 1 – Exploitable Knowledge and Use

Because of the abandonment of the project no results for exploitation and use was achieved.

7.2. Section 2 – Dissemination of Knowledge

Because of the abandonment of the project no results for dissemination was produced.

7.3. Section 3 – Publishable Results

Due to the actual situation no publication is planned.

8. Annex II – Deliverable and Milestone List

Del.No.	Deliverable name	Date due	Actual / forecast delivery date	Lead contractor
D1	Requirements of the MULTISOLAR panel	Month 03	30.09.2005	MILLENNIUM
D2	Preliminary concept of the peripheral solar facility	Month 04	23.09.2005	DTU
D3	Energy analysis of the building executed	Month 05	15.01.2005	UMWELT
D4	Drawings of MULTISOLAR collectors	Month 07	30.09.2005	MILLENNIUM
D5	Description of MULTISOLAR collectors	Month 07	30.09.2005	MILLENNIUM
D6	Design of the solar facility	Month 09	28.09.2005	DTU
D7	Design of the control system	Month 09	23.09.2005	DTU
D8	Design of the test bench for the field tests	Month 09	28.08.2005	UMWELT
D9	Report on the manufacturing of the MULTISOLAR collectors	Month 12	30.09.2005	MILLENNIUM
D10	Report on the installation of the solar facility and test bench	Month 15	30.11.2005	AD FONTES
D11	Report on the case studies considered for the field tests	Month 15	30.11.2005	UMWELT
D12	Report on the field tests	Month 24	31.08.2006	UMWELT
D13	1 st Project Report	Month 06	15.10.2005	UMWELT
D14	2 nd Project Report (mid-term report)	Month 13	15.10.2005	UMWELT
D15	3 rd Project Report	Month 18	28.02.2006	UMWELT
D16	4 th Project Report (final report)	Month 24	31.08.2006	UMWELT
D17	Use and dissemination of knowledge	Month 1 - 25	30.09.2006	UMWELT
M1	MULTISOLAR panels' requirements established	Month 05	30.09.2005	MILLENNIUM
M2	Concept of the peripheral solar facility decided	Month 05	23.09.2005	DTU
M3	Energy analysis of the building executed	Month 05	15.01.2005	UMWELT
M4	MULTISOLAR collectors designed	Month 09	30.09.2005	MILLENNIUM
M5	Solar facility and control system designed	Month 09	28.09.2005	DTU
M6	Test bench designed	Month 09	28.08.2005	UMWELT
M7	MULTISOLAR collectors manufactured	Month 15	30.09.2005	MILLENNIUM
M8	Facility components and test bench installed	Month 15	30.11.2005	AD FONTES
M9	Field tests accomplished	Month 24	31.08.2006	UMWELT
M10	Mid-term report	Month 13	18.10.2005	UMWELT
M11	Final Reports	Month 24	March 2008	UMWELT