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TNO report
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Final Report EU project EUR-ACTIVE ROOFer period: 21 July 2005 – 20 July 2008 *(including 3rd period activity report)* Contract No COLL-CT-2005-012478

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EUR-ACTIVE ROOFer

HORIZONTAL ACTIVITIES INVOLVING SMEs

Contents

1 Introduction

In the period from 21 July 2005 to 20 July 2008 the EUR-ACTIVE ROOFer project has taken place. This final report of the project gives an overview of activities and results of the project. Also the activities of the 3rd project period are taken up in this report.

1.1 Objectives of the project

The main strategic aim of EUR-ACTIVE ROOFer is to supply tools for the European roofing trade, which enables the European roofer:

1. To respond to the new demands for integration of roof accessories and fittings
2. To upgrade from delivering just roof tiles to delivering total (active) roofs.

This will provide great added value to the building, significantly reduce failures and increases the overall quality of roofs, and in this way enhances the profit of the roofing trade. EUR-ACTIVE ROOFer aims at both newly built roofs and existing roofs, which are aimed to be upgraded towards Active Roofs.

1.2 Main final objectives of the project

The main final objectives of the project are:

1. To set up and complete as far as possible a database for existing and future roof systems.
2. To produce a PV and solar thermal Best Practice catalogue concerning technical and architectural integration techniques for active roofs.
3. To produce a Best Practice guide and legislation proposal for safety devices.
4. To produce a Pre-standard on Active Roofs and introduce it into the EU normalisation circuit.
5. To execute full scale tests of active roofs and take up the experiences into the Best Practice documents
6. To produce a Guideline for Design and Application of Active Roofs
7. To set up and produce a Training Programme for Active Roofers
8. To disseminate the produced roof information via Newsletters, congresses, workshops, presentation, articles etc.

2 Management of the project

In this chapter an overview is given of the organization of the project and the frequency and dates of the meetings of the different project organization bodies.

2.1 Project partners.

In *Annex A* you will find an overview of the involved partners and their addresses, contact information and membership of the different Work Packages *(see figure 2.1).*

Fig 2.1: Group picture of the EUR-ACTIVEROOFer partners (October, 2007, Siofok/Hungary)

The following changes have taken place during the project (officially submitted and approved by the EC project officer):

- PV-UK is replaced by NEF (National Energy Foundation); *per 21 July 2006*
- STROOMWERK is replaced by SOLARVOLTA, *per 21 July 2006*
- NBI is merged with SINTEF to SINTEF Building and Infrastructure, *per 1 January 2007*
- The name SOLARWALL is officially changed in SINERGICHA, *per 5 May 2007*
- KUIPERS CONSULTING is replaced by DAKDEKKER SL, *per 21 July 2007*
- BIOHAUS is taken over by CENTROSOLAR, *per May 2006*

All the new partners has taken over all the work obligations and project activities of the concerning previous partners as stated in the Description of Work (DoW), including the membership of the involved WPs. The new partners and adapted company names are replaced in the adapted versions of the DoW of 25 January 2007, 16 July 2007 and 25 February 2008 (see project website: *EU Sixth Framework Programme CIRCA*).

2.2 Project management structure

The management structure of the project is illustrated in *Figure 2.2*

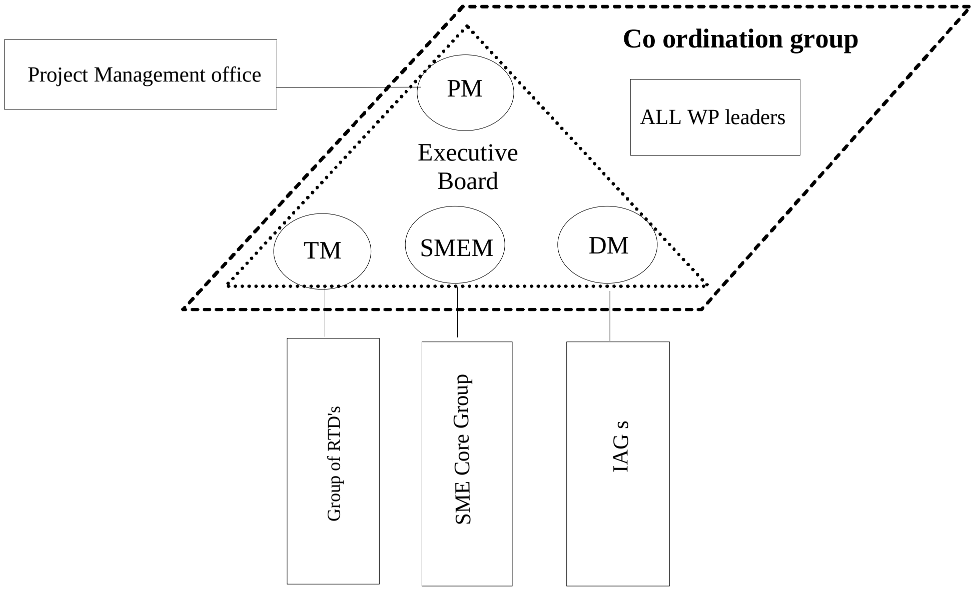

Figure 2.2: Organisation structure of the project (PM=Project Manager, TM=Technical Manager, SMEM= SME Manager, DM=Dissemination Manager)

The project is managed and controlled by the Executive Board in cooperation with the WP-leaders, working together within the Coordination Group. Each WP-leader manages a Work Package Group taking in account a different aspect of roof products. All the partners of the project are member of one or more Work Package Groups and are coming regularly together in separate meetings and the General Assembly meetings to inform each other about the progress of the work and to transfer the knowledge and experiences between the participants.

2.3 Executive Board

The Executive Board (EB) has the task to manage the central organising, planning and monitoring of the project. The EB also has the task to guarantee the transfer of knowledge between the participants.

During the whole project the Executive Board has come together 7 times:
- 1st EB Meeting: 21 July 2005, hosted by IFD in Köln/Germany
- 2nd EB Meeting: 11 January 2006, hosted by TNO in Delft/Netherlands
- 3rd EB Meeting: 7 July 2006, hosted by EMI in Veszprem/Hungary
- 4th EB Meeting: 2 February 2007, hosted by BTI in Vienna/Austria
- 5th EB Meeting: 29 June 2007, hosted by IFD in Cologne/Germany
- 6th EB Meeting: 23 November 2007, hosted by H&E Costellos in Dublin/Ireland
- 7th EB Meeting: 22 April 2008, hosted by EMI in Budapest/Hungary

The minutes of these meetings are available on the *EU CIRCA project* website.

2.4 Coordination Group

The overall coordination of the work is done by the Coordination Group (CG). This group controls and evaluates the technical progress of the project and is responsible for the decisions on actions undertaken during the whole project.

During the whole project the Coordination Group has come together 7 times:
- 1st CG Meeting: 12 October 2005 hosted by IFD in Mayen/ Germany
- 2nd CG Meeting: 9 March 2006 hosted by BRE in Watford/UK
- 3rd CG Meeting 14 November 2006 hosted by the Technical University of Warsaw and the Polish Roof Association PSD in Krakow/Poland
- 4th CG Meeting: 23 May 2007 hosted by SINTEF in Trondheim/Norway
- 5th CG Meeting: 2 October 2007, hosted by EMI and EMSZ in Siofok/Hungary
- 6th CG Meeting:: 14 February 2008, hosted by CRES in Athens/Greece
- 7th CG Meeting 25 June 2008, hosted by TNO in Amsterdam/Netherlands

The minutes of these meetings are available on the *EU CIRCA project website.*

2.5 General Assembly

All the partners of the project came together regularly in a General Assembly (GA) meeting to inform each other about the progress of the work and to transfer the knowledge and experience between the participants.

During the whole project the GA has come together 4 times in 2-day meetings:
- 1st GA Meeting: 12 and 13 October 2005 hosted by IFD in Mayen/Germany
- 2nd GA Meeting: 9 and 10 March 2006 hosted by BRE in Watford/UK
- 3rd GA Meeting: 15 and 16 November 2006 hosted by the Technical University of Warsaw and the Polish Roof Association (PSD) in Krakow/Poland
- 4th GA Meeting: 24 and 25 May 2007 hosted by SINTEF in Trondheim/Norway
- 5th GA Meeting: 2 and 3 October 2007, hosted by EMI and EMSZ in Siofok/Hungary
- 6th GA Meeting: 14 and 15 February 2008, hosted by CRES in Athens/Greece
- 7th GA Meeting: 26 June 2008, hosted by TNO in Amsterdam/Netherlands

The minutes of these meetings are available on the *EU CIRCA project website.*

After the 2nd GA-meeting an inquiry was held among the participants about the programme of the GA-meetings. A general remark was that the time available for the Work Package (sub) meetings was too short. In the 3rd GA-meeting an adaptation to the programme has been made on this point. And in order to get a good cross linking of knowledge and experience between all partners the sub WP sessions in the 4th GA-meeting were opened for all the partners. Since this adapted programme was very well appreciated the following three GA meeting were also programmed and structured in this way.

In order to get a good cross fertilisation between the EUR-ACTIVE ROOFer participants and the International Roof Federation (IFD) members, the GA meetings were as much as possible linked and close scheduled to the yearly IFD congresses, in particular to the IFD congresses in Mayen (2005), Krakow (2006) and Siofok (2007).

2.6 Work Packages

2.6.1 Introduction

The work plan has been organised in different Work Packages (WP) in order to structure the work that has been done and to make efficient use of the expertise of each of the partners and to provide a logical progression.

In total there are composed 10 WPs, presented in the following table:

Work Package	Work package title	Leading participant
A	New concepts for Active Roofs	CENERGIA
B	Wind and Seismic Effects	TNO
C	Rain and Wind Driven Rain Effects	BRE
D	Condensation	BTI
E	Snow and Ice Load	SINTEF
F	Safety, Installation, Maintenance and Repair	EMI
G	Guidance and dissemination	IFD
H	Pre-standardization and Labelling	TNO
I	Training Activities	ZVDH
J	Management	TNO

The participants are member of one or more of these Work Packages. In *Annex A* the membership of the partners of the different work packages is given.

The WPs A to F started immediately at the beginning of the project. WP G and H have been started up in the beginning of the second project year and the kick off of the final WPI is been given just before the start of the last project year, at the GA-meeting in May 2007 in Trondheim. In order to carry out the scheduled laboratory and full scale tests and to make use of the results of these tests, there is submitted (July 2007) to the EC Scientific Officer a request to enlarge the time schedule of all the WPs to the end of the project (month 36). This request is approved by the EC (September 2007). Finally WP J has taken care for the management of the project and was active during the whole project.

In order to make efficient use of time and money the WPs come together during the reported period at the organised General Assembly Meetings, where the WP-leaders also reported the progress and results to the participants. Between these GA-meetings separate meetings by the individual WPs were organized if necessarily.

2.6.2 Structure

Figure 2.3 illustrates the relations between the different WPs.

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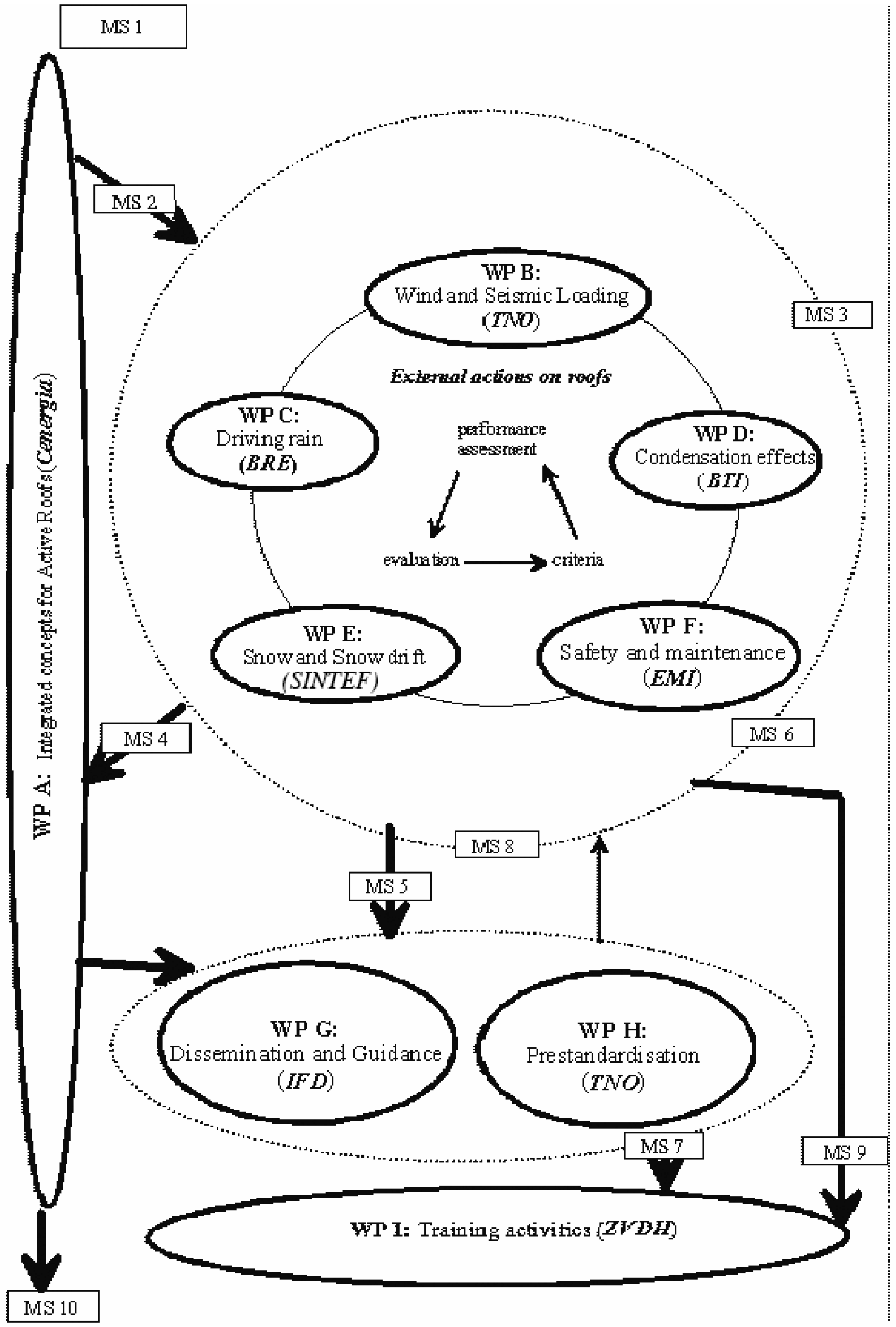

Figure 2.3: Relations between the different Work Packages

In the central work package WP A integrated solutions will be developed for Active Roofs, including parameterisation and characterisation of solar energy systems, aspects of functional use and comfort of spaces under roofs, illumination, ventilation and safety. This WP has connections with all the other WPs, illustrated in *figure 2.3* as a vertical WP and active from the start till the end of the project.

The WP B to F are working on the different aspects of roof products like wind, rain, condensation, snow, safety, maintenance etc. The results of these activities (test methods, classification, legislation, etc.) are used as input for WP G (dissemination and guidance) and WP H (pre-standardisation) of these product aspects. And finally all these results will be integrated by WP I in training material for roof installers.
All the output of these WPs will be integrated well structured in a EurActiveRoofer Database of which the general outline (and partly completed) is available on the database website (see: *http://sts.bwk.tue.nl/activeroof/).*

2.6.3 Planning of WP activities

In Annex B the general outline of the working plan and timetable is presented.
As indicated in this timetable and based upon logistical grounds after 24 months of the project WPs A to H were fully activated and WP I was activated in May 2007.

In the following chapters the activities of the WPs in the second project year are presented. Of each WP a detailed description of the activities is given, including a description of all deliverables, milestones, evaluation and produced documents..The produced documents of each WP are available at the *EU CIRCA project website.*

3 Main results of the project

Before entering the description of the activities and the final results of the various WPs (*see chapters 4 till 13*), a short summary of the main results of the project is given. The input for these results are base upon the experiences and project activities of many laboratories and full scale tests which are carried out in various places in Europe.

3.1 EUR-ACTIVE ROOFer Database

A database was developed in which both existing and future roof systems were included. This database focuses on the performance required by roofs, both now and in the future. The database was filled in based on information from the participating IAGs and the outcomes of the WPs. The content of the database has a dynamic character, so it developed during the project, depending on the availability of the results of other WP's and also will be further developed after the end of the project.

The classification systems have the following main features:
1: Design aspects (orientation, building, physics, materials and form).
2: Applications (renewable energy sources, energy storage, ventilation, smoke and heat evacuation).
3: User aspects (assembly, maintenance, safety).
4: Roof types (flat roofs, sloped roofs and bent roofs).

3.2 Best Practice Catalogue Active Roofs

A Best Practice Catalogue of Solar Thermal and PV integration in roofs has been created based on inputs from all partners of the involved WPs, roofing organizations, manufactures and contractors concerning installation techniques. Also active component suppliers and consultants contributed with knowledge on system contributed to the catalogue. In this catalogue are taken up pre-fabricated elements, building elements and traditional element for application on flat roofs, sloped roofs as well as bent roof.

3.3 Best Practice Guide and Legislation Safety

In the Best Practice Guide and Legislation Safety examples were gathered from the partners from different countries, focusing on the most interesting and innovative solutions. It was classified into five main areas: safe access to the roof, working platforms, guardrails, hooks/anchors and personal fall arrest systems.
One should consider that in roof works collective safety systems are preferred, and sophisticated roofer works require working platforms instead of hanging rope. Some promising mobile systems are worth including.

Additionally an overview of the legislation is given and proposals are made, such as the recommendation for a double independent safety system in use and necessary surveillance of permanent safety devices.

3.4 Pre-Standard on Active Roofs

In the developed Pre-standard on Active Roofs are summarized proposals for test methods and requirements for the most important aspects in order to define the quality of active roofs, especially focused on the building integration of solar energy systems. The content of this document is based on the results of the work packages. The final document is presented as a proposal for pre-standardization to the relevant CEN TC committees as input for a final European standard in this working field and accepted as a work item within the TC 128 (in cooperation with TC 254).

This European Pre-Standardisation document specifies the application of solar energy systems (photovoltaic as well as thermal) as a stand-alone or integrated part of building components or units. It concerns building roofs as well as façades, residential buildings as well as commercial and industrial buildings. Where relevant, the provisions described in this proposal are to be applied to complete solar systems that are installed (in accordance with the guidelines of the supplier) in its intended architectural context with all construction details included.

3.5 Guideline for Design and Application of Active Roofs

This document provides a basic guidance for the design, application and performance of Active Roofs as well as for the development of products for such roofs. It was drawn up as a foundation for the work of engineers, architects, planners, manufacturers and roofers. It is the basis for further standards which deal with individual products, test methods and application.

A wide variety of new products such as photovoltaic (PV) systems and solar collectors, roof lights, ventilation devices, insulation and safety devices are being introduced into roofing. The roof is thereby transformed into an "Active Roof". The quality of these products as well as safety equipment for installation and maintenance is, when installed in a roof system, in many cases insufficient because there are currently no standards or legislation to assess their performance. At the same time, good products get poorly installed by inexperienced roofers. This Guideline will help the roofing trade to improve their products and to reduce barriers to trade, restore consumer confidence in Active Roof products and improve competitiveness, allowing them to increase their markets. Also this document may lead to a mark for Active Roofs in the future ("EAR-Mark").

3.6 Training Programme

A general training programme is developed in order to raise the quality of the installation of active elements on roofs. This was realized in close cooperation with those SME core group members who have experience in educating their national roofing schools

The following training systems are developed consisting of modules on 3 levels and key point, meant for roofers, roof managers and roof contractors/consultants:

Module I: Euractive Roofer
- Systems I: Systems and their installation
- Penetrations I
- Structural physics/Structural analysis I
- Safety I

Module: II Euractive Roof Manager
- Systems II: Assessment of suitable systems and methods of installation
- Penetrations II
- Structural physics/Structural analysis II
- Safety II
- Project management
- Career and occupational teaching I

Module III: Euractive Roof Contractor/Consultant
- Climate protection/Energy efficiency I-III
- Legal environment for power engineering activities
- Systems III: Integration of active elements

4 Work Package A: New Concepts for Active Roofs

WP-Leader: Cenergia
Period: 21 July 2005 till 20 July 2008

4.1 Short Objectives/scope

WP A has been the central work package of the EUR-ACTIVE ROOFer project.
The objectives were firstly to identify new and innovative Active Roof solutions that have been used recently, and to share the knowledge and experience gained from these solutions. The solutions have been discussed among the partners, and pros and cons has been summed up. Based on these experiences, a number of solutions were identified, which represent the most interesting of the known Active Roof solutions, also presenting techniques which are relevant to test.

Tests have been carried out in 4 countries covering northern Europe, central Europe and southern Europe. These tests of energy performance have been full-scale tests where the chosen solutions are implemented in building projects. At the same time recommendations has been made for which constructions are been tested in WPs B to F.

In this way an overview of best practice Active Roofs Europe has been created in combination with a web based database of existing and future roof systems which includes this overview. Besides WP A has been used to define the boundary conditions for newly developed products by collecting the relevant results of the research oriented WP’s B to F into the database.

And recommendations were also developed concerning integrated solutions for active roofs, including parameterization and characterization of solar energy systems, aspects of functional use and comfort of spaces under roofs, illumination, ventilation and safety. At the same time the objective has been to develop new and more integrated and intelligent concepts for active roofs, where there is synergy between different demands concerning these roofs.

And finally it has also been an objective to develop and apply a decision supportive methodology for integral design of active roofs. And in connection to this when using a methodical design approach the implementation of prescriptive work on current practice has been investigated.

A detailed description of the main objectives is the following:

Set-up and maintenance of the Data Base
First, a database was developed in which both existing and future roof systems were included. This database focuses on the performance required by roofs, both now and in the future. The database was filled based on information from the participating IAGs and on the outcomes of this and the other WP’s. The content of the database has a dynamic character, depending on the availability of the results of other WP's. The central coordination of the database was part of WP A.

New concepts for Active Roofs
The overall idea was to end up with a number of integrated concepts, which combine building integrated solar energy / ventilation designs and innovative roofs, and which can have a documented good function in practice. New and more reliable under roof concepts was also developed which increase the overall quality of Active Roofs.

A combined air solar collector/PV module roof in combination with an innovative under roof construction was optimized for a long lifetime in the project. This includes the development of air inlet and extracts solutions for roofs together with development of an integrated roof unit designs which can e.g. be used for:

1. Solar assisted air extraction.
2. Combined solar assisted air extraction and air inlet (in cooperation with Sinergicha/Italia).
3. An integrated unit with heat recovery ventilation, which can be a roof module together with building integrated solar energy modules (in cooperation with EcoVent).

Also, innovative solar air collector roofs in combination with PV preheating ventilation air and PV-VENT systems were applied.

Testing and evaluation
An important task in WP A was to perform testing activities concerning new and innovative concepts of active roofs. Testing facilities were developed and applied to test innovative active roof solutions like those mentioned above as well as full scale tests was performed.
The results concerning integration of innovative solar collectors and PV and PV/T solutions are very relevant in relation to future building projects which aim at CO_2 neutral building designs and "Plus Energy" buildings where it is aimed to obtain relatively large PV areas compared to the available roof size.
Testing facilities for roof structures were used in Spain, Hungary, Italy and Denmark, covering the main regions in Europe. Detailed monitoring of these systems concerning different performance indicators was made. These tests were set up in close cooperation with the work done in WP B to F. Based on the test results recommendations concerning the new concepts for active roofs was made and transferred to WP G together with a total overview of best practice active roof solutions.

4.2 Short description of the activities and achieved results

The following activities are undertaken and results are achieved in WPA:

4.2.1 Web based database for existing and future roof systems (DA.1)

This task was coordinated by the Technical University of Eindhoven, focusing on making a web based database for existing and future roof systems (*http://sts.bwk.tue.nl/activeroof/ , see Figure 4.1*).

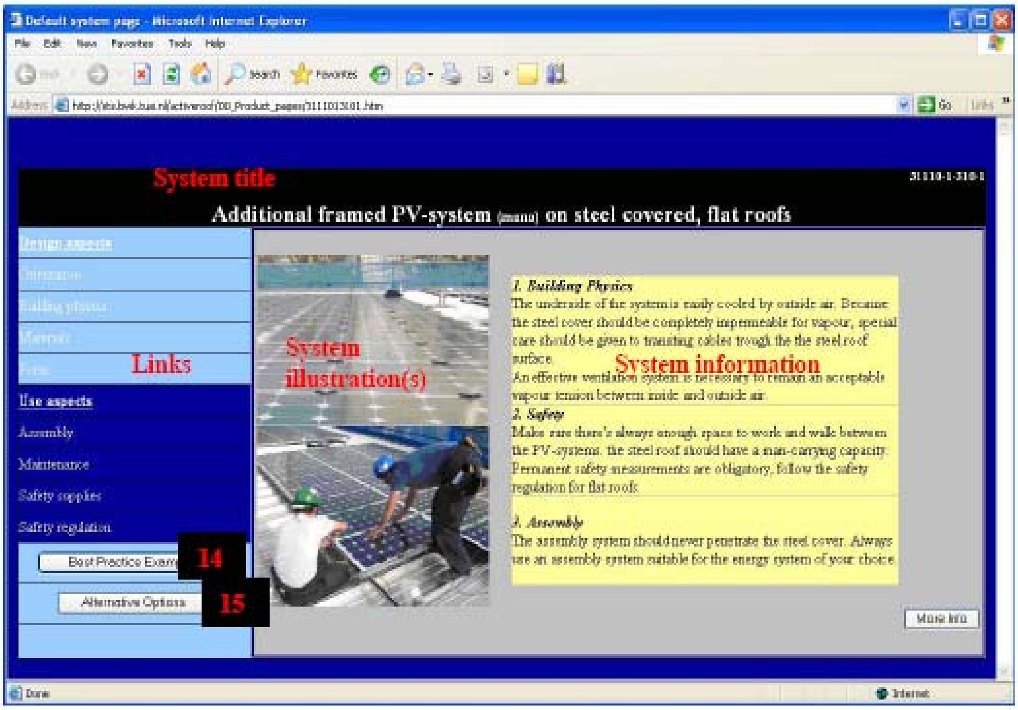

Figure 4.1: Illustration from web based database made in the EUR Active Roofer project.

An input from the work on DA.2., the Best Practice Catalogue for Active Roofs, has at the same time been introduced. The classification systems have the following main features:

1: Design aspects (orientation, building, physics, materials and form).
2: Applications (renewable energy sources, energy storage, ventilation, smoke and heat evacuation).
3: User aspects (assembly, maintenance, safety).
4: Roof types (flat roofs, sloped roofs and bent roofs).

4.2.2 Best Practice Catalogue of Solar Thermal and PV-integration in roofs (DA.2)

In connection to the work in WP A, a Best Practice Catalogue of Solar Thermal and PV integration in roofs have been created based on input from all partners in WPA and the other involved WPs (B-F). Firstly a draft report was made and after this extra information was introduced by roofing organizations, manufactures and contractors concerning installation techniques while active component suppliers and consultants contributed with knowledge on system performance and relevance *(see Figure 4.2).*

Photos	
Description	On the South pitch of the existing metal roof is mounted out the Solarwall panels, to create an air gap. Outside air is drawn through the perforation in the metal picking up the solar heat from the metal panel surface: this heated air is used to pre-heat ventilation air.

Fig 4.2: Illustration from the Best Practice Catalogue of Solar Thermal and PV-integration in Roofs.

4.2.3 Identification test samples for innovative active roof integrated components (DA.3)

In this deliverable test samples were prepared for testing in the WP B-E *(see Figure 4.3)*. First ideas for test samples were presented at a workshop, and then relevant parameters for tests in each WP B-E were identified and a shortlist of relevant systems to test was made based on the systems available in the draft catalogue of DA.2. Test samples were made by component suppliers who were members of WP A.

Master Roof falls under roof system	D-Condensation
	1. Type of system : Master Roof falls under roof product from www.borry.dk 2. Size (length x width): approx. 2 x 2 m 3. Materials: Solar cell panel surface together with innovative diffuse open underroof system with paper granulate insulation. 4. Place/institute/university conducting the test: EMI/BTI 5. Time of test: 6. Further details: None **Supplier: Borry Henriksen**

PV tiles (small modules)	B-Wind
	1. Type of system : PV integrated between tiles 2. Size :about 1 m2 per panel; 2 times 4 panels. 3. Materials : Glass, or dummy 4. Place / institute or university conducting the test :TNO Delft 5. Time of test :Two winter periods 6. Further details :Test already running, on test roof at TNO; data analysis for wind loads as part of this project. No products needed anymore

Figure 4.3: Illustration of test samples for tests in WP B-E.

4.2.4 Integrated Design Methodology (DA.4)

In this deliverable an integrated design methodology for multidisciplinary collaborative design of active roofs were developed, coordinated by TU Eindhoven *(see Figure 4.4).*

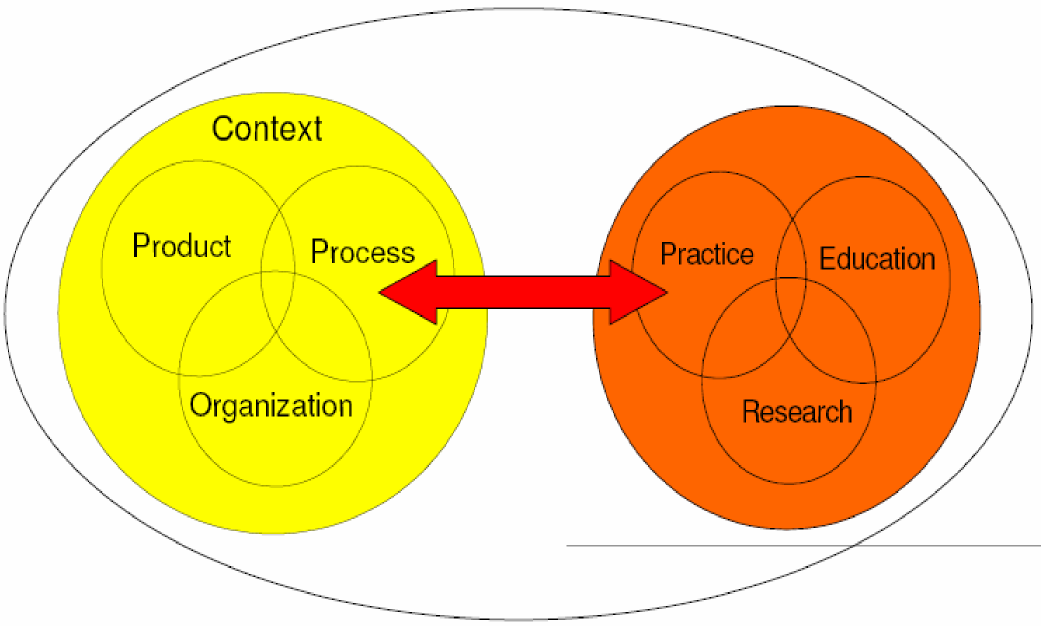

Figure 4.4: Illustration of integrated design methodology for Active Roofs.

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4.2.5 Path to success Model (DA.5)

A “path to success” model for multidisciplinary product innovation by process innovation of design and engineering was developed. This included a selection matrix to support the decision making for the best active roof concept in the specific design process.

4.2.6 Full Scale tests of innovative solutions in 4 countries (DA.6)

This activity was focused on preparation and realization of practical tests of innovative PV and solar thermal integration techniques incl. relations to the overall roofing, building design and ventilation. These were made as full-scale tests in four different countries.

Full scale tests in Denmark
The Danish company EcoVent was responsible for the development and realization of a PV-assisted extract ventilation system which was tested at the Engstrand School in Denmark *(see Figure 4.5).* Here supporting the natural ventilation system at the school, which can be insufficient especially in the summer period..

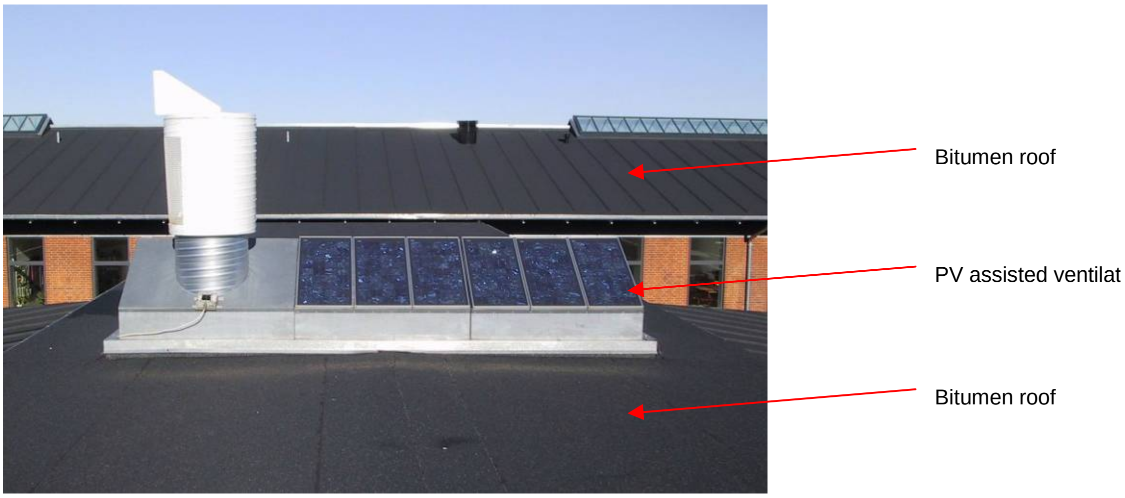

Fig 4.5: Photo of the PV driven exhaust system at the Engstrand School in Denmark

The system included *(see Figure 4.6)*:

- An exhaust grille built into a rotating top which automatically turns the grille away from the wind to increase the natural driving wind force.
- A box with a fan powered by a 48 V DC motor
- A damper
- Control unit
- PV system: 6 PV modules from Gaia Solar. Total area is 12 m2, and power output is 96 Wp. The modules are angled 32° and oriented towards the south east. The system also includes batteries and a battery charger.

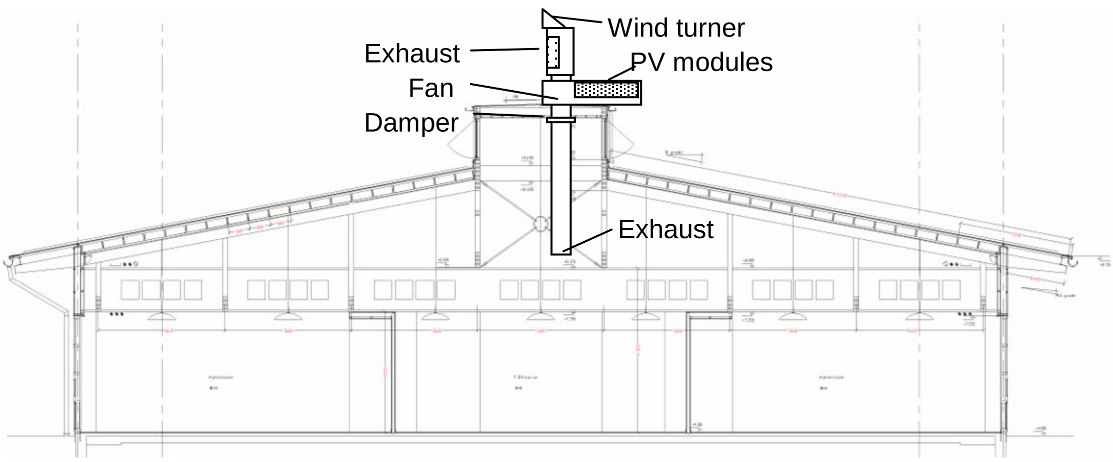

Figure 4.6: Sketch of the PV assisted exhaust systems

The system is applicable to flat roofs and roofs with a small pitch. For steeply pitched roofs, the individual components (PV modules, fan and exhaust) should be built into the roof and integrated.

The measurement results in *Table 4.1* showed that the fan kept running during the night when the fan ran at a low speed, powered by the electricity stored in PV batteries. When the fan ran at maximum speed, the airflow was higher during the day, but the fan did not continue operating at night.
The two modes of operation are compared and 2 days with similar total solar radiation. It is seen that the extracted airflow for a 24-hour period is 32% higher when running at low speed than when running at high speed.
Using the batteries to store electricity during the day will thus increase the total volume of extracted air on a 24-hour basis, but the peak airflow during the warm mid-day period will be reduced.

Table 4.1: Results of the fan speed measurements

Fan speed	Solar radiation kWh/day	Airflow M^3/day	Difference in airflow %
High	7.724	15.617	-
Low	8.034	20.559	32

The airflow at low fan speed is between 600 and 1100 m^3/h, while on high fan speed the airflow is up to 1800 m^3/h. This means that the air change rate generated by the PV ventilation system is between 0,24 and 0,4 air changes per hour. The target airflow for the building is between 1 and 2 air changes per hour based on the actual use of the building – in particular the number of persons at a given time.
The additional air flow from the PV ventilation system thus corresponds to between 13% and 50% of the target air flow for the building. The remaining air flow must be generated by the natural ventilation system.

At the same time EcoVent has worked on developing new compact HRV systems which are useful in connection to CO_2 neutral houses of the future like the “SOLTAG-1” and “SOLTAG-2” housing units which were involved in full scale testing in Denmark coordinated by Cenergia *(see figures 4.7 to 4.9)*. In connection to this EcoVent has also performed important work on a more efficient HRV heat exchanger system, which has a dry HRV efficiency of approx. 90%.

Figure 4.7: Illustration of SOLTAG 1 and 2 buildings which was tested in Denmark, also involving the Danish company VELUX

Figure 4.8: Illustration of daylight quality in the SOLTAG-1 dwelling


Figure 4.9: Control and monitoring equipment at SOLTAG 2

Full scale tests in Hungary

In Hungary different PV and Solar Thermal components were integrated in and above the roof of a test building *(see Figure 4.10*). Here were tested problems with e.g.

condensation for the different types of components *(see also the WPD report in chapter 7)*.

Figure 4.10: Illustrations from full scale tests in Hungary

Full scale testing in Italy

In Italy a full scale test was made in connection to a building were the so called “Canadian Solar Wall” was used in a sloping roof *(see figure 4.11)*. Here PV-modules were installed on top of the air solar collector at the same time improving the cooling of the PV-modules by the inlet air flowing through them.

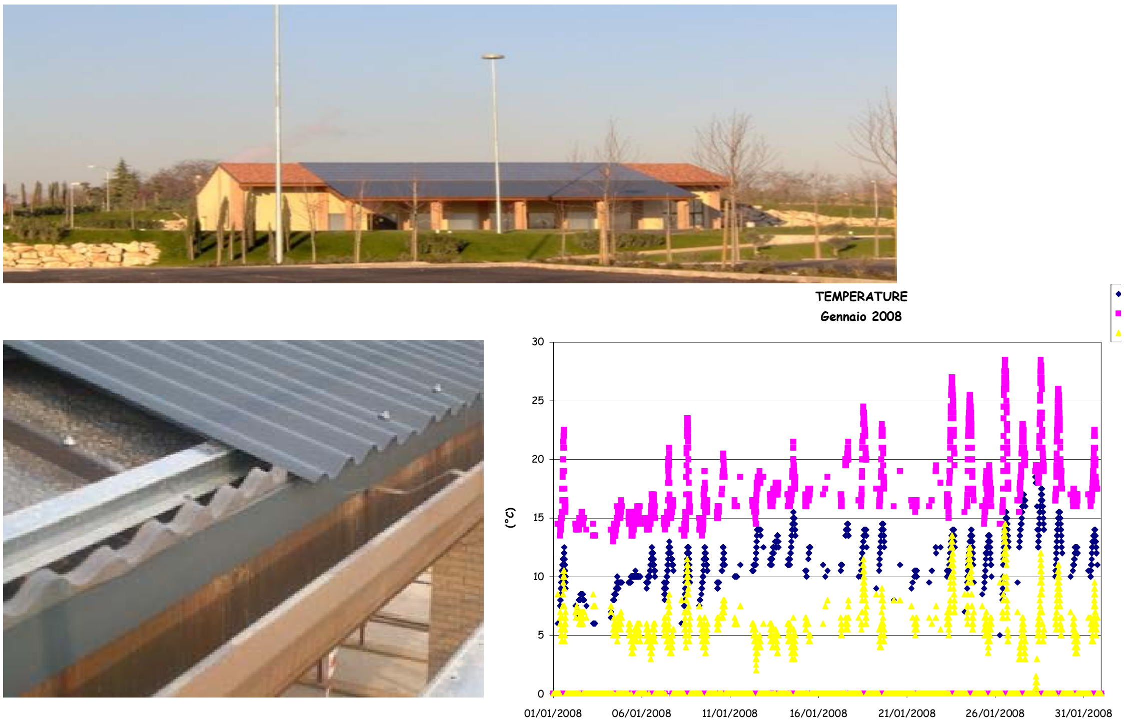

Figure 4.11: Illustrations of full scale testing in Italy with “Canadian Solar Wall” PVT air solar collector integrated as a roof.

Full scale tests in Spain

In Spain a full scale test was carried out where an old PV installation in a roof which had a lot of problems was changed to a new one with a much better quality (*see figure 4.12).*

Figure 4.12: Illustration from full scale test in Spain with new type of roof integrated PV solution as substitution of old PV-installation of poor quality

4.2.7 Introduction of results from WP B-F into best Practice Catalogue (DA.7)

Important results from test activities in WP B, C, D, E and F have also been introduced into a revised version of the Best Practice Catalogue concerning active roofs. This e.g. includes experiences from Hungary concerning condensation problems in tested active roof solutions.

4.2.8 Several innovative concepts for active roofs (DA.8)

Work has also been made to compile and present a number of innovative concepts for active roofs. Here can e.g. be mentioned the Danish SOLTAG concept. In the following *figures 4.13-4.21* are given some examples.

Figure 4.13: Architecturally optimized integration of active roofing elements

Figure 4.14: PVT panels where heat is fed to a heat pump in this way cooling the PV modules

Figure 4.15: Architecturally optimized PV integration into "Copenhagen" roof for an old housing block in Copenhagen

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Figure 4.16: PV panels on flat roof operated by Copenhagen PV-Coop (www.solcellelauget.dk). Here only 25% of the roof can be used as PV area.

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Figure 4.17: SOLTAG 2. Solution with innovative diffuse open Master Roof False roof solution with paper granulates insulation and a PVT solution in the roof which works in combination with a heat pump.

Figure 4.18: PV solution for flat roofs which utilize up to 80 % of the available roof area as PV area.

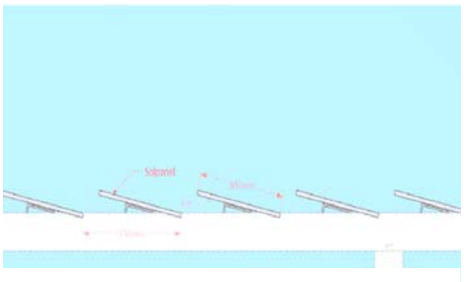


Figure 4.19: New build SOLTAG project, Breidablik in Roskilde with zero energy houses made according to a passive house standard.

Figure 4.20: SOLTAG design prepared for renovation of concrete housing areas in Denmark.

Figure 4.21: SOLTAG-SOUTH. A SOLTAG housing unit established by Velux in Bilbao, Spain.

4.2.9 End version of database for existing and future roof systems (DA.9)

Based on a workshop in The Netherlands with students and practitioners, a final version of the web based database was made (see *http://sts.bwk.tue.nl/activeroof/).*

4.2.10 End version of PV and Solar Thermal Best Practice Catalogue (DA.10)

In connection to a final WPA workshop in Denmark and the final Active Roofer meeting in Holland in June 2008 it has been possible to make the final version of the EUR-Active ROOFer Best Practice Catalogue concerning technical and architectural integration techniques for active roofs.

4.3 Overview of the Deliverables and Milestones

List the deliverables and milestones and the final results (see main Deliverables Reports on the EU CIRCA site

Nr.	Month	Description work to be done	Results	Produced documents
Deliverables				
DA.1	8	A web-based database will be developed in which both existing and future roof systems will be included. This database focuses on the performance required by roofs, both now and in the future. The database will be filled based on information from the participants and on the outcomes of the other WPs. The content of the database has a dynamic character, changing during the project, depending on the availability of the results of other WP's.	The database has been created and is available online at http://sts.bwk.tue.nl/activeroof/. The target groups for the database are roofers and architects. The database is completed with application of PV systems on different roof shapes and materials.	http://sts.bwk.tue.nl/activeroof/ 21/5 2006: Report: A Additional outline of a database for existing and future roof systems 16/5 2007: Final report on DA1: "A general outline of a database for existing and future roof systems"
DA.2	10	A best practice catalogue of innovative active components and integration techniques must be created. The catalogue will cover the solutions, products and techniques used or known by the participants of WPA.	The draw up of the Best Practice Catalogue (BPC) on innovative active components started with collecting input from the participants. A questionnaire was created and issued to the participants. A draft version of the catalogue was ready by May 2006 and has since been introduced on the web space. April 2007 an updated version of the BPC came available on web space. Checks has been made from Roofer side on applicability of best practice catalogue. Reviewer: Peter Schönefeld (Schröder), Kevin Taylor (NFRC),	21/6/06 Best Practice Catalogue (BPC) Questionnaire for BPC BPC on web space 1/5/07: Updated version (final draft) available Critical review group gave an input before final version was made.

Nr.	Month	Description work to be done	Results	Produced documents
			Herm Brueren (HHD), Amolak Hunjan (EETS), Beat Hanselmann (SVDW).	
DA.3	16	WP's B-E will test a selection of innovative active components integrated in roofs. The identification of the relevant systems will be made as cooperation between WP A and B-E.	In co-operation with the leaders of WP B-E, relevant systems for tests have been identified. By help of a questionnaire issued to the members of WP A. SMEs that are able and willing to supply test samples for the climatic tests have been identified.	7/9/2006: Samples for climatic tests have been identified and presented in an overview
DA.4	18	An integral design methodology will be developed and evaluated as a design methodology for multidisciplinary product development. The methodology aims to integrate use of sustainable energy systems in active roofs, including the impact for the active roofers, in the conceptual phase of architectural and building design.	A draft integral design methodology has been created, and has been refined through workshops involving students and professors at TU/e.	21/5/07: Final report on Integral Design Methodology for Multi-disciplinary Collaborative Design of Active Roofs 20/8/2008: Final Report Workshop Innovative Roof Design
DA.5	30	Path to success model must be produced, for multidisciplinary product innovation by process innovation of design and engineering, including a selection matrix to support the decision making for the best active roof concept in the specific design process.	Compilation of inputs for selection matrix has been made A presentation was made at the GA meeting in Trondheim.	20/8/2008: Final Report on Path to success model for Active Roofs
DA.6	30	Full scale tests of innovative solar thermal and PV and PV/T solutions must be	6 innovative systems have been tested for energy performance in Hungary, Italy, Spain	26-11-2006: Report on full scale tests

Nr.	Month	Description work to be done	Results	Produced documents
		performed. The full scale test will be implemented at actual building projects in 4 countries. The full scale tests will evaluate the energy performance of the systems in relation the energy performance of buildings directive.	and Denmark. A report with descriptions of the systems is ready incl. monitoring results.	Separate case reports: - PV assisted ventilation and SOLTAG-1 and 2 in Denmark. - PV-T system in Italy
DA7	32	Report on testing results as a basis is for recommendations for a Best Practice Catalogue which will be used as input on how active roofs cab be utilized in relation to the demands of a EU-Energy Performance Directive	Reports have been presented from WP B, C, D, E and F. Results has been introduced in the Best Practice Catalogue.	Report on full scale tests of innovative solutions August 2008
DA8	32	Several innovative concepts for Active Roofs	A draft version was made in august 2007. An updated version has been worked at the end of the project.	Final Report on "Several innovative concepts for Active Roofs" October 2008
DA9	32	End version of the database for existing and future roof systems	The updated final version is been produced in June 2008	Final version of database for existing and future roofs: http://sts.bwk.tue.nl/activeroof/
DA10	32	End version of a PV and solar thermal Best Practice Catalogue concerning technical and architectural integration techniques for active roofs	A large number of inputs have been compiled in a dialogue with the partners.	Final report on PV and Solar Thermal Best Practice Catalogue. August 2008
Milestones				
MA1	4	General outline of database ready and first draft of best practice catalogue.	Draft database and best practice catalogue are ready.	Link to database: http://sts.bwk.tue.nl/activeroof/
MA2	6	Start preparation of test facilities.	Preparation of test facilities has been started.	

Nr.	Month	Description work to be done	Results	Produced documents
MA3	13	First evaluation of WP A, starting tests of new active roof concepts in 4 countries, preparation of test samples for other WP’s.	Full scale tests have been identified and were started in June 2007. Samples for climatic tests have been identified.	See DA.3
MA4	19	Presentation of first results at IFD’ 06	Results presented at IFD conference in Krakow in November 2006	Presentation at IFD 2006 conference.
MA5	25	Database filled and made available to all participants, including compilation of testing results as basis for recommendations for Best Practice Catalogue	Final version has been made version is been produced in June 2008	Final Database and Best Practice Catalogue.
MA6	31	General meeting, presentation of final reports of WP B-F at IFD 2007	Final results presented at IFD conference in Siofok in October 2007	
MA7	33	Coordination group meeting, preparation of final reports, evaluation of the project	Realized	Minutes and reports are available at EUR Active Roofer website.
MA8	36	End of project, all deliverables available, Workshop on Integral Designs of Active Roofs where a model for design of active roofs will be presented at Dach und Wand 2008	All deliverables are available. The results are presented at the Active Roof Conference in Amsterdam/Netherland s (June 26, 2008), instead of Dach und Wand 2008	See DA.1 to DA.10

4.4 Encountered problems in the reported period

It is difficult to make partners, especially SMEs, participate by sharing their knowledge. Most work is done by WP leader with TU Eindhoven and a good contribution from Schröder. SMEs has been addressed personally to gather the right information. This was time-consuming but has given the best results.

It is also difficult to find companies willing to supply test samples. Often the companies doesn't supplied the samples they have agreed to deliver. Generally, a lot of time is spent on communication hereabout.

The completion of the test sites for full scale tests has been delayed compared to the original time schedule, but as tests start in the summer of 2007, there has been sufficient time to perform the tests and report the results. Therefore the time schedules of the involved WPs are enlarged to the end of the project (month 36).

4.5 Short view into the planned activities in the coming period

It can be concluded that it was possible to complete all the expected deliverables and milestones in the WPA part of the Eer-Active Roofer project.

With WP A it has been possible to introduce a large number of important principles for the future concerning active roofs. These are developed on basis of best practice traditional roof solutions, but with the important possibility of being able to supply energy besides ensuring the normal demands a roof shall live up to with respect to avoiding problems with moisture, rain, snow and wind.

Important work in WP A has been made on new concepts like e.g. the SOLTAG solution from Denmark (www.soltag.net) or the Canadian Solar wall roofing element which was tested in Italy. This is however only seen as the beginning of important work to develop and test a large number of active roof systems for the future, which is of vital importance if the policies from EU concerning renewable in Europe should be met in practice. The Best Practice Catalogue shall turn out as a worthwhile tool to realize these goals.

4.6 List of produced documents

- Database: http://sts.bwk.tue.nl/activeroof/
- Report on user manual for database (3/06/06)
- Report on a additional outline of a database for existing and future roof systems (draft: 21/5/2006, final: 16/5/2007)
- Best Practice Calalogue on innovative active components (1 draft 21/6/2006, 2nd draft 1/5/2007, final September 2008)
- Overview of the samples for climatic tests (7/9/2006)
- Final report on Integral Design Methodology for Multi-disciplinary Collaborative Design of Active Roofs (final: 21/5/07)
- Report on Path to success model for Active Roofs including workshop experiences on innovative roofs (final: 11-4-2008)
- Overview of test samples – final version 2006-09-07
- Report on PV Assisted ventilation at the Engstrand School in Denmark – 2006-11-22
- Presentations and minutes of GA-meeting and IFD congresses

5 Work Package B: Wind and Seismic Effects

WP-Leader: TNO
Period: 21 July 2005 till 20 July 2008

5.1 Objectives of the WP

The principal objective of this work package is to undertake pre-normative research and to develop technical guidance and assessment methods for evaluating the performance of Active Roofs, including accessories and fittings, to wind and seismic effects. The pre-normative research undertaken in this work package will result in values and design rules which form the basis for future European codes and guidelines.

5.2 Description of the activities and the achieved results

During the project, the following activities have been carried out in Work Package B:
1. A development of a classification of active roofs with respect to wind loads
2. A theoretical investigation of the relevance of including earthquake loading in design and engineering of active roofs
3. Wind tunnel experiments to the wind loads in roof valleys
4. Wind tunnel experiments on wind loads on stand-off PV modules
5. Full scale experiment on wind loads on stand-off PV modules
6. CFD (Computational Fluid Dynamics) investigation on solar energy products on flat and pitched roofs.
7. Development of a draft test method for the wind resistance
8. Input for the work packages on guidance and pre-standardization.

In some more detail, per item, the following results have been achieved:

5.2.1 Item 1: Classification of active roofs.

This work had led to a comprehensive report on the classification of active roof products. The classification has been presented both within the EerActiveRoofer project, as well outside, in the wind engineering community.

References:
Chris Geurts, Carine van Bentum
Windlasten an Solardächern
In: WtG Berichte Nr. 10, 2007 , Praktische Anwendungen in der Windingenieurtechnik, pg.3-15

C.P.W. Geurts, C.A. van Bentum
Wind loads on Solar Energy Roofs
Heron, No. 52 (2007) volume 3, pp. 201-222
This part has lead to fulfilling deliverable DB.3 of this WP.

TNO Report 2006-D-R0203: *Classification of Active Roofs*, C.A. van Bentum, C.P.W. Geurts, September 2006

5.2.2 Item 2: Relevance of earthquake loading.

Since in the design of structures and structural elements, only wind and earthquake loads lead to a pre-dominantly horizontal loading, in this item it was studied whether, in Europe, a design with respect to wind loads could be sufficient to cover the earthquake loads. Large parts of Europe have very low seismic activity. In those regions, no detailed earthquake design is needed. For southern and south-eastern Europe, e.g. Greece, earthquake loads may become relevant. However, in the safety philosophy, the damage to secondary parts of a building is accepted, as long as no personal losses are expected.

It was concluded that a correct design against wind loads leads to a sufficient level of safety for these products, with respect to earthquake design in Europe. It may become an economical issue whether additional demands with respect to earthquakes are given. This is up to the contractor and owner of the active roofs. No further guidance is given in this project.

Reference:
TNO Report 2006-D-R0204: *Earthquake loading of active roof*s. Authors: F. van Duin, CA. van Bentum, C.P.W. Geurts, September 2006

5.2.3 Item 3: Wind tunnel experiments to the wind loads in roof valleys

Roof valleys are very vulnerable to wind damage. In the current codes of practice, no values for the wind loads are found. When applying active roofs, this becomes more important, since damage to the roof may lead to considerable costs.

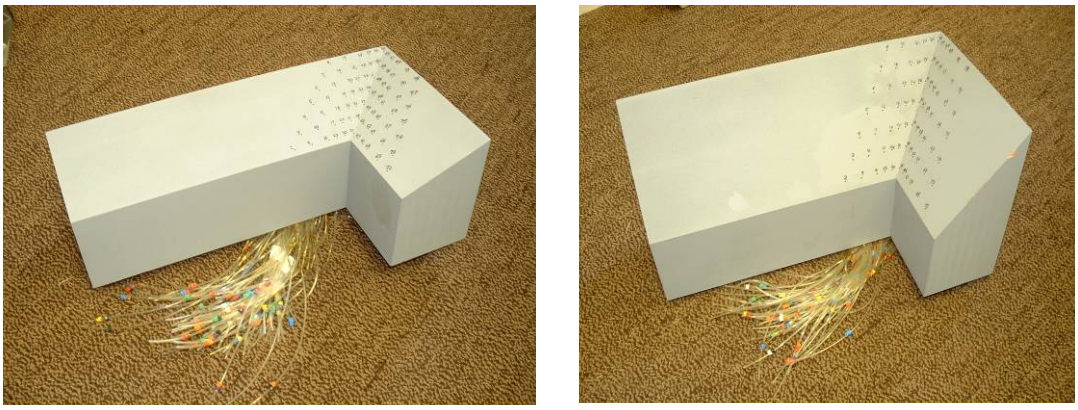


Figure 5.1: Two models that have been tested on wind loads in the wind tunnel

In a wind tunnel study, two models have been tested, and values for the pressure coefficient on roof valleys have been determined *(see figure 5.1)*. These values have been compared with the values in the Eurocode, and a proposal for including these values in this standard has been drafted.

Reference:
BRE Report number 232-729: *Wind Tunnel Tests to Determine the Wind Pressures on Roof Valleys*, Paul Blackmore. November 2006

5.2.4 Item 4: Wind tunnel experiments on wind loads on stand-off PV modules

The wind loads on stand-off PV modules has not been taken into account in any wind loading standard. Both the Dutch NVN 7250 as BRE Digest 495 gives very crude values. Within this project, both a wind tunnel land a full scale test has been carried out.

The wind tunnel test was performed as a comparative test to the full scale situations. A house, situated in a dike in the Netherlands has been used (*see figure 5.2 and also item 5)*. In the wind tunnel, various stand-off distances have been investigated. It was found that there is a large level of correlation between the pressures on the top and bottom of the PV modules, leading to relatively low resulting pressures on the module. Variation of the stand off distance gives only slight differences in results.

Figure 5.2: Wind tunnel model of the 'dike' house in The Netherlands

References:
BRE report number 241-821: *Wind tunnel tests to determine the wind pressures on a roof mounted PV module,* January 2008, Paul Blackmore

Wind Loads on roof mounted PV modules, P A Blackmore - BRE, Garston, Watford, WD2 7DU, C P W Geurts - TNO Built Environment and Geosciences, Delft, The Netherlands, Paper presented at the WES conference in UK, July 2008.

5.2.5 Item 5: Full scale experiment on wind loads on stand-off PV modules

The full scale experiment was performed on the house of Rene Blickman, who is working at SolarVolta, one of the SME partners in the project *(see figure 5.3*). Two dummy panels were installed and pressure measurements have been performed during one winter season. The results of the pressure differences are similar to the final results of the wind tunnel research. This item, together with item 4, leads to new design values for the calculation of the fixings of stand off systems.

Figure 5.3 Test house and installation of the PV dummy for the wind load tests

Reference:
TNO Report 2008-D-R0777/B: Full scale measurements of wind induced pressures on stand off PV systems: Authors R.D.J.M. Steenbergen, C.P.W. Geurts

5.2.6 Item 6: CFD investigation on solar energy products on flat and pitched roofs.

CFD (Computer Fluid Dynamics) is a promising tool for future prediction of wind loads on structures and elements *(see Figure 5.4)*. The TU Berlin has investigated the applicability of a range of CFD solvers to predict the local loads on roofs and on solar systems. With CFD, the wind tunnel work on roof valleys, and on a earlier TNO study on flat roofs, has been modeled. The results for the local loads are yet not sufficiently accurate to apply CFD as a standard tool for such values.

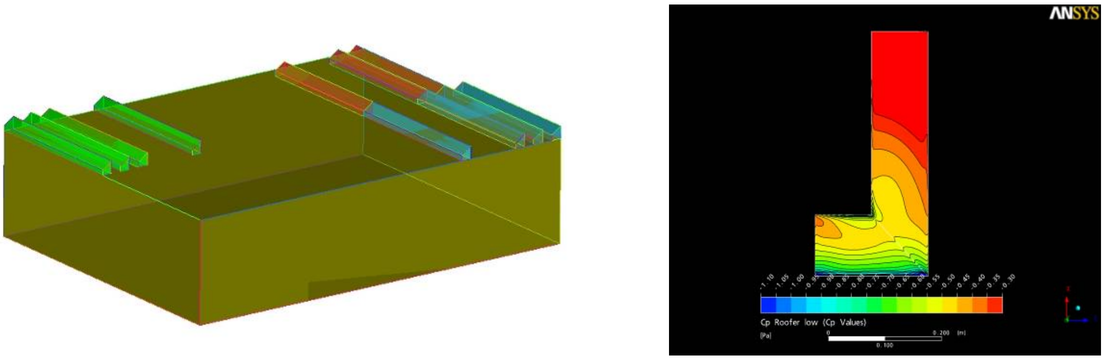


Figure 5.4 The used model for wind load (left) and a characteristic output picture of the CFD tool (right)

5.2.7 Item 7: Development of a draft test method for the wind resistance

The wind resistance of fixings of active roof products can in most situations sufficiently be determined by current guidelines and codes for steel and aluminum structures. For stand-off systems, this is not always the case. For these types of products, a draft test method has been given, based on EN 14437 for roofing tiles *(see Figure 5.5)* . This item produces deliverable DB.4 of this work package.


Figure 5.5 Dynamic wind load indoor test facility

Reference:
TNO Report 2007-D-R0836/A: EUR-Active Roofer WP B: Uplift Resistance of Active roof products: Author: C.P.W. Geurts

5.2.8 Item 8: Input for the work packages on guidance and pre-standardisation

From the results of the former items, input has been delivered towards work packages G and H. This has been done partly in meetings of WP G, and partly on a one to one contact with the project leaders of these WP's. This input is reported separately, but is also included as a chapter in both the guidance and the pre-standardization work.

Reference:
TNO Report 2007-D-R0835/A: Wind and Seismic Effects: EUR-Active Roofer pre-standardization document for wind loading and seismic effects, authors C.P.W. Geurts, C.A. van Bentum

5.2.9 Work Package meetings

In total, 9 work package meetings were held, 7 of them together with the overall project meetings, and 2 separate meetings, jointly with Work Package C.

First WP-B meeting, WP-B meeting, joint with WP-C, at Mayen, Germany
Second WP-B meeting, WP-B meeting, joint with WP-C, at Watford, UK
Third WP-B meeting, WP-B meeting, joint with WP-C, at Paderborn, Germany

Fourth WP-B meeting, joint with WP-C, at Krakow, October 2006
Fifth WP-B meeting, joint with WP-C, at Trondheim, May 2007
Sixth WP-B meeting, joint with WP-C, at Dublin, July 2007
Seventh WP-B meeting, joint with WP-C, at Siofok, October 2007
Eight WP-B meeting, joint with WP-C, at Athens, February 2008
Ninth WP-B meeting, joint with WP-C, at Amsterdam, June 2008

5.3 Overview of the Deliverables and Milestones

List the deliverables and milestones and the final results (see Deliverables Reports on the EU CIRCA site)

Nr.	**month**	**Description work to be done**	**Results**	**Produced documents**
Deliverables				
DB1	19	Intermediate WP report, provided as input for WP G.	Reports are produced about wind load, wind tunnel tests and earthquake load as input for WPG	Final reports on: - TNO 2006-D-R0203: Wind loads on active roofs Part 1: Introduction and Classification of Systems. - TNO 2006-D-R0204: Earthquake loading of active roofs - BRE 232-729: Wind tunnel tests for roof valleys
DB2	19	The basis for CEN test methods, as input for work package H, where the necessary steps towards pre-standardization are taken.	Pre-standardi-zation reports are produced on wind loading, seismic effects and uplift method resistance as input for WPH	Final reports on: - TNO 2007-D-R0835 /A: Pre-Standardization Document for Wind loading and seismic effects - TNO 2007-D-R0836 /A: Uplift Resistance for Active Roofs
DB3	25	Inclusion of wind and seismic effect-related issues into the database.	Reports are produced about wind load, wind and earthquake load as input for the database	Final reports on: - TNO 2006-D-R0203: Wind loads on active roofs Part 1: Introduction and Classification of Systems. - TNO2006-D-R0204: Earthquake loading of active roofs

Nr.	**month**	**Description work to be done**	**Results**	**Produced documents**
DB4	31	A series of test methods and assessment procedures (as appropriate) for wind and seismic effects testing of different classifications of active roof systems. These methods will be drafted as technical industry guides for the application and benefit of SMEs and IAGs.	Tests were carried out and test and assessment procedures were defined	Final reports: - BRE 241-821:Wind tunnel tests to determine the Wind Pressures on roof mounted PV module - TNO 2008-D-RO777/B: Full scale Measurements of Wind Induced Pressure on Stand-off Photovoltaic systems - CDF-Analyses, TU Berlin (July 2008)
Milestones				
MB 1	9	Delivery of relevant items to the Database	Input for work in WP A	See DB3
MB 2	13	First evaluation work WPB	Reports with relevant information are available	See DB1 and DB2
MB 3	19	Workshop first results at IFD	Results presented and discussed in the IFD congress in Krakow in November 2006	
MB 4	25	Relevant information included in database	Reports with relevant information are available	See DB3
MB 5	31	End of WP B. All deliverables available, presentation of results at IFD 2007	Final results are presented at IFD Conference 2007, EAR conference and the Dutch Actieve Daken Conferentie (both in June 2008)	See DB1 to DB4

5.4 Short Evaluation of the project

The atmosphere within the project was very good, and people were all open to share experiences and knowledge.

The meetings themselves were not so much working meetings, but more presentations of progress and commenting the draft results. It was very hard to have working meetings with about 15 to 20 people around the table.

A first problem was the language problem. Changing between English and German was not so difficult for the WP leader, but people tend to ‘disappear’ from discussions if they do not understand what is being said.

In a research driven project, it is hard to have full commitment from the SME partners. Where they are delivering material, or when they can host a meeting (Paderborn, Dublin), they are fully committed. Most of the work was done by the three main research institutes in this WP: TNO, BRE and TU Berlin. They produced all the reports, and little input was received from the other partners when drafting this report.

It was foreseen that there is a large overlap in the people involved in WP B and C. Therefore it was decided to organize the meetings of both WPs together, to avoid people being absent from one of the work packages concerned.

The time foreseen to prepare and perform a full scale measurement is longer than in the original work plan. Therefore an extension of the deadlines for this WP was needed until about May 2008.

In the end, we have a nice set of research results available, which can be applied on various levels in codes, guidelines and training programs, both European and nationally. This would not have been possible without this EU project.

5.5 List of produced documents

Reports

- TNO Report 2007-D-R0835/A: Wind and Seismic Effects: EUR-Active Roofer pre-standardisation document for wind loading and seismic effects, authors C.P.W. Geurts, C.A. van Bentum
- TNO Report 2007-D-R0836/A: EUR-Active Roofer WP B: Uplift Resistance of Active roof products: Author: C.P.W. Geurts
- TNO Report 2006-D-R0203: Classification of active roofs: Author C.P.W. Geurts
- TNO Report 2006-D-R0204: Earthquake loading of active roofs. Authors: F. van Duin, CA. van Bentum, C.P.W. Geurts, September 2006
- TNO Report 2008-D-R0777/B: Full Scale Measurement of Wind Induced Pressures on Stand-off Photo-voltaic systems. Authors R.D.J.M. Steenbergen, C.P.W. Geurts
- BRE report number 241-821: Wind tunnel tests to determine the wind pressures on a roof mounted PV module, January 2008, Paul Blackmore
- BRE Report number 232-729: Wind Tunnel Tests to Determine the Wind Pressures on Roof Valleys, Paul Blackmore. November 2006
- CDF-Analyses: Final report July 2008 (TU Berlin)

Publications, conferences

- Heron Magazine: ‘Wind Loads on Solar Energy Systems’
- WTG Tagung (in German)

- WES conference
- PV conference, Barcelona, poster presentation
- TVVL presentation (in Dutch)
- Input for Guidance and Pre-standardization (WP G and H)
- Newsletter from WPB on Wind loads

6 Work Package C: Rain and Wind Driven Rain Effects

WP-Leader: BRE
Period: 21 July 2005 till 20 July 2008

6.1 Objectives of the WP

The three principal objectives of Work Package C are:

- To undertake pre-normative research into the performance of Active Roofs under rain and driving rain action
- To develop technical solutions for minimizing leakage of Active Roofs.
- To prepare technical guidance and assessment methods for evaluating the performance of roof accessories and fittings of Active Roofs to driving rain.

The main issues to be addressed by this WP are the problems of rain penetration through active roofs. On Active Roofs there will be many interfaces and penetrations through the waterproof roof envelope from different accessories such as ventilation devices, PV systems, etc., which could be potential or actual sources of leakage. This causes problems such as deterioration of the roof timbers and building structure, damp, mould growth and reduced effectiveness of roof insulation. These roof problems cost the EU many millions of Euros every year to repair. The work undertaken in WPC is mainly research of a pre-normative nature.

6.2 Description of the activities and the achieved results

The work of WP1 was carried out in three phases.

Phase 1 – Product Classification and Database

Phase 2 – Research and Technological Development

Phase 3 – Preparation of Technical Guidance

A description of each of these three work phases follows:

6.2.1 Phase 1 – Product Classification and Database

This initial phase of the WP was mainly data gathering and assessment of existing Active Roof systems in order to characterize them according to type, design, source of potential leakage, leakage mechanisms. This classification system was based on the experiences of the WPC members who all provided information from their own countries and technical area. The information collected during this initial phase was supplied to WPA to help develop the overall product database. A specific database and classification system was also developed specifically for wind driven rain related performance of Active Roof Systems. From this classification two main categories of roof mounted PV systems were identified: roof integrated and stand-off systems. Within these two categories a number of sub-categories were also defined depending on size of PV panel, design, installation requirements, type of fixing, etc. Each of these categories and sub-categories of PV system have different issues regarding rain and driving rain resistance. From this work a classification system was developed. This classification system is of use to the members of WPC and to the wider Active Roofing industry as a means of identifying the likely sources of rain water leakage for the different PV systems.

The main generic categories and sub-categories of roof integrated PV systems are shown in *Table 6.1*. The classification of stand-off systems and fixing methods is shown in *Table 6.2*. The tables include the names and photographs of example proprietary products.

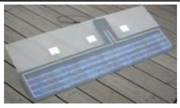
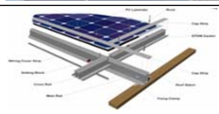
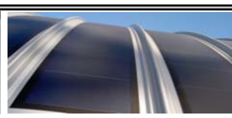
There are six generic roof integrated systems listed in *Table 6.1*, these are;
- Shingles
- Interlocking tiles
- Slates (no interlock)
- Large format tiles
- Weather tight laminate & module systems
- PV laminates bonded to metal pan.

Within these six classes, 14 sub classes have been identified.

There is less variability in stand-off systems. Only two generic types of PV system and three types of roof fixings are listed in *Table 6.2*, these are;
- Laminates
- Modules
- Fixing to battens
- Fixing to rafters
- Tiles with attached fixings

The classifications shown in Tables 1 and 2 have been developed by the members of WP C who between them have considerable experience of Active Roof systems and the PV industry. These classifications are not exhaustive but the majority of European PV installations will fall within these classes and sub-classes. These classifications provided an essential starting point for the next phases of the work in WP C. This work is described in more detail in deliverable DC.2 (WP C output number WPC-11E 21st April 2006).

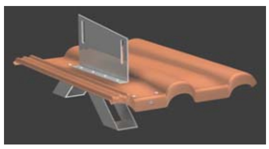
Table 6.1 Classification of integrated PV systems

Generic Main Type	Generic sub type	Example	Representative Picture
Shingles	Shingles	UNI-SOLAR® SHR17	
Tiles (interlocking)	Individual flat tile	Kaneka amorphous PV tile	
	Multiple flat tile	Solar Century C21 Marley Solar Tile Lafarge PV800	  
	Individual profiled tile	Solardachstein SRT	
	Multiple profiled tile	Sesol -Quick	
Slates (no interlock)	Individual slate	Atlantis Sunslate	
	Decrative individual slates	Rathscheck Schiefer - Solarsklent	
	Multiple slate	Soltech Arizona	
Large format tiles (using standard modules)	Interlocking units	PV Solar tile Phonix Newtec solar tile	 
Weather tight Lamimate & Module systems joined/flashed with tiles	Weathertight sub-tray systems	Econergy Intersol Lafarge PV 80	 
	Hidden gutter systems	3S Megaslate	
	Self supporting aluminium subframe types	PV Systems RIS©	
Bonded to metal pan	Standing seams	Rheinzinc Solar PV Corus Kalzip AluPlusSolar	 
	Horizontal panels	Rheinzinc Quick Step	

EUR-ACTIVE ROOFer

HORIZONTAL ACTIVITIES INVOLVING SMEs

Table 6.2 Classification of stand-off PV systems

STAND-OFF SYSTEMS			
Main generic type	**Mounting Method**	**Mounting type**	**Representative Picture**
Laminates	Metal sub frame and clips	Diamond clips	
		Laminate clips	
Modules	Metal subframe & clamps	Aluminium or steel clamp	
	Two parts fastened together	Two-part aluminium extrusion	
	Slide-in module framing	Single-part aluminium extrusion	
ROOF FIXINGS			
Generic Fixing	**Fixing type**	**Example**	**Representative Picture**
Hook	Under tile hook (to rafter)	Schletter hook	
	Bolt-through studs with flashing (to rafter)	Solar Century	
	Under tile strap (to batten)	NAPS UK	
Tile	Tile with attached fixing	Solarstocc - QuickStocc	 

6.2.2 Phase 2 – Research and Technological Development

This phase of research and technological development into the performance of Active Roofs has been carried out in three parts:

Part 1 – Development of a driving rain test method

There are no available test methods for assessing the performance of Active Roof systems under the action of wind driven rain. Such methods are necessary because Active roof systems are generally new innovative systems without any long-term history of successful performance on roofs. When these systems are installed on roofs they must not leak but they must also not affect the weather tightness of the existing roof to which they are installed.

There have been many examples of PV systems which have allowed rain to penetrate through the building envelop causing considerable damage to the building fabric and contents. Therefore a test method is essential to test the performance of these systems and to allow a common level of performance to be achieved and ultimately lead to CE marking. A test method was developed based on an existing test method for tile and slate roofs but modified to make it applicable to Active Roof systems. Fourteen tests were carried out on seven different types of Active Roof system. Plus a further parametric tests to investigate specific aspects of the performance of Active Roof systems such as determination of the measurement location for the reference wind speed over stand-off PV systems and the effect of gaps in roof coverings caused by hook fixings. The test products were supplied by the SME members of WP C and were chosen based on representative systems identified in the classification system from Phase 1 of this project. *Figures 6.1 to 6.4* shown some of the Active Roof systems tested in this phase of the work and *Figure 6.5* shows some of the parametric testing.

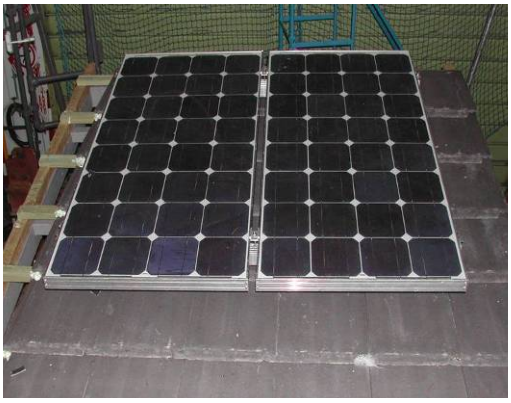


Figure 6.1 Stand-off PV module over tiled roof

Figure 6.2 Pre-fabricated chimney unit

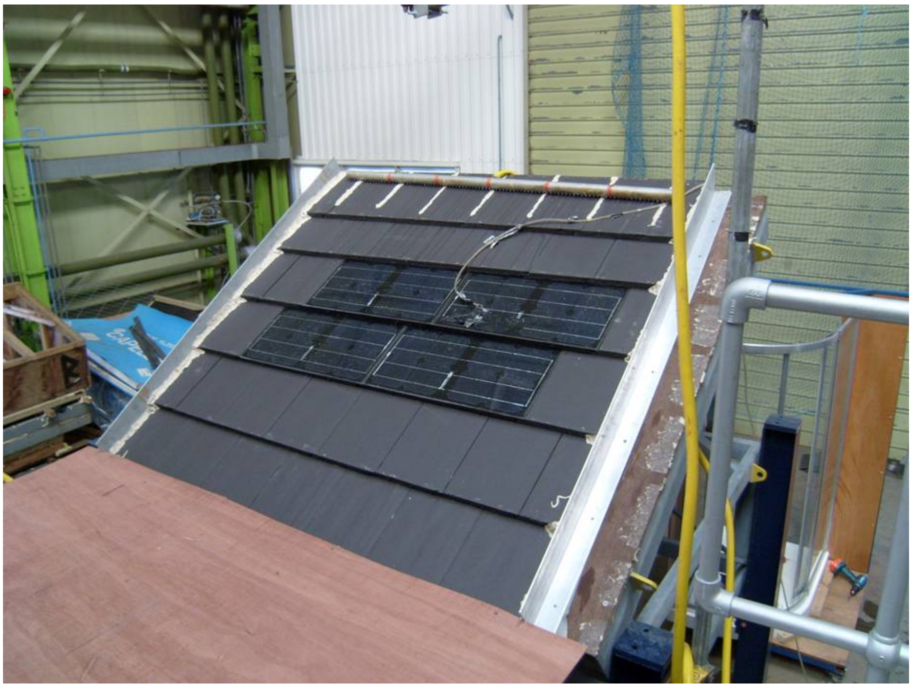


Figure 6.3 Solar slates in a slated roof

Figure 6.4 Stand-off system with proprietary under-roof

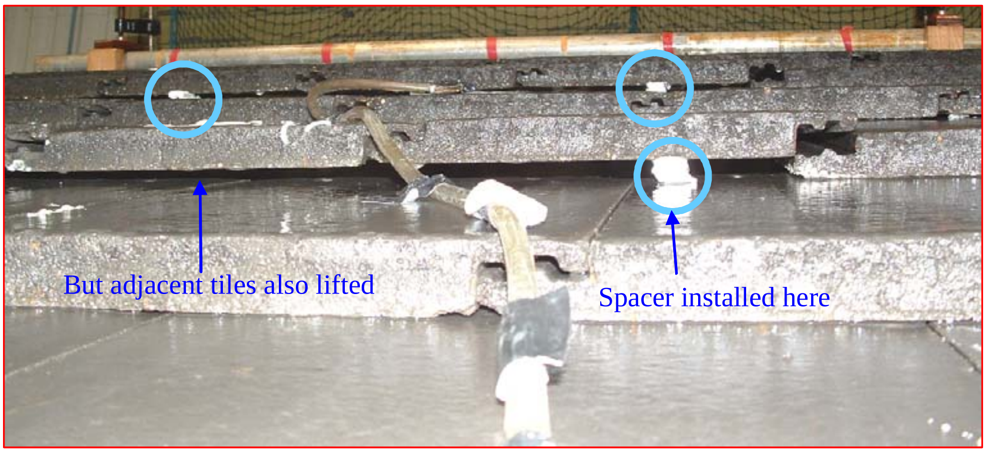


Figure 6.5 Parametric testing to determine the effect of gaps between tiles caused by hook fixings

The results from these tests and the lessons learned were used to develop and improve the driving rain test method in to a test for Active Roof systems. The test method itself was drafted as part of Phase 3 and is described later in this report.

Part 2 - Numerical CFD modeling
A series of numerical Computational Fluid Dynamics (CFD) studies were undertaken by Berlin Technical University to model wind driven rain over a roof. This work was carried out to supplements the laboratory tests that were described in Phase 1 of this part of the study.

The objectives of this study were to model driving rain around roofs and buildings to predict the water penetration through gaps between roof tiles. In this study the focus is on the numerical modeling of rain penetration which has not previously been studied.

There are differences between the modeling of driving rain around building and the modeling of the penetration through gaps. This study started by modeling the driving rain and the air flow around buildings. Then the trajectory of the raindrops was calculated. It was assumed that the raindrops have no influence on the flow field around the building. The trajectory is determined only by the flow field of the air.
For the modeling of rain penetration it is necessary to calculate the air flow field and the water flow field in one step. It is based on the fact, that in gaps these two flow field influence each other. To solve the shared flow field a Eulerian-Eulerian Multiphase model is used. The air is considered as a homogeneous fluid and the water is considered as a dispersed fluid.

For modeling flow through the gaps in the roof gaps it is necessary to have several cells layered on top of each other inside the gap. Gap widths from 1 mm to 10 mm require cell sizes in a range of millimeters or smaller. Only a very small area around and within the gaps can be considered when calculating flows through gaps.

The model which is used for the numerical calculations has a 45° pitched roof with roofing tiles. There are four layers of tiles (*see in Figure 6.6 and 6.7*). The gaps between the tiles are only in the horizontal direction (perpendicular to the incoming flow). There no gaps in the flow direction. The gaps have a width from 10 mm and a depth from 60 mm.

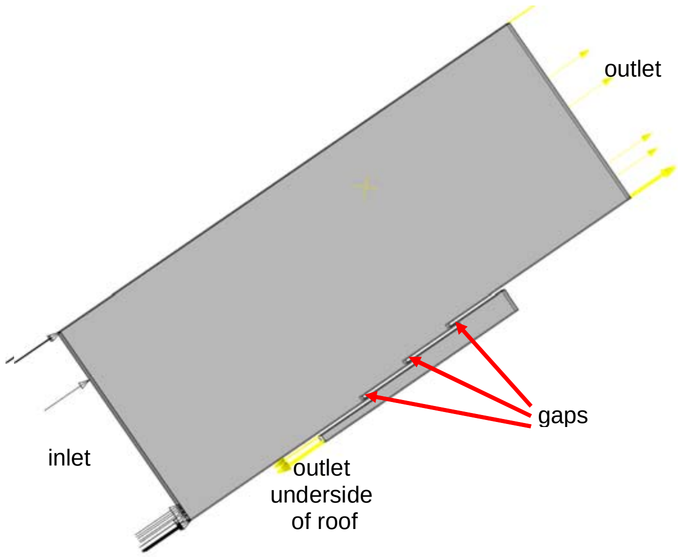


Figure 6.6 The general numerical domain used for the calculations

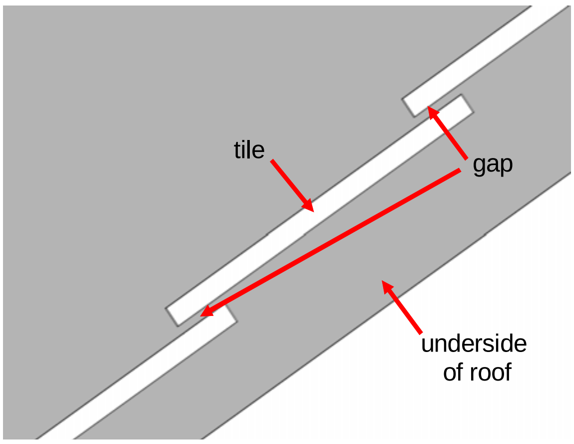


Figure 6.7 A close-up view of the gap widths which were modeled

The boundary condition where chosen according to an earlier BRE CFD investigation of rain penetration and the information given in CEN standard prEN 15601: 2006. Based on the given air and water mass flow the volume fraction for both fluids was calculated. The velocity of the air and the volume fraction were taken as the inlet boundary conditions.

The results from this study were somewhat inconclusive. This is for a number of reasons concerning modeling deficiencies. It seems that based on the current state of the art of CFD modeling it is not possibly to carry out a numerical simulation of rain penetration through small gaps. The CFD software used does not model all necessary physical phenomena which are important in the process of driving rain penetration through small gaps in roofs. Changes of the gap width caused by wind uplift pressure (pressure differences between the upper und under roof) on the tiles have necessarily been disregarded. However, the modeling does give an indicative assessment of how rain might penetrate through gaps, although the modeling needs to be further developed to give better precision and confidence in the results. *Figure 6.8* shows the volume fraction of the water in the numerical domain and in the gaps between the tiles.

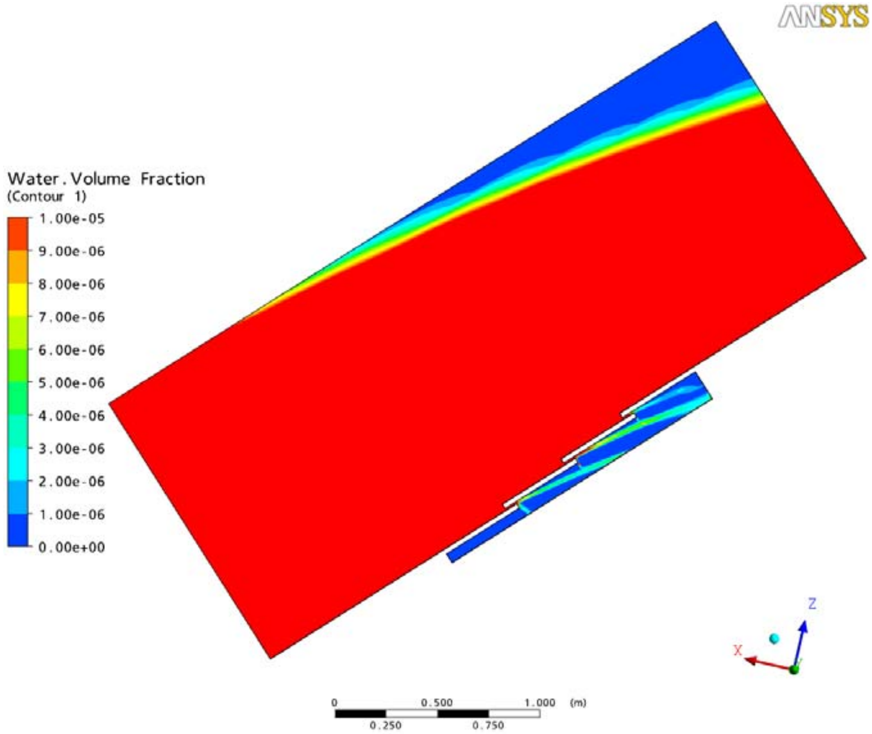


Figure 6.8 Water volume fraction from the numerical model

Statistical Analysis of full-scale wind driven rain data by BRE:
The driving rain test method gives the following four wind and rain combinations for each of three climate zones:

a. Low wind speed with severe rainfall rate
b. High wind speed with high rainfall rate
c. Severe wind speed with low rainfall rate
d. Maximum rainfall rate with no wind (deluge)

The test method also allows the use of site specific data instead of the provided wind/rain conditions. However, the test method does not give a procedure for determining the joint probability of the wind and rain conditions. Therefore, full scale measurements, such as those measured during the Biohaus experiment cannot be presented in a format compatible with the wind-rain condition in the test method. This makes comparison between the test method and full-scale measurements very difficult. Therefore, BRE carried out a statistical analysis of full-scale wind speed and rain fall rate measurements using 45 years of data from nine UK Met Office weather stations.

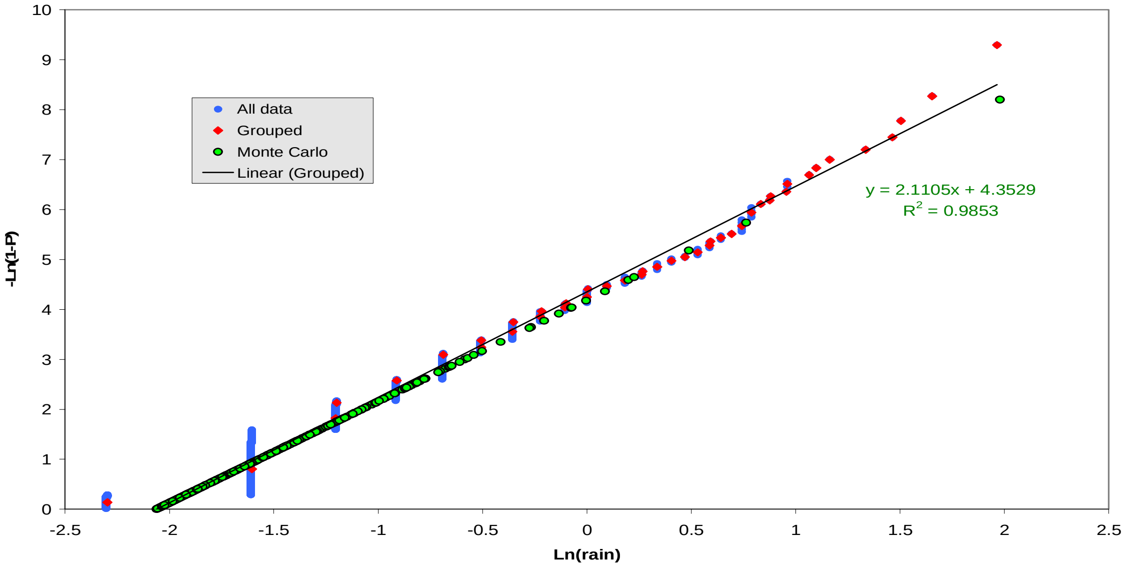


Figure 6.9: Parent rainfall rate data at Squires Gate during periods of wind

This analysis developed the statistical extreme-value methods necessary to model the parent wind speed and rainfall rate curves for wind, rain and combined wind and rain. An example of the statistical model for parent rainfall rate is shown in *Figure 6.9* and an example of the extreme-value wind speed is shown in *Figure 6.10.* This methodology allows full-scale wind and rain measurements to be analyzed to give wind driven rain conditions that are compatible with the test method.

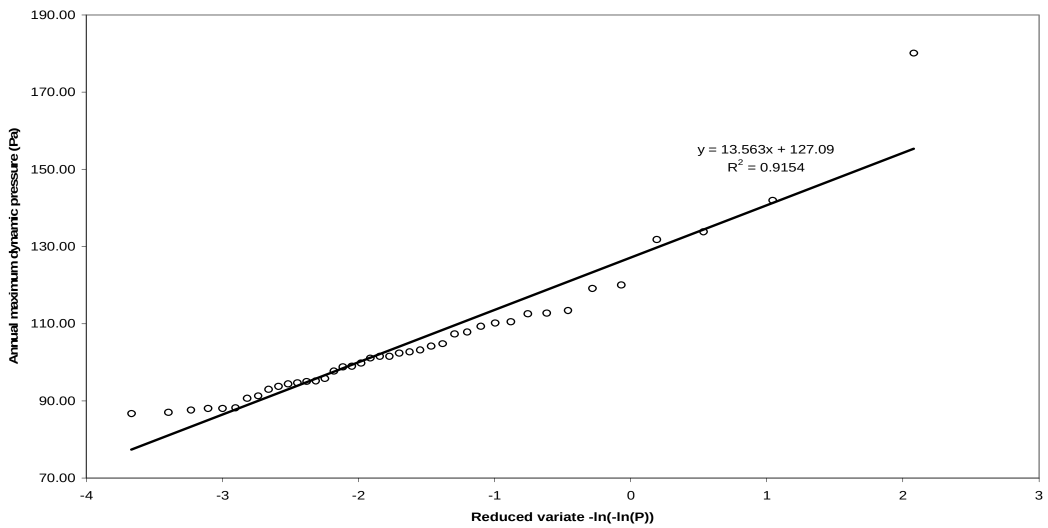


Figure 6.10 Plot of extreme wind pressure during periods of rain at Heathrow

6.2.3 Part 3 - Full-scale testing and assessment

A series of full-scale measurements of wind driven rain were carried out by Biohaus (since May 2006 part of Centrosolar) using a BIOSOL integrated PV roof system module specially constructed and installed on the roof of a Biohaus office building in Paderborn, Germany, where it was exposed to wind driven rain. *Figure 6.11* shows the test specimen on the roof.

The test rig was installed on the Biohaus office building in July 2007. The aims of the experiment were to measure wind speed, wind direction, rainfall rate and leakage effects through the test specimen. The test rig was adjustable between 20° and 30° to allow the effect of pitch angle to be investigated. To examine the leakage effects the test rig was designed to measure water ingress in defined areas of the whole test rig surface.

The WPC working group met at Biohaus offices in Paderborn prior to the installation of the test rig to see the site and to discuss and advise on the installation and setup of the full-scale experiment. In order to identify potential leakage areas a series of pre-tests were carried out using simulated wind driven rain. From these pre-tests it was decided to arrange the water collection devices in to three critical areas. These were the general “surface” area, the “eaves” area and the “crossing point” (the centre of the test panel where the horizontal and vertical capping strips meet. Each of these areas had its own individual rain water collector.

Figure 6.11 Full-scale test rig installed on a building roof by Biohaus

The meteorological parameters were measured using a DAVIS Vantage PRO 2 wireless weather station with data logging device which was mounted on the roof of the Biohaus office building close to the test rig. The weather station measured wind speed, wind direction, rainfall, rainfall rate and a range of other parameters. The data were sampled and stored at 1 minute intervals. *Figure 6.12* shows the DAVIS weather station on the roof of the building.

The full scale measurements were carried out between August 2007 and May 2008. During this period there were unfortunately long periods without rainfall. There were also some problems with the weather station equipment. This limited the number of useful measurements of wind driven rain that were recorded. However, data were collected for a wide range of wind and rain conditions ranging from a maximum wind speed of 20 m/s rain fall rate of over speed of over 20 m/s and a rainfall rate of over110 mm/hr.

Figure 6.12 Biohaus weather station

6.2.4 Phase 3 – Preparation of Technical Guidance

This is the final phase of the work of WPC which draws together the work of the previous phases. The work carried out in Phases 1 and 2 led to the development of a draft test method for a driving rain test for Active Roofing products. It was decided that it would be most appropriate to base the test method on the principles of prEN15601, which is a test method for discontinuously laid small roofing elements. A preliminary draft test method was subsequently prepared based on this initial testing as output DC.3 from Phase 2 of the project. Further testing and analysis was then carried out at BRE and the other WP C partners to assess and develop the preliminary test method to improve its applicability for Active Roof systems.

In this final phase of the project the findings and results from Phases 1 and 2 of WPC have been evaluated by the Working Group. The main findings and lessons from these first two phases of work have been incorporated into a final draft of the pre-normative standard for rain and wind driven rain performance. This driving rain test method has been incorporated into the comprehensive draft standard for Active Roof systems prepared by Work Package H which was been submitted to CEN as a pre-standard. Further full details of this work are provided in output DC.4.

Further guidance prepared by WP C has been in the form of technical guidance at training seminars prepared under WPI and conference papers. The following technical seminar presentations and conference papers have been prepared by WP C:

- How to Design Solar Systems for Wind Loading & Driving Rain, - Paul Blackmore, (BRE)
- Siting Roof Mounted Wind Turbines to Optimise Output - Paul Blackmore, (BRE)
- J Smith, P Blackmore, S Otto, Wind tunnel and CFD modeling of roof valleys, UK Wind Engineering Society Conference, Surrey University, July 2008
- P A Blackmore, Optimising the location of micro-wind turbines on house roofs, UK Wind Engineering Society Conference, Surrey University, July 2008
- P A Blackmore, C P W Geurts, Wind Loads on roof mounted PV modules, UK Wind Engineering Society Conference, Surrey University, July 2008

6.3 Overview of the Deliverables and Milestones

List the deliverables and milestones and the final results (see Deliverables Reports on the EU CIRCA site)

Nr.	Delivery month	Description work done	Results	Produced documents
Deliverables				
DC.1	10	Inclusion of driving rain related issues in to the first version of the Best Practice Catalogue being prepared by WP A	Members of WPC supplied details of products which were compiled and sent to WP A for inclusion in the Catalogue	Report with overview of various PV systems (January 2006) See also Best Practice Catalogue WPA
DC.2	10	Development of a product classification for rain and driving rain resistance of Active Roofs	A report was produced which gave a classification system for building integrated and non integrated PV systems and a brief overview of the National Building Regulations with respect to PV systems	Report Classification of Active Roof systems for rain and wind driven rain (see WPC-11a)
DC.3	16	The development of the basis for a CEN (or EOTA) standard or technical approval, for driving rain testing of Active Roof systems	A draft test method for driving rain testing of Active Roof systems has been developed based on the preliminary testing undertaken at BRE	A technical report has been produced which sets out the draft test method in a CEN standard format (see WPC-14E)

Nr.	Delivery month	Description work done	Results	Produced documents
DC.4	301	Pragmatic, research based test methods and numerical models for assessing driving rain effects on different classifications of active roof systems.	This output is based on additional wind tunnel testing, CFD modeling, full-scale testing and analysis and has led to improvements in the preliminary driving rain test method developed for DC.3	A comprehensive report has been produced describing the work (see WPC-26E) and also 3 further reports: WPC-24E WPC-25E WPC-27E
Milestones				
MC1	9	This milestone was the decision point regarding the number and type of tests that will be carried out in Phase 2.	A total of approximately six Active Roof products were selected for testing. These include large and small format PV systems, modular systems and stand-off systems as well as a selection of chimney products and there flashings	No documents produced but information supplied to WPA (relevant points for the decision were the Minutes of WPC meeting at Paderhorn, 27 June 2006, WPC-12E)
MC2	13	First evaluation of the work done in WPC	See Activity report of 1st project year	Activity Report 1st project year
MC3	19	Presentation of preliminary result at IFD	The preliminary results from this work were presented at IFD in Nov. 2006	A technical presentation was produced
MC4	25	Decision to make of choice of test methods for further development into industry standards	The research and testing has shown that the most appropriate test method for driving rain testing of Active Roof systems is that based on prEN 15601. Therefore this test method will be taken forward and developed as the agreed industry standard test method	Documents relevant to this Milestone are as follows WPC-16E WPC-17E WPC-18E WPC-19E WPC-20E

Nr.	Delivery month	Description work done	Results	Produced documents
MC5	31[1]	End of WPC. All deliverables available	This milestone was completed in June 2008 according to the revised schedule. All outputs and deliverables were completed and the work of WPC was successfully concluded	Final deliverable report WPC-26E

[1] *changed to month 35 with agreement of the European Commission*

6.4 Short Evaluation of the project

No major problems have been encountered during this work. Minor problems were encountered in the initial stages of the project trying to get the participants to become fully involved in the project and to realize the benefits of their input to the successful outcome of the work. Once partners started to understand the benefits and developed a good working relationship with the task leaders and with other members of the Work Package then their involvement and commitment improved and a strong team spirit was developed which led to focused outputs which benefited all participants and the wider Active Roofing industry.

The driving rain test method is the major deliverable of WPC. Although it is still only a draft test method it has been used by a number of the members of WPC to test their products and looks likely that this test method will be taken up as the standard test method for PV systems and other Active Roof systems either by CEN or EOTA so this is a very successful outcome to this WP, which is due to the support and involvement of all of the members.

6.5 List of produced documents

Doc. Nr.[*]	Title/Description of document
WPC-1E	Spreadsheet giving details of generic PV systems commonly used in the UK
WPC-2E	Summary of the draft prEN 089030 test method for driving rain testing of tiles and slates
WPC-3E	Spreadsheet of WPC participant effort
WPC-4E	Start-up document for WPC, giving state of the art, standards, etc
WPC-5E	Minutes of the WPC meeting in Mayen on 13 October 2005
WPC-6E	BRE Digest 495 Installation of PV systems
WPC-7E	BRE Digest 489 Wind loads on PV systems
WPC-8E	Minutes of the WPC meeting at BRE on 9 March 2006
WPC-9E	Details of PV systems and fixing methods and a report from Photon

	Magazine about damage caused by incorrect installation of PV systems (English version)
WPC-10G	Details of PV systems and fixing methods and a report from Photon magazine about damage caused by incorrect installation of PV systems (German version)
WPC-11	First draft of deliverable DC.2 classification system for Active Roofs
WPC-11a	Final version of deliverable DC.2 classification system for Active Roofs
WPC-12E	Minutes of the WPC meeting at Paderborn on 27 June 2006
WPC-13E	Minutes of the WPC meeting at Krakow on 15th November 2006
WPC-14E	Final version of deliverable DC.3 – draft driving rain test method
WPC-15E	Technical report - Measurements of wind pressures on roof valleys
WPC-16E	Minutes from WPC meeting in Trondheim
WPC-17E	Biohaus presentation in Trondheim
WPC-18E	WPC progress report presentation in Trondheim
WPC-19E	Remaining work in WPC - presentation at Trondheim
WPC-20E	Presentation to WPC in Dublin
WPC-21E	Minutes of WPC meeting in Dublin
WPC-22E	WPC presentation given at Athens GA meeting in February 2008
WPC-23E	Analysis of full-scale wind speed and rainfall data
WPC-24E	Report of full-scale tests carried out by Biohaus
WPC-25E	Numerical modeling of wind driven rain
WPC-26E	Final deliverable DC.4 – Test method and numerical methods for assessing driving rain effects
WPC-27E	CDF-Analyses, Final report (July 2008)

**E refers to documents in English; G refers to documents in German*

7 Work Package D: Condensation

WP-Leader: BTI
Period: 21 July 2005 till 20 July 2008

7.1 Objectives of the WP

The aim of this work package is to avert damages and to assure high durability of roofs and roof constructions caused by condensation, due to energy saving actions like the installation of active solar elements and the improvement of constructions by increasing the insulation and the tightness of the buildings. And the results and data are valid for both, for new constructions and renovations.

WP D supports the roofers to design the roofs and to select materials and make a contribution to the training of roofers and to further research and standardization, taking in account the regional climatic conditions and the technical characteristics of the roof.

The main objectives of WPD, which were not changed during the project period, are

- *Durability*
  The behaviour of roofs is changing and new condensation problems could occur by energy saving installations like active roof (solar) elements and additional insulations. The new situation of moisture and humidity combined with other forms of warm bridges and the given boundary conditions have been investigated. There are mainly two requirements: the amount of moisture has to be sufficient low to avoid damage in wood components and corrosion of metal parts and on the other hand it has to be assured that the increase in moisture during winter period is compensated by decrease during summer. This aspect were performed by BTI, WUT, EMI, Puskas, NBI, ZVDH and H&E.

- *Expected Lifetime*
  A change of ageing may reduce the expected life time of roofing materials and may influence the warranty conditions. The ageing behaviour of the roofing materials and components with added or integrated active solar components was investigated. This aspect was performed by EMI, Puskas, Alukol, Cenergia, Ecovent, Sinergicha, BTI, WUT, CRES and Dakdekker.

- *Method for simulation*
  An accelerated ageing laboratory test for roofs with integrated/added solar components was developed and compared with results of calculation models including the boundary conditions. The output is a testing method for future standardization and assessment of construction. This aspect was performed by BTI, WUT and CRES.

- *Assessment methods*
  For the development of safe constructions in different climatic zones basic data and

simple rules are developed. This sort of presentation was one of the main requirements of the roofer enterprises. Performed WUT, CRES, BTI, EMI, SMEs.

- *Improvement of numerical methods*
  Two leading software tools were used: WUFI by WUT and Physibel by CRES. Each software and the boundary conditions were tested by calculating the laboratory models and the full scale models and comparison of the results. In addition a new software tool for the roofers was developed. This aspect was performed by WUT and CRES.

7.2 Description of the activities and the achieved results

In principle the project work in WPD was divided in 3 phases:

- Phase I: Data collection
- Phase II: Classification
- Phase III: Research, test and analyze data

7.2.1 Phase I: Data collection

This activity took a period of 3 months, started with the kick off meeting in Mayen in September 2005 until the WP D meeting in Aigen/Austria in December 2005. On the one hand the individual conceptions of the participants and the requirements of the roofers had to be combined; on the other hand the general arrangement of WPA (Best Practice Catalogue) had to be considered. Based on these facts the work was divided up, the role of each participant was defined and the whole project was scheduled (see document WPD-02 *Minutes of meeting Aigen* and WPD-03 S*tart document*. This phase resulted finally in the decision of the construction of BTI laboratory test model.
Reported in the report WPD 05 *Decision of model type for Calculations and testing.*

In this phase the following results were achieved:

Durability – WUT Best Practice (DD1):
As a general input is drawn up and reported to WPA to avoid damages caused by condensation, examples of roofs are selected. This roof types are not only used in the Best Practice Catalogue, but also as basic constructions for further investigations and tools for roofers. The report consists of drawings and descriptions of all common roof constructions including Mansarde roofs and Active Roof Components (see two examples in *Figure 7.1)*.

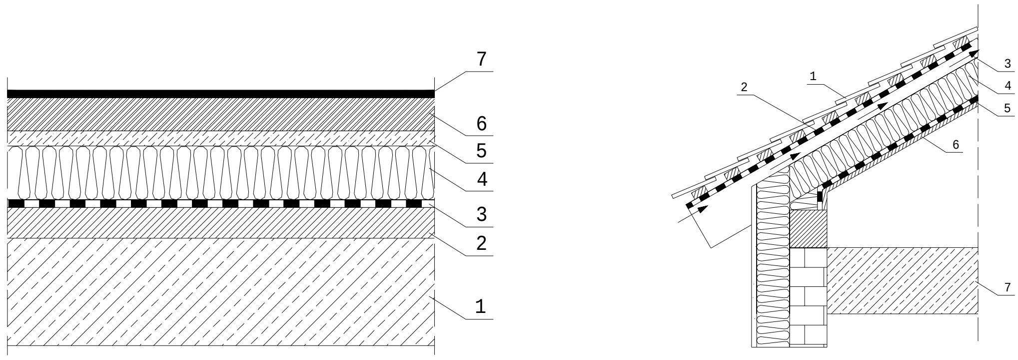


Figure 7.1 Two examples of common roof constructions (flat and pitched roof). From Report "Best practice concerning roofing and moisture condensation on roofs" by WUT published in May 2006.

Moisture condensation on roofs
In a preliminary study basic data of moisture content in roofs on different roof types and the consequences of condensation for health and physics as well as the installation of solar components were documented (reported in WPD-06_1 by WUT)

WUT request for calculation:
A list of required data to compare simulation and measurements within WPD was circulated (reported in WPD-06_2).

WUT data collection:
The relevant national regulation and standards, the EN and ISO standards concerning condensation in roofs and roof constructions from material properties to the climatic data were listed (reported in WPD-06 *Standards and regulations* by WUT)

7.2.2 Phase II: Classification

In this phase the following results were achieved:

Decision of model types for calculation and testing (MD1)
At the WPD meetings in Aigen (Dec.2005), and Budapest (Jan.2006) the members agreed on the models for BTI /laboratory tests (*see Figure 7.2*) and EMI/full-scale test (*see Figure 7.3*).

The models are in accordance with the types in the presented best practice constructions and also with the selected roof types, which are basic for WUT calculations and are given in the following section. The models are documented MD1– report WPD-05 by BTI.

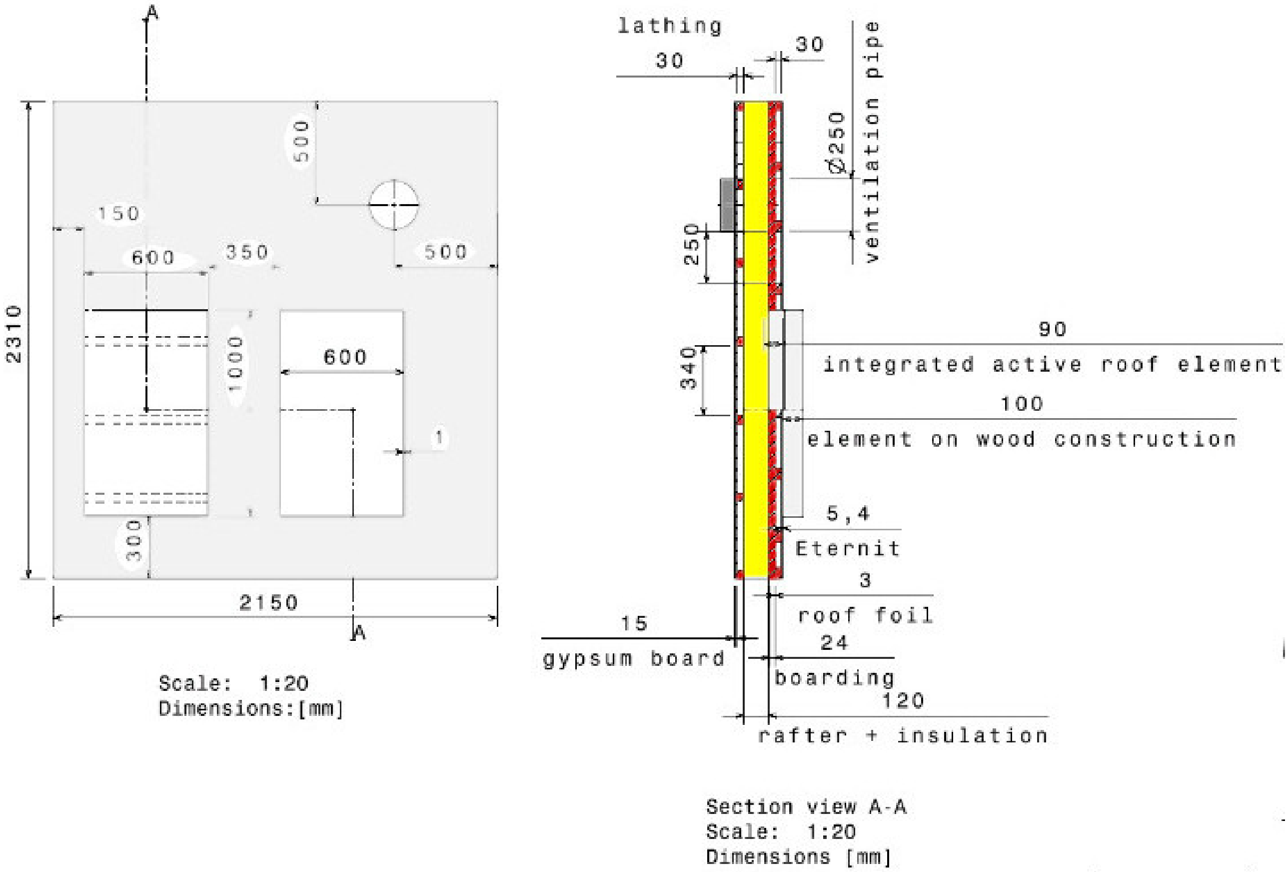


Figure 7.2 BTI Model for laboratory tests

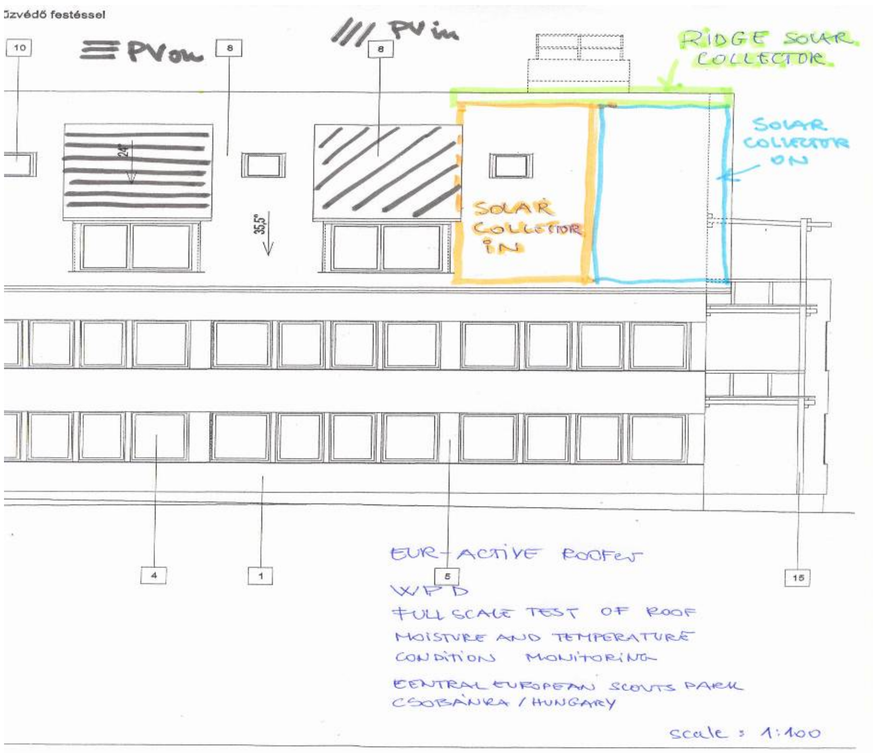


Figure 7.3 Layout of EMI Model – full scale test.

Moisture distribution in selected types of roof und different indoor conditions (WUT calculation, DD1)
In Warsaw WPD meeting (May 2006) the members agreed to develop basic information concerning the risk of condensation for selected roof types. Each construction is defined and the risk of condensation was calculated for 3 levels of internal climates *(see Table 7.1)*..

Table 7.1.Roof systems: the risk of condensation.

Outside temperature <0°. Internal conditions:	Flat roof			Pitched roof			
				With ventilation cavity			Without ventilation
	Warm roof	Cold roof	Green (inverse) roof.	Vapour open covering *)	Low vapour resistance covering **)	High vapour resistance covering ***)	
<16° /<50%	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Medium risk
<20°/<65%	Medium risk	Medium risk	Medium risk	Low risk	Low risk	Medium risk	High risk
<24°/<75%	Medium risk	Medium risk	Medium risk	Low risk	Medium risk	High risk	High risk
Above 24° or 75%	High risk	Medium risk	High risk	Medium risk	Medium risk	High risk	High risk

*) system for example: multi-unit covering (tiles etc)
**) system for example:PVC
***) system for example: metal, built up roof

Result: this is a tool as requested by the roof, where a quick estimation of the risk of condensation for particular roof is possible and reported under DD1.

Input for database Part 2 (DD1):
Laboratory tests – description of the test method and first results
Durability - BTI Laboratory tests
The aim was to develop a test procedure for roofs with installed photovoltaic or solar components in order to test:

- whether there is humidity due to condensation on and adjacent solar elements
- whether the humidity is dried in the hot period or humidity is increasing and the construction material will be damaged.

During the tests the materials were investigated, to estimate the probability of accelerated ageing of the materials.

In the developed test procedure the climatic chamber (2x2x2 m) was divided up in two parts by a regular insulated roof construction *(see figure 7.4)*. The construction was equipped with two different solar panels: one integrated the other near the surface of the roof (see report WPD 30 *Preliminary-Test*).

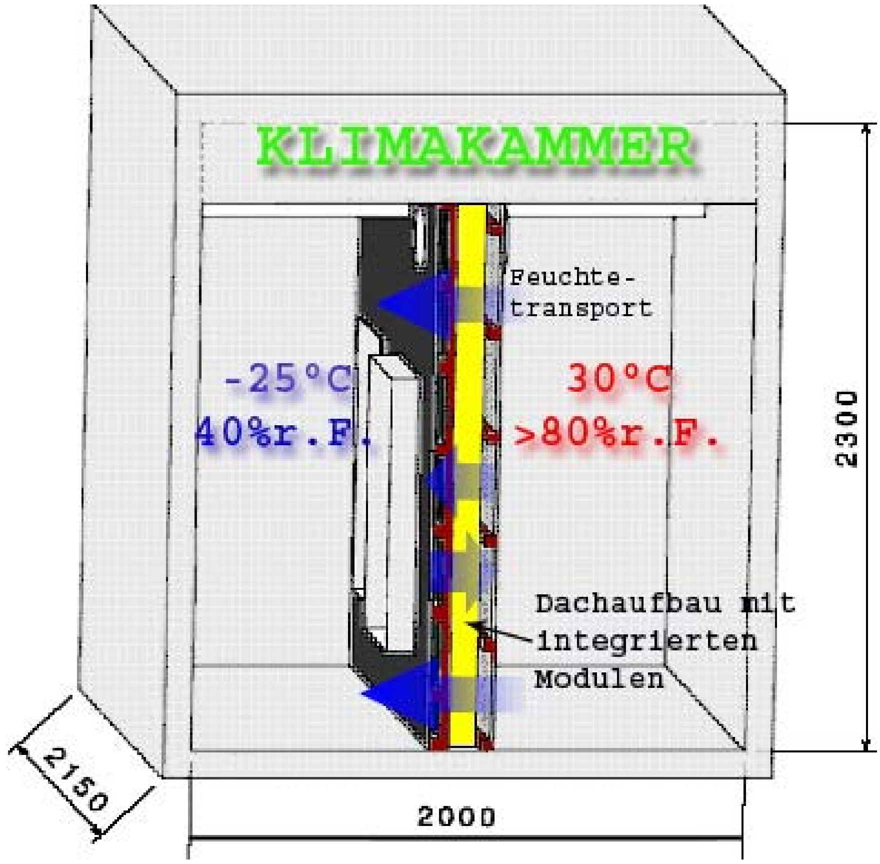


Figure 7.4 Climate Chamber for humidity and ageing of materials

A detailed report of the test procedure is given in WPD 11-2. The final procedure is reported in the milestone report WPD-15 (MD2).

7.2.3 Phase III: Research, test and analyse data

Durability - Investigation of damages caused by condensation in roofs of indoor swimming pools (by BTI)
The WPD tests and calculations are done for regular roof constructions with usual indoor climate as given for apartments, offices and commercial buildings. To get additional information for the roofers for the roof construction in buildings with severe indoor climate, some Austrian roof constructions were investigated concerning the design and the possible damages. Because damages are a short way to get information about which design is not suitable *(see Figure 7.5)*.

*Figure 7.5: Although the construction is not well designed, because of ice and snow-free areas, there is no condensation inside because of the ventilation space of larger than 1 m. And such a wide space also could be found at other (renewed) roof constructions. This resulted in a recommendation for roofers to provide enough space for the ventilation and use roof area for solar elements. For the design the client has to have physical consultancy and suitable indoor ventilatio*n.

Durability - *Climatic zones in Europe as a function of moisture condensation risk*
As a further tool for the roofers to get support in the question of condensation, WUT has developed on the basis of the climatic data of several European cities three zones for the risk of condensation. The diagram is valid for regular buildings and as an input the roofer needs only the information of the external ambient air temperature of the 30 coldest days of a year. *Figure 7.6* illustrate condensation risk weather zones.

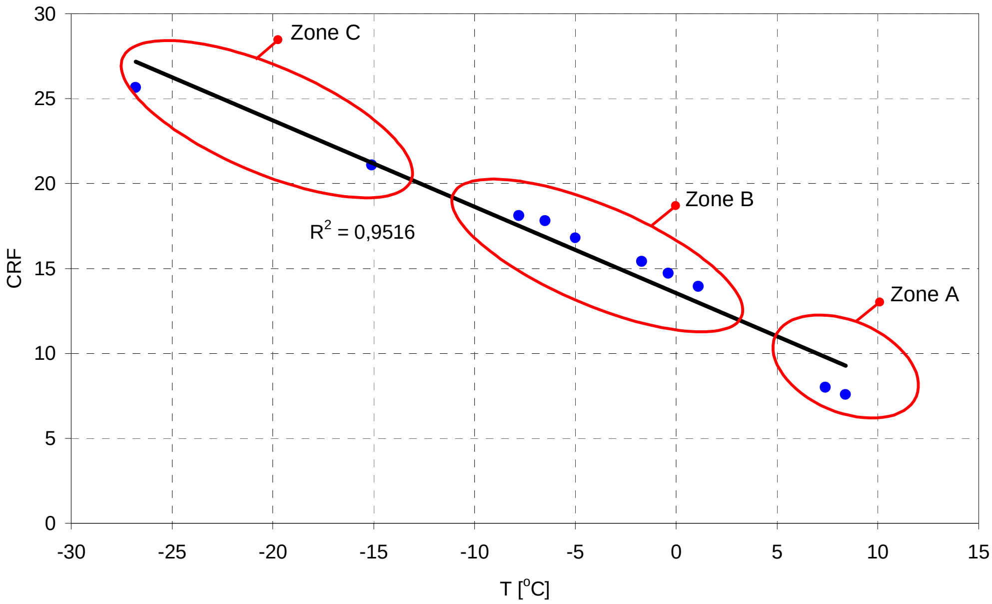


Figure 7.6 Condensation risk factor for 10 locations as the function of mean external ambient air temperature for 30 coldest days of the year and condensation risk weather zones

EUR-ACTIVE ROOFer

HORIZONTAL ACTIVITIES INVOLVING SMEs

Basic data - Indoor humidity and temperature (by WUT)
This report *Indoor_stat.doc* (by WUT, January 2007) presents results of investigation of parameters of indoor air, such as temperature, relative humidity and moisture content. The investigation was done for about 50 weeks in 25 buildings in Warsaw Poland, between 2000 and 2006.

This measurements focus on naturally ventilated dwellings but it was considered also swimming pools as an extreme humid environment. Dwellings were divided on with- and without moisture problems. Also bathrooms were separated from dwelling rooms. The measurements were done also in offices spaces but only with exhaust mechanical ventilation or with natural ventilation. Except swimming pools the indoor humidity was not controlled at all *(see Figure 7.7)*.

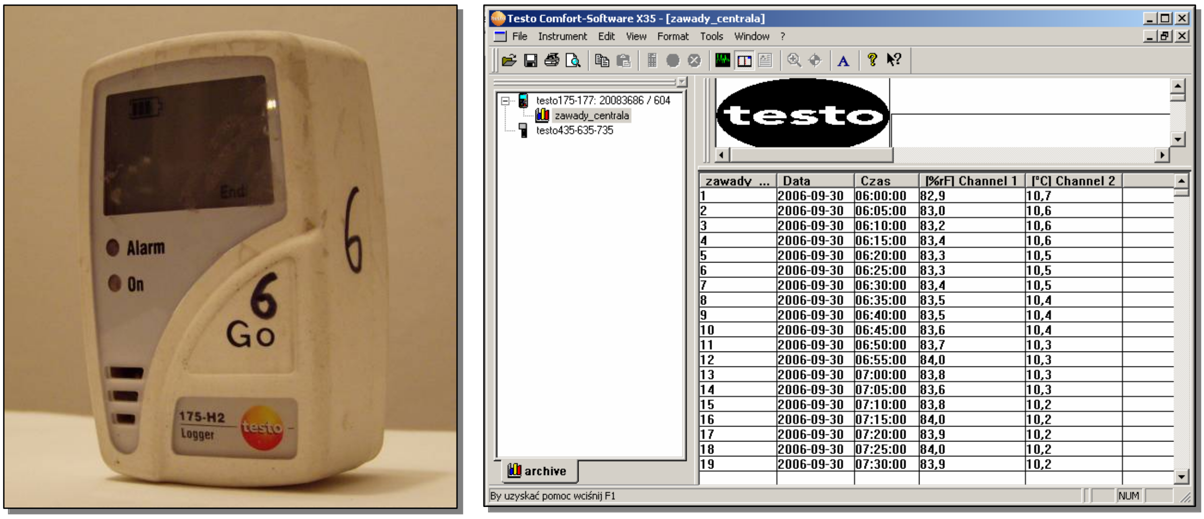


Figure 7.7: Moisture measurement and resulted data file

The reported values may be used as boundary conditions for calculation, designing and other investigation of moisture condensation in roofs of building without humidity controlling environment and typical using. In other building relative humidity values varies between 40 and 60% depending on winter or summer and class of thermal comfort controlling.

Durability - Spanish Roof constructions, investigation of construction Dakdekker and BTI and simulation by CRES calculation software
On a Spanish villa photovoltaic elements were installed. Because of several problems Dakdekker had to renew the construction *(see Figure 7.8)*. This was the possibility to investigate such a roof under real conditions. The design was not in line with the regular requirements. The basic data were sent to CRES to check the risk of condensation.

Figure 7.8: General roof Conditions of Spanish villa:
- *No skilled workmanship*
- *Air gap inside*
- *Insulation with gaps*
- *No vapour barrier*

The final result was that no condensation was visible, but workmanship should be improved to avoid problems (concerning documents: WPD-09_1 *Minutes of meeting Barcelona 04.04.2006* and WPD-09_2 *Material properties of Spanish roof.*

Simulation for drying period, moisture distribution evolution, water content evolution (DD2 by CREST).
The three Spanish roof structures which were investigated by BTI were simulated with the CRES Physibel software (WPD_14_2)

a) Investigated roof as described above *(see Figure 7.9)*:

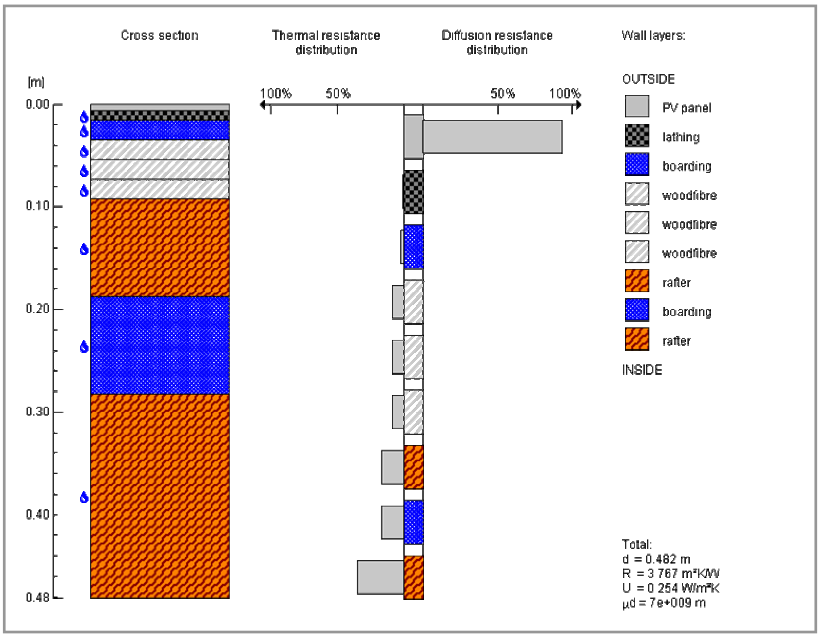
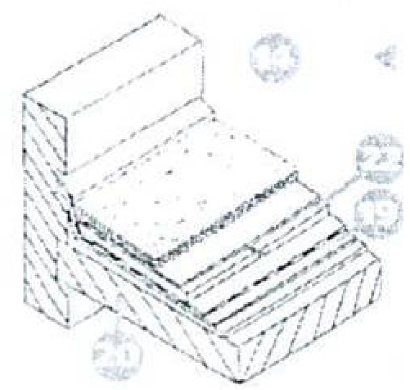


Figure 7.9: Picture of the Spanish roof and diagram of the cross section of the Active Roof with PV panels (Physibel software)

b) Investigated Standard Flat roof *(see Figure 7.10)*



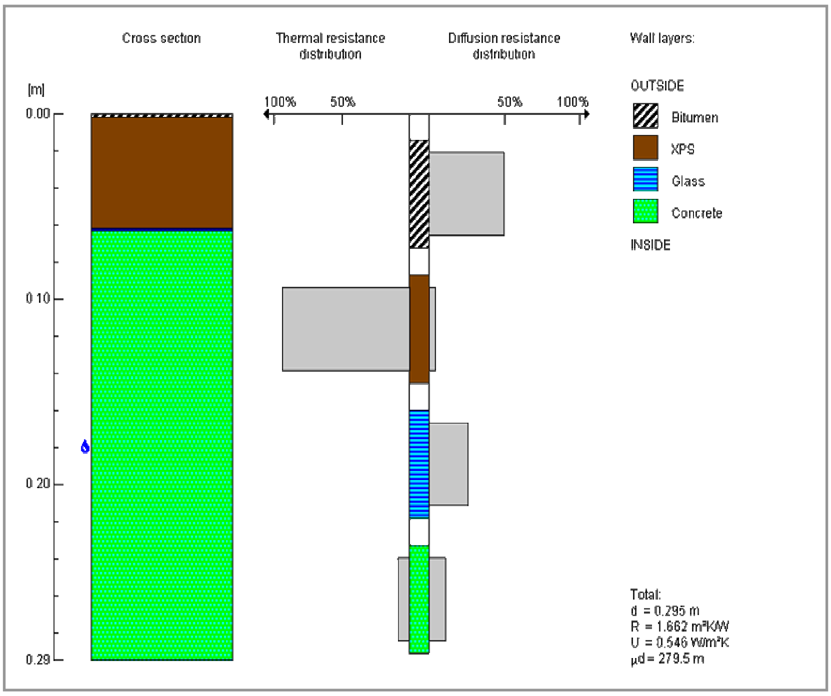


Figure 7.10: Sketch and cross section of a standard roof structure (Physibel software)

Laboratory tests, procedure for accelerated tests (DD2 by BTI)
The tests which started at the end of 2005 were finished in February 2006.
It was possible to reach stable conditions during the test period and condensation occurred, although the repeatability is not 100% *(see Figures 7.11 to 7.14)*

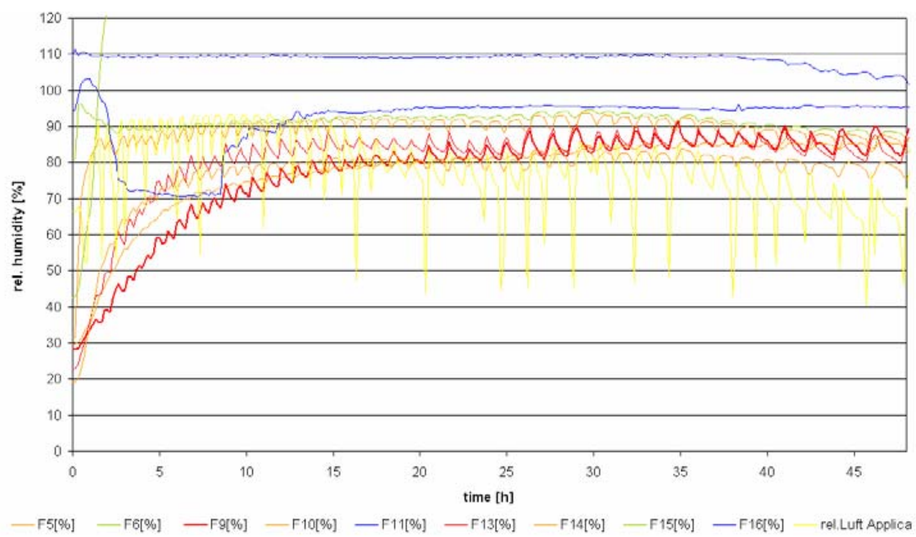


Figure 7.11 Humidity distribution through the panel

EUR-ACTIVE ROOFer

HORIZONTAL ACTIVITIES INVOLVING SMEs

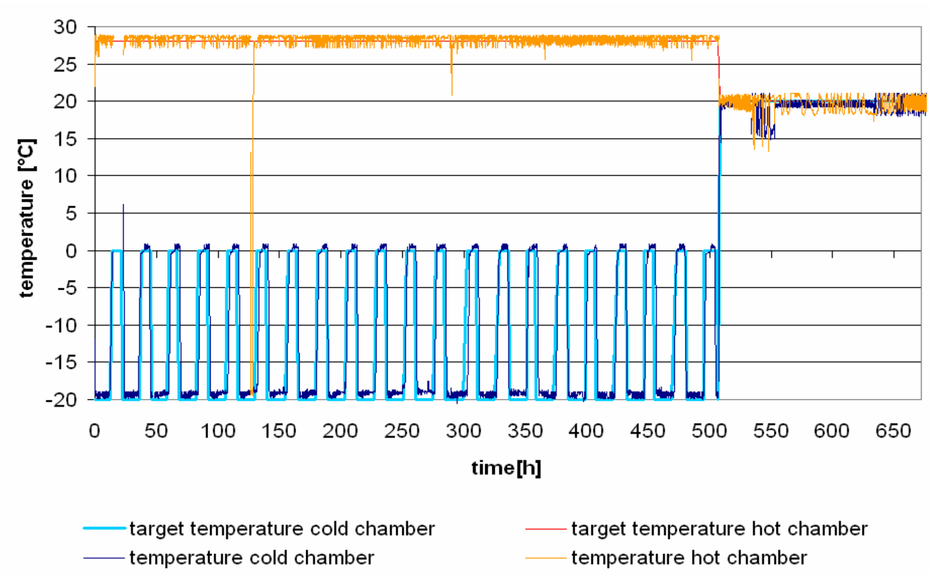


Figure 7.12 Temperature behaviour in cold and hot chamber

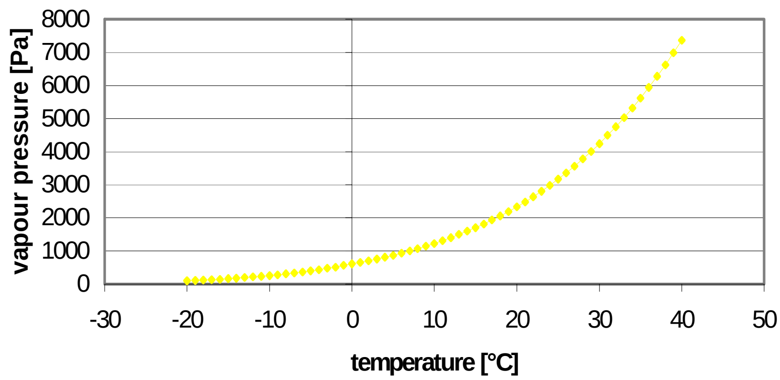


Figure 7.13 Water vapour pressure behaviour depending from temperature

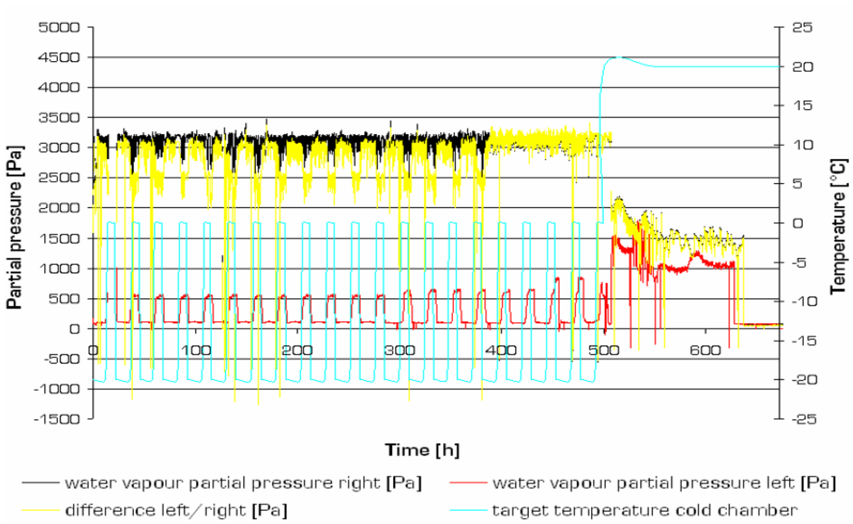


Figure 7.14 Water vapour pressure in left and right chamber and difference

This activity resulted in a procedure for tests and can be used for further standardization.

Investigation of some damages caused by within roof's condensation (DD2 by WUT)
Investigations on damages caused by condensation were done by WUT. In the rooms there were moisture and mould problems. For the Investigations a thermal camera was used. Visible temperature differences with condensation problems *(see figure 7.15).*

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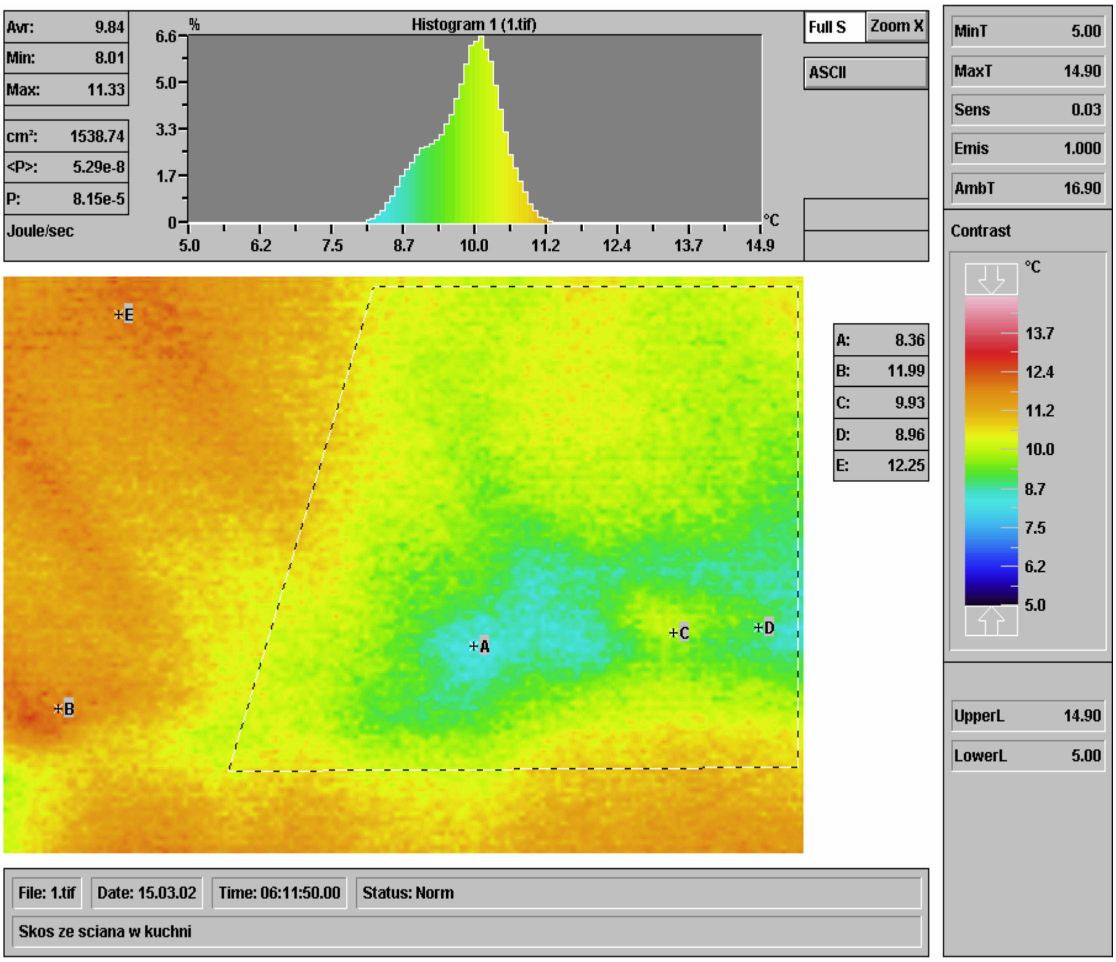

Figure 7.15 Visible temperature differences with condensation problems

This activity resulted in damages cause by poor workmanship. Training turned out to be very necessary

Sensitivity analysis of moisture condensation risk for selected types of roofs (DD2 by WUT)
WUT calculations were carried out with the German WUFI software. In a former report base studies and analyses were done. The objective of this work is to find the parameters that are crucial for vapour condensation within a roof. The calculations were done for several roof types (*see as example Figure 7.16*)

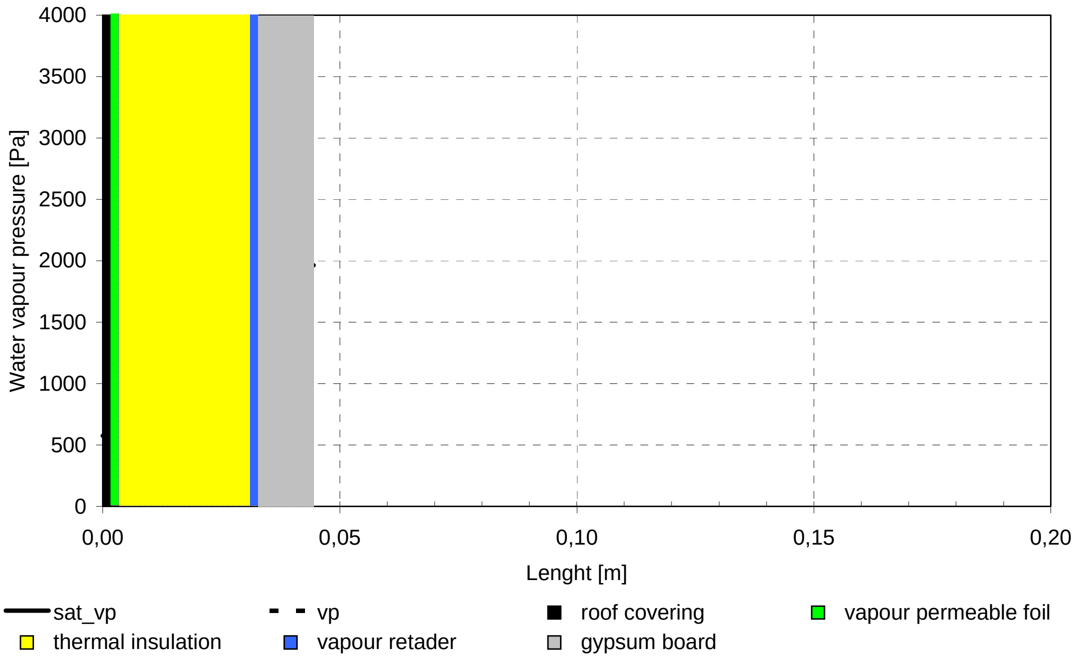

Figure 7.16 Pitched roof without ventilation – a case with thermal insulation layer thickness of 0.07 m (U = 0.502 W/m2K). Mean thermal insulation layer temperature t = 8.3 ºC.

This activity resulted in the observation that a correct installation of vapour barrier and retarder is very important. Failures or change of the foil may cause condensation problems (WPD_14_3).

Workshop on the first results during the IFD 2006 convention (MD3).
All partners of WP D presented their work and if possible the results. Discussions were held within WP D as well as with other partners in the forum of General Assembly in Krakow (November 2006) in order to stimulate the cooperation and cross fertilization between all participants (WPD_18_ *Minutes of Krakow*).

Discussion of preliminary results at General Meeting (MD4).
During General Assembly in Trondheim the preliminary results of WPD were discussed (WPD_20_*Minutes of Trondheim*).

WPD meeting Dürnstein (September 3-5, 2007)
In the meeting progress technical and economical the project of the participants were checked. In addition the results and experiences of all members were discussed and the programme for the last period of this project was coordinated (WPD_23_*input WPG* and WPD_24_*Minutes of Dürnstein*)

WPD-WPG joint meeting Warsaw (April 15, 2008)
In order to fulfill the request of WPG for input for the Guideline for Design and Application of Active Roofs a joint meeting between WP D and WP Gwas held (WPD_25 Agen*da Warsaw* and WPD_26 *Resistance to condensation damages*)

Durability - *Test method BTI laboratory tests Heat-Rain-Simulator (DD3):*
In order to compare the temperature and humidity sequences, a segment of a roof was built and placed under a construction with infrared lamps and water nozzles. This construction has an irradiation of about 3000 W/m2 and the water nozzles simulate rain, so that the roof could be cooled. The module was built as a common roof covered with roof tiles and an integrated solar component *(see Figures 7.17 and 7.18)*

Figure 7.17 Indoor (artificial heating) and outdoor (natural heating) test facility for durability tests

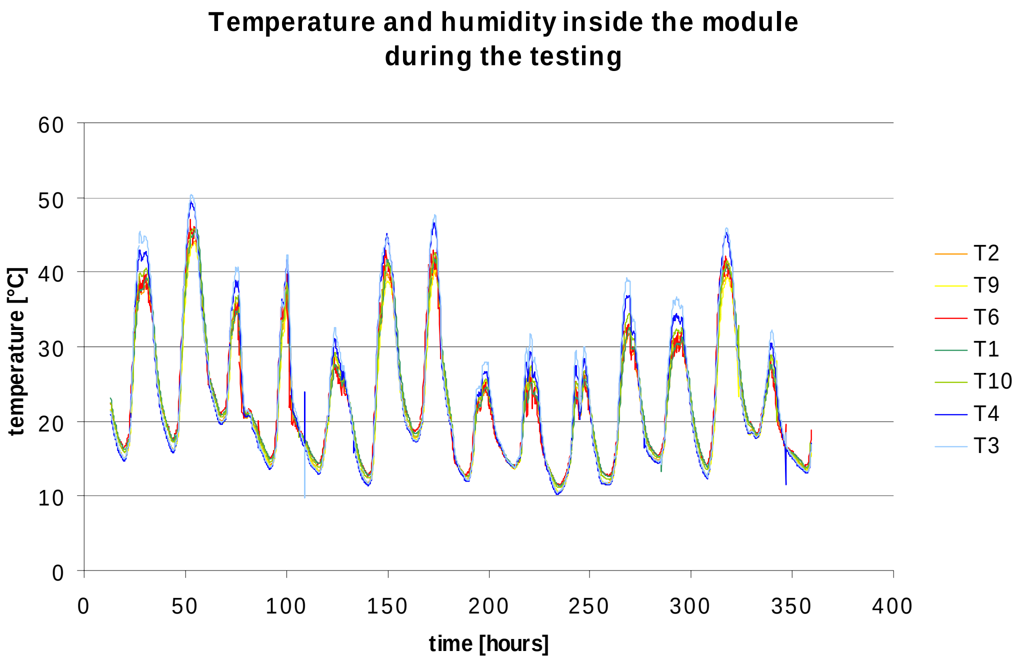

Figure 7.18 The graph shows the temperature and humidity inside the module during the south orientated outdoor test. The humidity peaks are very stable but neither a stable temperature nor humidity is reached. During the measurement with south orientation the atmospheric conditions was very constant.

The final conclusion is that is a good conformity between laboratory test and calculation. But there is no conformity with the real climate, because in the nature never stable conditions are given. This has to be considered in further tests and calculations (WPD_26_*Heat-Rain-Simulator*).

Durability -Test method BTI laboratory test concerning ventilation gap (DD3)
To avoid condensation damages it can be very helpful to have sufficient ventilation. To learn more concerning the ventilation of a roof with integrated solar component, a flow speed measuring test in the ventilation gap of roofs under the Sun-Rain-Simulator were carried out in BTI *(see Figure 7.19).*

Figure 7.19 Ventilation gap between batten and counter baton

The results of this ventilation test are:
- The gap between batten and counter baton should be minimum (2 x 3 =) 6 cm.
- It’s important to design adequate openings for intake and outlet.
- Solar elements provoke fewer problems because of untight joints to the surrounding roof.
(see also document WPD_29_*flow_speed_ventilation gap*)

WUT development of calculation software “ARPI” (DD3)
A special calculation tool for roofers was developed by WUT. It is called “ARPI” = Active Roof Physics Instruction. The main purpose of this tool is to check by calculation the risk of condensation of a particular roof structure. But also the U-value and the risk of mould grow on indoor surfaces is calculated. For the material properties the main data are in the calculation memory, which gives a very user-friendly procedure. ARPI software can be downloaded from Eur-Active Roofer homepage (ARPI_method.doc).

The results of the risks of condensation of the BTI and the CRES calculation were compared and evaluated. As given before there is no conformity between test in nature and the calculation or laboratory (WPD_31_*Comparison of results*)

Expected Lifetime – Full scale tests EMI (DD3):
In the meeting in Budapest January 2006, the test structure and the test procedure was presented by EMI to be in line with the other WPD program. In Csobank near Budapest, a wide roof area is available to carry out different full scale tests under the same climatic conditions *(see Figure 7.20 and 7.21*). Solar and photovoltaic components with different substructures were installed and the equipment for artificial indoor climate were installed.

The aim of the tests was:

- To check when and under which circumstances climate condensation occurs
- To check different materials like under layer, insulation (Cenergia MsterFalse), indoor panels
- To check the possibility for accelerated ageing test structure.

The installation started in spring 2006. Because of the mild winter 2006/2007 the main tests had to be postponed. So the first results were published June 2008. See. WPD – *EMI Csobanka* for a full test description and two attachments, all documents are published under *www.euractiveroofer.org*

Figure 7.20 Full scale test on the roof of Csobanka at Budapest

Further consequences of a well-designed Active Roof construction are the reduction of heat loss and the improvement of living comfort by avoiding bad air due to module.

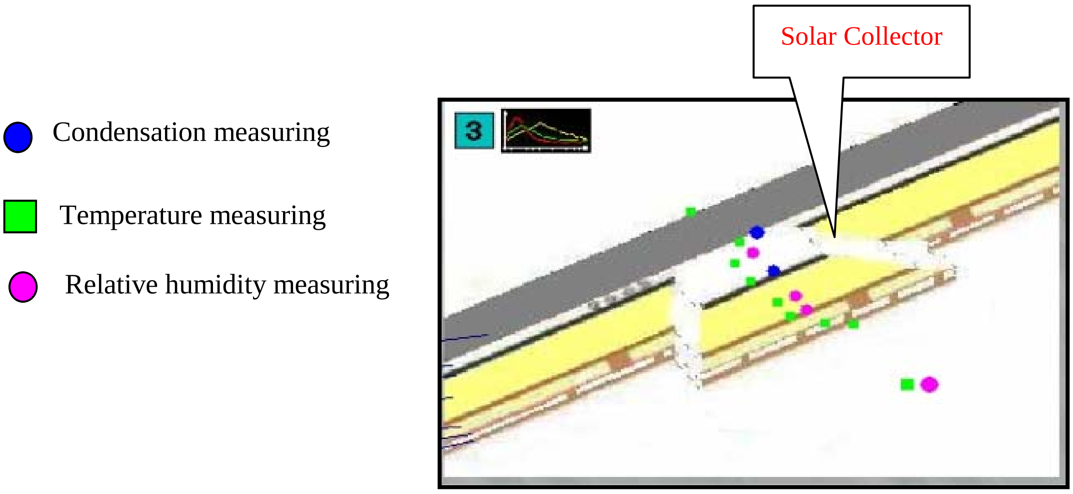

Figure 7.21 Measurements results of the 3rd roof section

The test results are published in January 2006 (MD1). According to EMI the tests will be continued and the results will be published in the IFD News

Further WP D documents: are delivered as input for WPG, WPH and WPI

7.3 Overview of the deliverables and milestones

List the deliverables and milestones and the final results (see Deliverables Reports on the EU CIRCA site)

Nr.	**Delivery month**	**Description work to be done**	**Results**	**Produced documents** *(See reference list hereunder)*
Deliverables				
DDI	10	Inclusion of condensation related issues into the data base	- best practice models - moisture distribution in selected types of roofs under different indoor conditions - Laboratory test – description of test method	- DD1-1 WUT - DD1-2 WUT - DD1-3 BTI
DD2	16	The basis for CEN test methods, as input for WPH, where necessary steps towards pre-standardization are	- BTI Laboratory test procedure - WUT investigation of damages - WUT sensitivity analysis of moisture condensation risk for	- DD2-1 BTI - DD2-2 WUT - DD2-3 WUT

Nr.	Delivery month	Description work to be done	Results	Produced documents *(See reference list hereunder)*
		undertaken	selected roof types - WUT climatic zones Europe	 - DD2-4 WUT
DD3	30 6/2008	A series of test and calculation methods and assessment procedures (as appropriate) for roof design to prevent damaging condensation of different classifications of active roof systems. These methods will be drafted as technical industry guides for application and benefit of SMEs and IAGs,	- BTI Heat-Rain-Simulator comparison of tests - BTI flow speed measuring in the ventilation gap - WUT development of calculation software "ARPI" - Condition of condensation. - Description and report of full scale test in Sobanka/Budapest	- DD3-1 BTI - DD3-2 BTI - DD3-3 WUT - DD3-4 EMI - DD3-5 EMI - DD3-6 EMI
Milestones				
MD1	6 01/2006	Decision of model types for calculation and testing	Decision of model types for calculation and testing (EMI, BTI)	- MD1 BTI
MD2	13	Evaluation of test and calculation results, decision of relaunch of the models	Evaluation of tests: results are satisfying. BTI: test procedure and model have been optimized, no further relaunch.	- MD 2 BTI
MD3	19	Workshop on first results of WP at IFD `06	Minutes of meeting Krakow November 2006	- MD3 BTI
MD4	25	Discussion of preliminary results at General Meeting	Minutes of meeting Trondheim May 2007	- MD4 BTI
MD5	31	Presentation of results at IFD `07	Presentation Siofok IFD Nov. '07	- MD 5-1 EMI - MD 5-2 BTI

Reference list of Deliverable and Milestones:

- DD1-1 WUT: Best practice concerning roofing and moisture condensation on roofs
- DD1-2 WUT: Additional information for DD1 Input for database Part 1 – Moisture distribution in selected types of roof under different indoor conditions
- DD1-3 BTI: Input for database Part 2: Laboratory tests – description of the test method and first results
- DD2-1 BTI: Basis for CEN Test Method
- DD2-2 WUT: Investigation of some damages caused by within roof's condensation

- DD2-3 WUT: Sensitivity analysis of moisture condensation risk for selected types of roofs.
- DD2-4 WUT: Climatic zones in Europe as a function of moisture condensation risk
- DD3-1 BTI: Heat Rain Simulator. Comparison of outdoor measuring and measurements under the Heat-Rain-Simulator
- DD3-2 BTI: Flow speed measuring in the ventilation gap of roofs under the Sun-Rain-Simulator
- DD3-3 WUT: Description of ARPI`s calculation method
- DD3-4 EMI: Full scale test description Csobanka/Budapest
- DD3-5 EMI: Csobanka Full scale test. Jelentés 2
- DD3-6 EMI: Csobanka full scale test. Várfalvi összefoglaló 1
- MD1 BTI: Decision of model types for calculation and testing
- MD2 BTI: Evaluation of test and calculation results, decision of relaunch of the models
- MD3 BTI: Minutes of meeting Krakow 15.11.2006
- MD4 BTI: Minutes of meeting Trondheim 24.5.2007
- MD 5-1 EMI: IFD congress Siofok: power point presentation of full scale tests in Csobanka/Budapest.
- MD 5-2 BTI: Presentation IFD Congress Siofok 2007

7.4 Short Evaluation of the project

Due to energy savings with big insulations and air tight construction, the knowledge of condensation gets more important than in the past. And the examples from Spain and Poland show that there is a lack of know how and an improvement of workmanship is necessary.

Concerning the test we have observed that he comparison between laboratory tests or calculation methods and in situ show differences in the general conditions. We always should have in mind that there are simplifications and we can not trust these results for 100%.

As we learned in discussion with roofers, there is a big request in simple tools, which make quick decisions on site possible. With the help of diagrams, tables and sketches, which are forwarded to WPI, these requirements should be fulfilled.
Due to the good general management and personal contacts in the meetings we learned to trust each other and it was no problem to acts in such a big and inhomogeneous team.

7.5 List of produced documents

Documents produced by WUT:

W 1: DD1-1 Mijakowski 10.9.2007.
Best practice concerning roofing and moisture condensation on roofs

W 2: DD2-4 Mijakowski 10.9.2007.
Climatic zones in Europe as a function of moisture condensation risk

W 3: DD1-2 Mijakowski 10.9.2007.
Additional information for DD1 Input for database Part 1 – Moisture distribution in selected types of roof under different indoor conditions

W 4: DD1 Input for database – Moisture distribution for selected roof types under different indoor conditions
W 5: DD2-3 Mijakowski 10.9.2007.
Sensitivity analysis of moisture condensation risk for selected types of roofs
W 6: Polish regulations and standards concerning roofing and moisture condensation on roofs
W 7: Roof systems: the risk of condensation - summary (DD2)
W 8: Description of WUFI Pro Ver 4.0 IBP
W 9: DD2-2 Mijakowski 10.9.2007.
Investigation of some damages caused by within roof's condensation
W 10: DD3-3 Mijakowski 7.5.2008.
Description of ARPI's calculation method
W 11: Indoor humidity and temperature - results of measurements
W 12: Report from full scale measurements
W 13: Report of activity - June 2005- November 2006
Warsaw University of Technology
W 14: Report of activity - December 2006 - May 2007
Warsaw University of Technology
W 15: Report of activity - July 2005 - June 2008
Warsaw University of Technology

Documents produced by BTI:
WPD-1: Minutes of meeting Mayen Oct 2005
WPD-2: Minutes of meeting Aigen Dec 2005
WPD-3: Start document 20_12_2005
WPD-4: Minutes of meeting Budapest 9.1.2006
WPD-5: MD1: Decision of model types for calculation and testing
WPD-6: WUT documents
WPD-7: Minutes of meeting Watford 9.3.2006
WPD-8: Investigation Spanish roofs 4.4.2006
WPD-9: CRES document
WPD-10: Minutes of meeting Warsaw 15/16.5.2006
WPD-11: DD1-3 Gärtner, 17.11.2006
Laboratory tests – description of the test method and first results
WPD-12: Agenda Athens
WPD-13: 1st year activity report
WPD-14: DD2-3 Gärtner, 17.11.2006
DD2 delivery WUT (2x), CRES and BTI
WPD-15: MD2: Evaluation of test and calculation results, decision of relaunch of the models
WPD-16: Agenda Krakow 15.11.2006
WPD-17: Minutes of meeting Athens 11/12.9.2006
WPD-18: MD3: Minutes of meeting Krakow 15.11.2006
WPD-19: Agenda Trondheim 24.5.2007
WPD-20: MD4: Minutes of meeting Trondheim 24.5.2007
WPD-21: Midterm report
WPD-22: 2nd year activity report
WPD-23: Input WPG 4.9.2007
WPD-24: Minutes of meeting Dürnstein 3-5.9.2007
WPD-25: Agenda Warsaw WPG/WPD 15.4.2008
WPD-26: Report: Heat Rain Simulator – Comparison
WPD-27: Input WPG, WPH WPI Guide lines condensation resistance
WPD-28: CRES Report

WPD-29: Report: Ventilation gaps of roofs
WPD-30: Report: Preliminary Tests 12.1.2006
WPD-31: Report: Comparison of results
WPD-32: MD5-2: Presentation IFD Congress Siofok 2007
Dissemination: Presentation Dutch Roofer Congress 2008
Management: EB Meeting Vienna 1-2.2.2008

Documents produced by CRES:
C-1: DD2 Basis for CEN test methods – Part2
C-2: Simulation BTI laboratory specimen

Documents produced by EMI:
E-1: Full scale test Csobanka description
E-2: Full scale test Csobanka result 1
E-3: Full scale test Csobanka result 2

List of documents produced by H&E:
H-1: Technical document

Documents produced by CENERGIA:
The experience with full scale tests are reported under WPA. No condensation problems were noticed.

8 Work Package E: Snow and ice load

WP leader: SINTEF
Period: 21 July 2006 till 20 July 2007

8.1 Objectives of the WP

The work which is carried out in WP E has been specified into the following three definite work tasks:

A. Friction between snow/ice and roofing/active roof installation surfaces.
B. Fresh air ventilation intake and snow inlet problems.
C. Insulated pitched wooden roofs and active roof installations.

8.2 Description of the activities and the achieved results

1. Eur-Active Roofer - Kick-Off Meeting in Mayen, Germany, 12-13 October 2005.
2. Eur-Active Roofer - 2nd General Assembly Meeting, BRE, Watford, United Kingdom, 9-10 March 2006.
3. Eur-Active Roofer - 3rd General Assembly Meeting, Krakow, Poland, 15-16 November 2006.
4. Eur-Active Roofer - 4th General Assembly Meeting, Trondheim, Norway, 24-25 May 2007.
5. Eur-Active Roofer - 5th General Assembly Meeting, Siófok, Hungary, 2-3 October 2007.
6. Eur-Active Roofer - 6th General Assembly Meeting, Athens, Greece, 14-15 February 2008.
7. Eur-Active Roofer - 7th General Assembly Meeting, Amsterdam, The Netherlands, 26 June 2008.
8. Eur-Active Roofer – Work Package E – Snow and Ice Load, Invited lecture at 55th Congress of the International Federation for the Roofing Trade (IFD), Siófok, Hungary, 4-6 October, 2007.
9. Eur-Active Roofer - Meeting WP A and WP E Leaders at Cenergia, Ballerup, Copenhagen, Denmark, 3 May 2006.
10. *Eur-Active Roofer – Work Package E – Snow and Ice Load*, *Student Lecture – NTNU – An Example of On-going Research Methods*, Lecture within the student subject *Research Methods*.
11. TPF and Eur-Active Roofer meeting held at SINTEF, 12.06.2006.
12. Various WP E meetings held in Trondheim with only SINTEF participants, 2005-2008.

13. Information about the Eur-Active Roofer project given at various meetings in Trondheim, 2005-2008.
14. A series of snow friction experiments carried out (see SINTEF Method 169), 2005-2007.
15. Inclined Angle Roofing Snow Friction Table designed and fabricated.
16. *SINTEF Method 169, Measurement of Friction between Snow and Roofing*.
17. *SINTEF Method 169 Measurements and Calculations*, MS Excel program for input of measurements and calculations in connection with friction coefficient determination in SINTEF Method 169.
18. *Snow and Ice Load*, Newsletter, August 2006.
19. *Friction between Snow/Ice and Roofing/Active Roof Installation Surfaces*, Newsletter, September 2006.
20. *Fresh Air Ventilation Intake and Snow Inlet Problems*, Newsletter, October 2007.
21. *Insulated Pitched Wooden Roofs and Active Roof Installations*, Newsletter, Planned issued after official closure of the Eur-Active Roofer, October 2008.
22. *How to Remove Snow Downfall on Photovoltaic Solar Cell Roofs in order to Maximize Solar Energy Efficiency?*, Newsletter, Planned issued July 2008.
23. *Eur-Active Roofer - Newsletter 06-2007*, Input to first collective newsletter for all WPs, June 2007.
24. *Eur-Active Roofer - Newsletter 02-2008*, Input to second collective newsletter for all WPs, February 2008.
25. *Eur-Active Roofer - Newsletter 03-2008*, Input to third collective newsletter for all WPs, June 2008.
26. *Guidelines for the design and application of Active Roofs, IFD guideline drawn up in the framework of the EUR-ACTIVE ROOFer Project, WPG Deliverable DG4-5*, Input from WP E.
27. *Proposal for Pre-Standardization of Active Roof Components – Solar Energy Systems – IFD guideline drawn up in the framework of the EUR-ACTIVE ROOFer Project, WPH Deliverable DH1-6*, Input from WP E.
28. Flate tak – Et temahefte om utførelse av flate aktive tak - En sammenfatning av preaksepterte løsninger med eksempler på utførelse (Flat Roofs – Thematic Booklet concerning Implementation of Flat Active Roofs – Summary of Pre-Accepted Solutions with Implementation Examples) (in Norwegian, first draft issued July 2008). Parts of the document exist of English versions in other Eur-ActiveRoofer documents, e.g. in the "Fresh Air Ventilation Intake and Snow Inlet Problems (Newsletter October 2007) and several documents dealing with snow and ice friction
29. *Fresh Air Ventilation Intake and Problems with Snow and Rain Inlet*, First draft completed, Article work in progress initiated by the Eur-Active Roofer project which will be continued after official closure of the Eur-Active Roofer project, Planned submitted for publication October 2008.
30. *Friskluftinntak i ventilasjonsanlegg og problemer med snø- og regninndrev* (*Fresh Air Ventilation Intake and Problems with Snow and Rain Inlet*) (in Norwegian), First draft completed, Article work in progress initiated by the Eur-Active Roofer

project which will be continued after official closure of the Eur-Active Roofer project, Planned submitted for publication October 2008.

31. *How to Remove Snow Downfall on Photovoltaic Solar Cell Roofs in order to Maximize Solar Energy Efficiency?*, Special scientific article, Work in progress initiated by the Eur-Active Roofer project which will be continued after official closure of the Eur-Active Roofer project, Planned submitted for publication December 2008.

8.3 Overview of the Deliverables and Milestones

List the deliverables and milestones and the final results (see main Deliverables Reports on the EU CIRCA site

No.	**Delivery month**	**Description work to be done**	**Results**	**Produced documents**
Deliverables				
DE1	12	Inclusion of the snow and ice-related issues into the data base. A product classification system which will determine the actual implementation details of the testing and evaluation procedures. Newsletter.	Lectures. Input to database - DE1 Report WP E. Product classification system according to roofing surface and snow friction. Newsletter *Snow and Ice Load*, August 2006.	1-15
DE2	18	Summarizing how the main types of installations are affecting the constructions and climatic barriers, and how snow and ice load in these contexts are handled. Where required or found appropriate, input will be given as a basis for future CEN test methods. Note that work	Lectures. Newsletter *Fresh Air Ventilation Intake and Snow Inlet Problems*, October 2007. Newsletter *Active Compact Flat Roofs and Active Pitched Ventilated Roofs*, July 2008. Thematic Booklet - *Flate tak – Et temahefte om utførelse av flate aktive tak* - *En sammenfatning av preaksepterte løsninger med eksempler på utførelse (Flat Roofs – Thematic Booklet concerning Implementation of Flat Active Roofs – Summary of Pre-Accepted Solutions with Implementation*	1-13, 15 17-18, 23-27

No.	Delivery month	Description work to be done	Results	Produced documents
		package H will undertake the necessary steps towards pre-standardisatio n. Project report.	*Examples)* (in Norwegian), July 2008. *Guidelines for the design and application of Active Roofs, IFD guideline drawn up in the framework of the EUR-ACTIVE ROOFer Project, WPG Deliverable DG4-5*, Input from WP E. *Proposal for Pre-Standardization of Active Roof Components – Solar Energy Systems – IFD guideline drawn up in the framework of the EUR-ACTIVE ROOFer Project, WPH Deliverable DH1-6*, Input from WP E.	
DE3	24	A series of experimental test methods, assessment procedures and application techniques as appropriate for snow and ice load for classifications of active roof systems. These methods will be drafted as technical industry guides for the application and benefit of SMEs and IAGs. Newsletter.	Lectures. Newsletter *Friction between Snow/Ice and Roofing/Active Roof Installation Surfaces*, September 2006. Inclined Angle Roofing Snow Friction Table designed and fabricated. *SINTEF Method 169, Measurement of Friction between Snow and Roofing.* *SINTEF Method 169 Measurements and Calculations*, MS Excel program for input of measurements and calculations in connection with friction coefficient determination in SINTEF Method 169. Snow friction experiments carried out.	1-13, 15-16, 28-31
DE4	30	Establishment of new knowledge that will be fundamental to gain a comprehensive understanding of the snow and ice load influence on active roofs. Final project report.	Lectures. Approaching this problem/challenge: Traditionally, roofs have been designed to keep the snow in its place on top of the roofs. However, solar cell roofs should ideally have no snow at all on the top of the cells in order to maximize the solar cell energy production. One may think of both new material surface technology and new architectural roof design in	1-13, 16, 19, 25, 34-35

No.	Delivery month	Description work to be done	Results	Produced documents
			order to accomplish this objective. How may this be achieved in the best way? Brainstorming sessions addressing this challenge was held at the 4th, 5th and 6th GA meetings with subsequent discussions, and at other sessions (e.g. student lectures). Newsletter *How to Remove Snow Downfall on Photovoltaic Solar Cell Roofs in order to Maximize Solar Energy Efficiency ?*, June 2008. Special scientific article *How to Remove Snow Downfall on Photovoltaic Solar Cell Roofs in order to Maximize Solar Energy Efficiency ?* - Work in progress initiated by the Eur-Active Roofer project which will be continued after official closure of the Eur-Active Roofer project, Planned submitted for publication December 2008. Thematic Booklet - *Flate tak – Et temahefte om utførelse av flate aktive tak - En sammenfatning av preaksepterte løsninger med eksempler på utførelse (Flat Roofs – Thematic Booklet concerning Implementation of Flat Active Roofs – Summary of Pre-Accepted Solutions with Implementation Examples)* (in Norwegian), July 2008. *Eur-Active Roofer - Activity Report Work Package E*, Final report by SINTEF for the period 2005-2008.	
DE5	36	The project results from the final project report (DE.4) are summarized in a newsletter.	*Eur-Active Roofer - Activity Report Work Package E*, Activity report by SINTEF for the period 21.07.2005-21.07.2006. *Eur-Active Roofer - Activity Report Work Package E*, Activity report by SINTEF for the period 21.07.2005-20.07.2007. *Eur-Active Roofer - Activity Report*	

No.	Delivery month	Description work to be done	Results	Produced documents
			Work Package E, Final report by SINTEF for the period 2005-2008. *Eur-Active Roofer - Newsletter 06-2007*, Input to first collective newsletter for all WPs, June 2007. *Eur-Active Roofer - Newsletter 02-2008*, Input to second collective newsletter for all WPs, February 2008. *Eur-Active Roofer - Newsletter 03-2008*, Input to third collective newsletter for all WPs, June 2008. Newsletter *Snow and Ice Load*, August 2006. Newsletter *Friction between Snow/Ice and Roofing/Active Roof Installation Surfaces*, September 2006. Newsletter *Fresh Air Ventilation Intake and Snow Inlet Problems*, October 2007. Newsletter *Active Compact Flat Roofs and Active Pitched Ventilated Roofs*, July 2008. Newsletter *How to Remove Snow Downfall on Photovoltaic Solar Cell Roofs in order to Maximize Solar Energy Efficiency ?*, June 2008.	15-22 32-34,
Milestones				
ME 1	9	Database filled with relevant data of snow and ice load (month 9).	Input to database - DE1 Report WP E. Newsletter August 2006.	14-15
ME 2	13	First evaluation work done in WP E (DE.1) (month 13).	Input to database - DE1 Report WP E. Newsletter September 2006.	14, 16
ME 3	19	Presentation first results at IFD'06 (month 19).	Results have been presented at IFD'06 and elsewhere. Inclined Angle Roofing Snow Friction Table designed and fabricated. SINTEF Method 169. Snow friction experiments carried out.	16, 28-31
ME	25	All relevant	See DE.2 and DE.3 above.	1-13,

No.	Delivery month	Description work to be done	Results	Produced documents
4		information included in database as input for WP A (DE.2 and DE.3) (month 25).		15-18, 23-31
ME 5	31	End of WP E, all WP-deliverables available (at their specific times indicated in the Deliverables Table), presentation of results at IFD'07 (DE.4 and DE.5) (month 31).	Deliverables available as described above. Results have been presentated at IFD'07 and elsewhere.	1-35

8.4 Short Evaluation of the project

1. The project with all its participants has been very well handled by the project leader TNO.
2. The implementation of the General Assembly meetings have been very good and necessary for the project – with active and interested involvement from the participants – and also very well organized (special credit to TNO).
3. SINTEF's travel expenses have been quite high compared to our total budget within the project.
4. The meeting in Trondheim hosted by SINTEF was not planned in the original budget, and in order to accomplish this SINTEF had to use means within the project (person hour costs) which originally were allocated to the research work tasks.
5. The process of obtaining various solar cell samples, including BIPV systems, has been found to be far more time-consuming and difficult than first anticipated. After countless inquiries and reminders both by SINTEF and TNO, no samples have been received.
6. The work with "*Fresh Air Ventilation Intake and Snow Inlet Problems*" constitutes only a smaller part of the overall WP E work, but has nevertheless yielded interesting and useful results.
7. The snow friction experiments involve a vast amount of parameters thereby making these experiments very interesting and challenging.
8. The work with "*How to Remove Snow Downfall on Photovoltaic Solar Cell Roofs in order to Maximize Solar Energy Efficiency*" involves many aspects and is both very interesting and challenging.

9. Some budget reallocations from other participants have been done by TNO, enabling SINTEF to cover some of our increased expenses (travel expenses, Trondheim meeting, time consumed related to obtain solar cell samples) and to carry out some more work on specific work tasks.
10. SINTEF was able to obtain extra financial support from the Norwegian Research Council, concerning both travel expenses and continuation of specific work tasks within the Eur-Active Roofer project.

8.5 List of produced documents

1. Snow and Ice Load - Work Package E, Lecture, Eur-Active Roofer - Kick-Off Meeting in Mayen, Germany, 12-13 October 2005.
2. Snow and Ice Load - Work Package E, Lecture, Eur-Active Roofer - 2nd General Assembly Meeting, BRE, Watford, UK, 9-10 March 2006.
3. Snow and Ice Load - Work Package E, Lecture, Eur-Active Roofer - 3rd General Assembly Meeting, Krakow, Poland, 15-16 November 2006.
4. Snow and Ice Load - Work Package E, Lecture, Eur-Active Roofer - 4th General Assembly Meeting, Trondheim, Norway, 24-25 May 2007.
5. *Snow and Ice Load* - *Work Package E*, Lecture, Eur-Active Roofer - 5th General Assembly Meeting, Siófok, Hungary, 2-3 October 2007
6. *Snow and Ice Load* - *Work Package E*, Lecture, Eur-Active Roofer - 6th General Assembly Meeting, Athens, Greece, 14-15 February 2008.
7. *Snow and Ice Load* - *Work Package E – Final Results – A Summary*, Lecture, 7th General Assembly Meeting, Amsterdam, The Netherlands, 26 June 2008.
8. *Eur-Active Roofer – Work Package E – Snow and Ice Load*, Invited lecture at 55th Congress of the International Federation for the Roofing Trade (IFD), Siófok, Hungary, 4-6 October, 2007
9. Snow and Ice Load - Work Package E, Lecture, Eur-Active Roofer - Meeting WP A and WP E Leaders at Cenergia, Ballerup, Copenhagen, Denmark, 3 May 2006.
10. Snow and Ice Load - Work Package E, Lecture, Eur-Active Roofer - WP E General Summary Lecture, 20th of July 2006.
11. Building Integrated PhotoVoltaics (BIPV), Lecture, 2006.
12. *Eur-Active Roofer – Work Package E – Snow and Ice Load, Student Lecture – NTNU – An Example of On-going Research Methods*, Lecture within the student subject *Research Methods*.
13. Start Document Work Package E, Start Document, Last Version 16.03.2006.
14. DE1 Input Report Work Package E, DE1 Report WP E by SINTEF, Version 04.08.2006.
15. Eur-Active Roofer - Work Package E - Snow and Ice Load, Newsletter, August 2006.
16. Eur-Active Roofer - Work Package E - Work Task A - Friction between Snow/Ice and Roofing/Active Roof Installation Surfaces, Newsletter, September 2006.

17. *Eur-Active Roofer - Work Package E - Work Task B - Fresh Air Ventilation Intake and Snow Inlet Problems,* Newsletter, October 2007.
18. *Eur-Active Roofer - Work Package E - Active Compact Flat Roofs and Active Pitched Ventilated Roofs,* Newsletter, July 2008
19. *Eur-Active Roofer - Work Package E - How to Remove Snow Downfall on Photovoltaic Solar Cell Roofs in order to Maximize Solar Energy Efficiency ?,* Newsletter, June 2008
20. *Eur-Active Roofer - Newsletter 06-2007,* Input to first collective newsletter for all WPs, June 2007.
21. *Eur-Active Roofer - Newsletter 02-2008*, Input to second collective newsletter for all WPs, February 2008.
22. *Eur-Active Roofer - Newsletter 03-2008*, Input to third collective newsletter for all WPs, June 2008.
23. *Guidelines for the design and application of Active Roofs, IFD guideline drawn up in the framework of the EUR-ACTIVE ROOFer Project, WPG Deliverable DG4-5*, Input from WP E
24. *Proposal for Pre-Standardization of Active Roof Components – Solar Energy Systems – IFD guideline drawn up in the framework of the EUR-ACTIVE ROOFer Project, WPH Deliverable DH1-6*, Input from WP E.
25. *Flate tak – Et temahefte om utførelse av flate aktive tak - En sammenfatning av preaksepterte løsninger med eksempler på utførelse* (*Flat Roofs – Thematic Booklet concerning Implementation of Flat Active Roofs – Summary of Pre-Accepted Solutions with Implementation Examples*) (in Norwegian), July 2008
26. *Fresh Air Ventilation Intake and Problems with Snow and Rain Inlet*, First draft completed, Article work in progress initiated by the Eur-Active Roofer project which will be continued after official closure of the Eur-Active Roofer project, Planned submitted for publication October 2008
27. *Friskluftinntak i ventilasjonsanlegg og problemer med snø- og regninndrev* (*Fresh Air Ventilation Intake and Problems with Snow and Rain Inlet*) (in Norwegian), First draft completed, Article work in progress initiated by the Eur-Active Roofer project which will be continued after official closure of the Eur-Active Roofer project, Planned submitted for publication October 2008
28. Measurement of Friction between Snow and Roofing, Method A - Friction Coefficient Determination between Snow and Roofing by Horizontal Plane Applied Pulling Force Method, Method B - Friction Coefficient Determination between Snow and Roofing by Inclined Plane Slip Method, SINTEF Method 169, July 2006.
29. Måling a fission mellow son go attacking, Met ode A - Bestemmelse a friksjonskoeffisient mellow son go attacking ved horisontal trekkraft metoden, Met ode B - Bestemmelse a friksjonskoeffisient mellow son go attacking ved skråplan slipp metoden, SINTEF Met ode 169, Juli 2006 (Norwegian version of the above.).
30. SINTEF Method 169 Measurements and Calculations, MS Excel program for input of measurements and calculations in connection with friction coefficient determination in SINTEF Method 169.
31. Inclined Angle Roofing Snow Friction Table designed and fabricated.

32. Eur-Active Roofer - Activity Report Work Package E, Activity report by SINTEF for the period 21.07.2005-21.07.2006.

33. Eur-Active Roofer - Activity Report Work Package E, Activity report by SINTEF for the period 21.07.2005-20.07.2007.

34. *Eur-Active Roofer - Activity Report Work Package E,* Final report by SINTEF for the period 2005-2008.

35. How to Remove Snow Downfall on Photovoltaic Solar Cell Roofs in order to Maximize Solar Energy Efficiency?, Special scientific article, Work in progress initiated by the Eur-Active Roofer project which will be continued after official closure of the Eur-Active Roofer project, Planned submitted for publication December 2008.

9 Work Package F: Safety, Installation, Maintenance and Repair

WP-Leader: EMI
Period: 21 July 2005 till 20 July 2008

9.1 Objectives of the WP

The majority of the Installation, Maintenance and Repair (IM&R) works take part on existing roofs in different, often severe climatic conditions. In case of Active Roofs this kind of work will be increased because of the wide variety of products integrated in the roof, which leads to more risky joints and possibilities of failure than a traditional roof.

Many failures have their origin in the early design stage, where the roofer is usually not involved. Poor design will increase the chance of problems during IM&R works and during the use of the roofs, such as leakage and lacking safety devices.

Therefore the objectives of the work package are:

1. Improve the IM&R by providing input for the roofer in the design stage of the roof by developing knowledge and tools, which lead to effective installation, safer IM&R and more failure proof Active Roofs.
2. Improve the diagnostic methods of the existing situation for more proper, “intelligent” procedures and development of non-destructive detecting of the present moisture situation and possible failure spots inside the roof.
3. Innovative safety devices, best practice catalogues and basis for legislation of (mandatory) safety devices.

9.2 Description of the activities and the achieved results

9.2.1 Work item 1: Improving the installation, maintenance and Repair in the design phase

In the first WP-meeting at the General Assembly in Mayen (12-13 October 2005) the main classification issues (collective and personal safety devices) were discussed. In the second WP-meeting in Copenhagen (1 December 2005) the main risk sources and the generally used safety measures were presented and discussed with short overview of the national current practice. A questionnaire related to the national safety praxis was developed and filled out by the partners in March 2006. At the third WP-meeting at the GA in Watford (9-10 March 2006) the database structure and design methodology by TU Eindhoven and the risks and safety measurements classification by ÉMI were presented and discussed. The main issues for IM&R were integrated in the database made available by WPA by April 2006. The main structure of the decision supporting tools were presented in the fourth workshop/project team meeting on 10 May 2006 in Budapest, and the discussion was continued about the main risk features.

A simple and detailed Decision Support Tool was developed and reported as deliverable DF1 in May 2006 and discussed in the Krakow Workshop. In Siófok it was also presented at the IFD Congress and received a very good echo from the participants.
In 2008 spring a workshop with students was organised in the Technical University of Budapest (HU). Here the students became familiar with the main feature of safety planning, the Decision Supporting Tools and using that in their own semester project.
In summer 2008 a similar course with architects will be organised.

9.2.2 Work item 2: Intelligent diagnostic methods

A laboratory model was installed with three alternative normal roof systems in February 2006 at ÉMI/Budapest (Figure 9.1). The detecting and monitoring system was tested in two layers (under the vapour barrier and under the waterproofing). A GSM system was developed to collect the data of the monitoring far away from the testing point. The measurements show promising results and a good basis for full-scale outdoors investigation. In summer and autumn 2006 one more normal and one more inverted roof model was tested and achieved also promising results. The experiences were reported in the Krakow workshop (November 2006).

The innovative safety devices opportunities (mobile hooks/anchors, mobile ladders) were first presented in Watford in March 2007, and discussed in detail in the 4th Workshop in Budapest in May 2006. These devices give a good base for the developing a prototype for flat roofs and 4 systems for pitched roofs. Evaluations of IM&R works were also discussed in the Budapest workshops. The detailed features of the prototype of the innovative devices was presented and agreed in November 2007 at the Krakow workshop and reported in DF2..

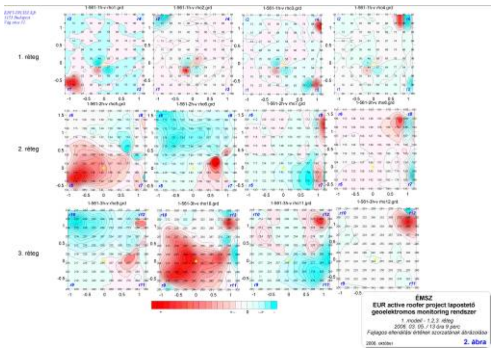

Figure 9.1 Installation of the moisture detection system (left) and an example of the results (right)

To increase the results a wire net- geo-textil was also tested in model roof and than a pilot testing in real roof in Budapest *(see Figure 9.1)*. The results in the model roofs were promising; however the pilot project in bitumen roof doesn't shows clear pictures.

In 2008 June two roof system was tested in Ireland with their special insulation material *(Figure 9.2*). The results were satisfactory.

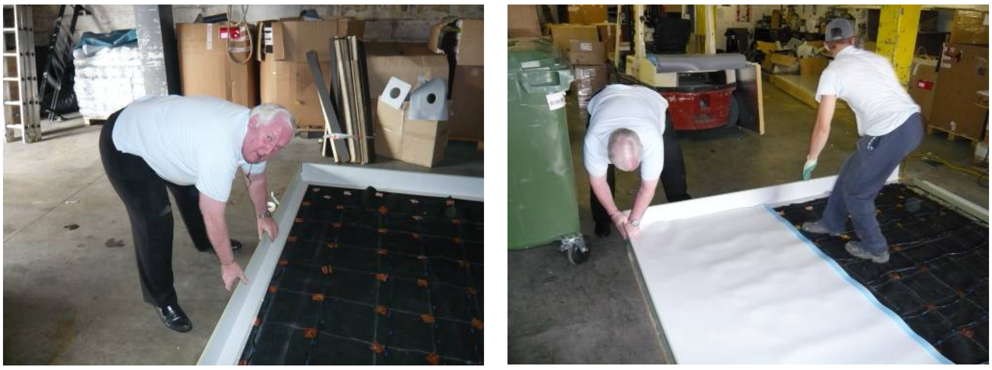

Figure 9.2 Testing of the moisture detection system In Ireland by H&E Costello Roofing

In 2008 July a new system will be tested substituting the geo-textile in the Hungarian pilot project.

9.2.3 Work Item 3: Innovative devices, best practice catalogues and legislation

The prototypes of the devices were manufactured in Hungary with involving SMEs, the experiences of realization of the devices and further challenges were discussed in Trondheim. The testing of the devices has been started in a laboratory model and the preparation to test the devices in real circumstances has also been initiated *(Figure 9.3 to 9.5)*. The legislation proposals relating Installation, Maintenance & Repair were presented also in DF2, focusing on the safe access the roof, the mobile of safety devices and the increase to safety via double independent safety systems.

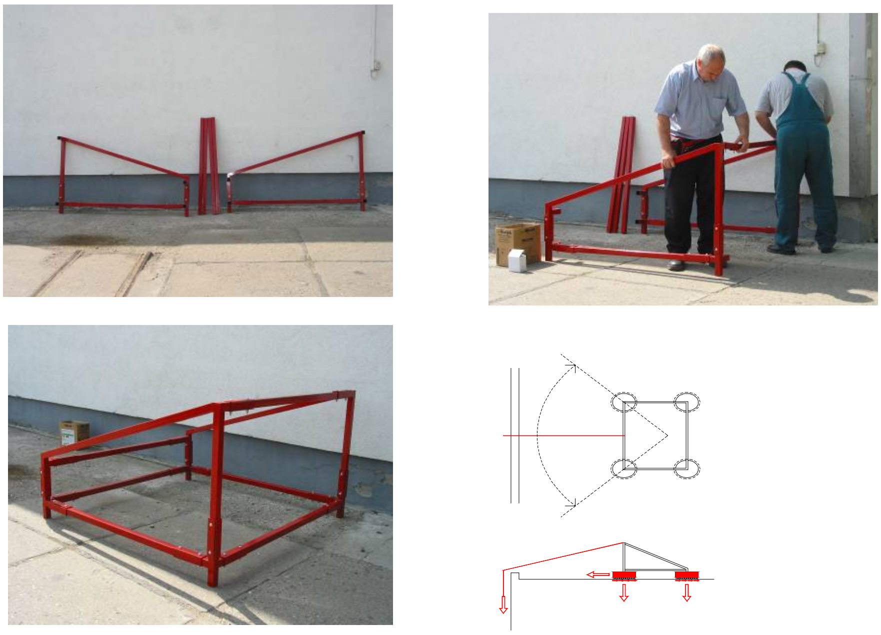

Figure 9.3 Innovative mobile safety devices: flat roof, initial phase

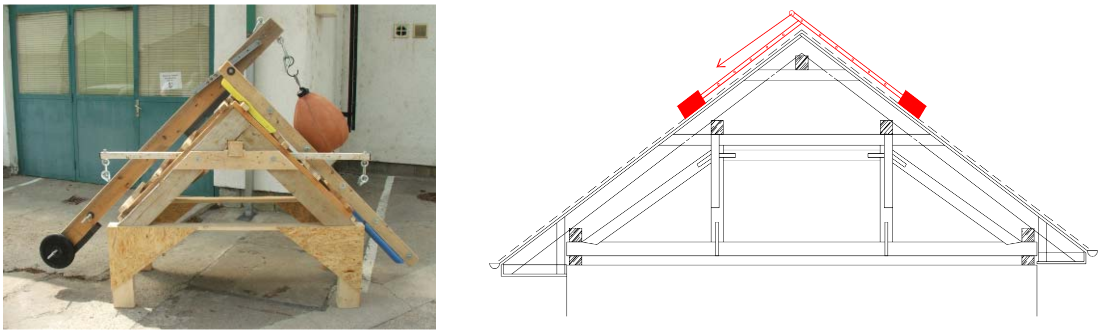

Figure 9.4 Innovative mobile safety devices: pitch roof (initial phase)

The mobile ladder has been tested in real roofing circumstances in Csobánka, Hungary in August 2007

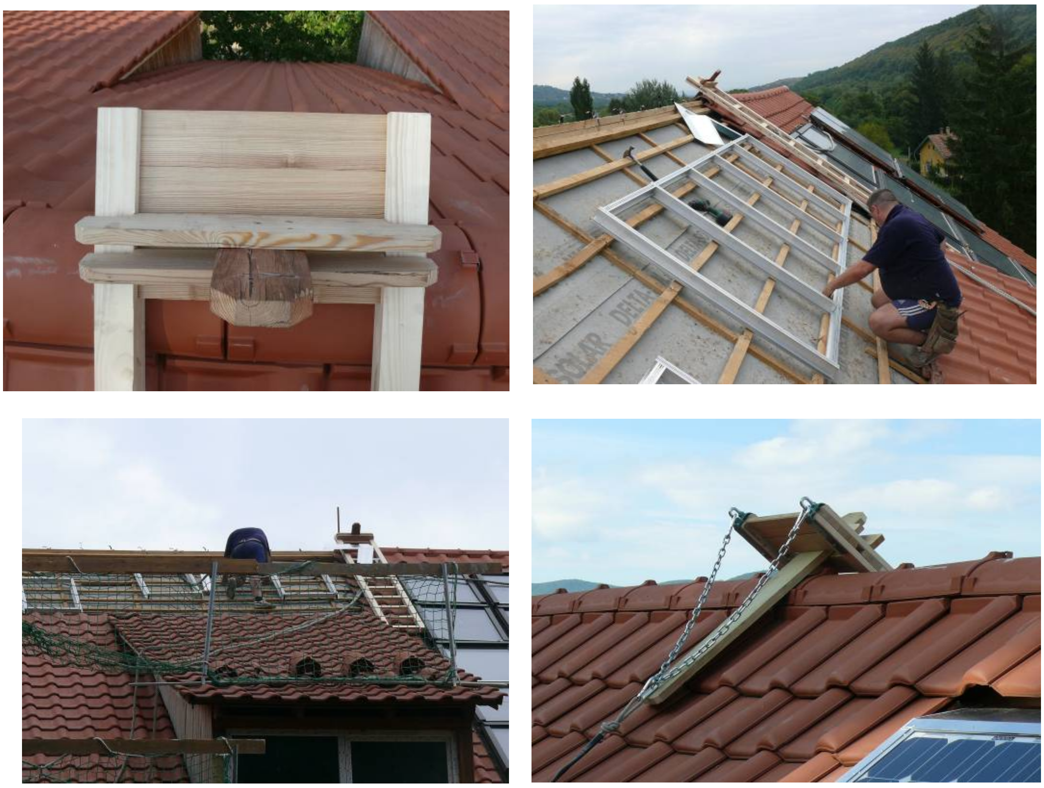

Figure 9.5 The mobile ladder has been tested in real roofing circumstances in Csobánka, Hungary in August 2007

Experiences on innovative mobile or fixed/mobile systems were discussed the Roofing Schools of EMSZ in Veszprém/Hungary *(Figure 9.6)*, of SVDW in Uzwill/Switzerland

(Figure 9.7) and of the Dutch Pitch Roof Federation (HHD) in Boxtel/Netherlands (*Figure 9.8)* and of ZVDW in Mayen/Germany *(Figure 9.9).*

Figure 9.6 Veszprém roofer school Hungary: application in real circumstances

Figure 9.7 Discussion in the SVDW roofing school in Uzwill, Switzerland (self testing)

Figure 9.8 Presentation and discussion in HHD roofer school, Boxtel/Netherlands

Figure 9.9 Presentation and discussion of the devices in ZVDH roofer school in Mayen/Germany

The legislation proposals relating Installation, Maintenance & Repair were presented also in DF2, focusing on the safe access the roof, the mobile of safety devices and the increase to safety via double independent safety systems *(Figure 9.10)*.

Figure 9.10 Using professional flat roof fixing and wire system at pitch roof: Top trust system in Holland (HHD)

9.3 Overview of the Deliverables and Milestones

List the deliverables and milestones and the final results (see Deliverables Reports on the EU CIRCA site)

Nr.	month	Description work to be done	Results	Produced documents
Deliverables				
DF1	10	Risks analysis, using morphology for identifying solution alternatives for collective and personal safety devices, identification of the main decision issues, evaluation methods, evaluation of the works	Simple Decision Supporting Tools and Detailed Decision Supported Tools have been developed, five main decision issues were identified; for evaluation the IM&R work a checklist has been created	Report DF1: "Tools in the design stage of the active roofer to improve installation, maintenance and repair, and an evaluation of the works"
DF2	16	Prototypes of mobile safety devices, best practice examples and legislation proposals.	Prototypes of mobile safety devices was presented, prototypes was manufactured, Best practice Catalogue and legislation was presented	Report DF2 "Prototypes of mobile safety devices, best practice examples and legislation proposals." (Final report: July 2008)
DF3	30	Catalogues of diagnostic methods, developing and testing systems for moisture condition monitoring and failure spot detecting, with pilot project application examples. These methods will be drafted as technical industry guides for the application and benefit of SMEs and IAGs.	Failure detection test system is monitored in further two laboratory model, pilot project application is installed and monitoring has started Hungary. Special attention of geo-textile with wires for better localization.	Report DF3: "Catalogues of diagnostic methods, developing and testing systems for moisture condition monitoring and failure spot detecting, with pilot

Nr.	month	Description work to be done	Results	Produced documents
			New layer testing	project application examples" August 2008
DF4	30	Input for label in WP G for the intended Installation, Maintenance & Repair works.	IM&R label system table	Has been taken up in the WPG Guideline
Milestones				
MF1	9	Database filled with relevant data of safety and maintenance	Input IM&R issues into the database	MF1 report: "Database filled with the relevant data of safety and maintenance "
MF2	13	First evaluation works done in WPF; integrated moisture detecting and monitoring system are ready for experimental work	Evaluation has been done, failure detection system has been installed and tested by six models in Laboratory condition	See DF3 (Catalogues of diagnostic methods, etc.)
MF3	19	IM&R works labeling system ready for testing, Prototype of innovative mobile safety devices ready to be tested in model roofs/training centers, presentation first results at IFD 06	The labeling system is ready for testing, innovative safety devices are ready for testing, First results was presented at IFD Congress in Krakow '06	See DF4 (Has been taken up in the WPG Guideline)
MF4	25	All relevant information in database as input for WP H; Prototypes of mobile safety devices to be tested in real roofing circumstances	Relevant input is given to WPH	Has been taken up in WPH Pre-Standard
MF5	31	End of WP F, all deliverables available, presentation of results at IFD 2007	All the deliverables are available. Some tests of mobile safety devices will be going on after the project ending	See deliverables documents DF1 to DF4

9.4 Short Evaluation of the project

Regarding the promised innovative safety devices we think both five system which was introduced and tested is interesting in the future further development, basically because they are affordable. Further development was suggested by the flat roof devices (telescope system for using internal hole barrier) and the double ladder system should have less weight for better handling.

For failure detection system field only two best practice example was found in the literature, more investigation could be recommended. There are certain limitations of the developed system: it couldn't be used with EPDM membrane and also metal deck application would be questionable. The Best Practice Catalogue for safety devices could be used for training purposes as well. Decision Support Tools should be in national language as well. Pilot project for failure detection system has problems if real roof should be artificially leaked, models are more recommended for investigation, as we made in Ireland. Member of the project team were very positive and interested in topic.

9.5 List of produced documents

- Start document WPF
- Minutes of the 1st Workshop in Mayen
- Presentations and minutes of the 2nd Workshop in Copenhagen
- Questionnaire about national safety regulation and praxis
- Start document of WP F
- Presentations and minutes of the 3rd Workshop in Watford
- Database 1 Roofs as workplaces and risk analysis
- Database 2 Safety measurements and devices of roof works
- Database 3 European and national standards for roof works
- MF1 Milestone report: *"Database filled with the relevant data of safety and maintenance"*
- Presentations and minutes of the 4th Workshop in Budapest
- DF1 Deliverables report: *"Tools in the design stag of the active roofer to improve installation, maintenance and repair, and an evaluation of the works"*
- Suggestion for the prototypes of the innovative safety devices (draft)
- Activity report of 1st project period
- Suggestion for the prototypes of the innovative safety devices (2 draft)
- DF2 Deliverables Report: *"Prototypes of mobile safety devices, best practice examples and legislation proposals."*
- Midterm report
- Presentation in GA meeting Trondheim
- Presentation at IFD Congress in Siófok 2007: Decision Supporting Tools and Best Practice Catalogue
- Presentation at IFD Congress in Siófok 2007: innovative Solutions
- Presentation in GA meting in Siófok: Best practice examples, innovative solutions
- Presentation in GA meting in Siófok: Pre-standard safety
- DF3 Deliverables Report: *"Catalogues of diagnostic methods, developing and testing systems for moisture condition monitoring and failure spot detecting, with pilot project application examples"* August 2008

10 Work Package G: Guidance and dissemination

WP-Leader: IFD
Period: 21 July 2005 till 20 July 2007

10.1 Objectives of the WP

General
The 'state of the art' of guidance documents and guidelines in the field of active roofs is at this moment on a very low level. In the EurActiveRoofer project are therefore set up some work packages to study the main aspects of roof products like protection against wind, rain, condensation, snow, ice etc. The aim of this work is to generate information on all the relevant aspects in order to take this up in European guidelines for active roofs. To realize this purpose Work Package G guidance and dissemination is established.

The main objectives of Work Package G are laid down in the following four points:

1. Evaluation of the performance criteria of work packages B to F on wind loading, rain and driving rain, snow and snowdrift, condensation effects and Safety in Installation, Maintenance and Repair
2. An increase of competitiveness of roofers through development of simple rules for design and guidelines on Active Roofs.
3. Gathering of best practice examples.
4. Providing guidance documents for the European SMEs on Active Roofs.

State of the art
Guidelines in the field of roofs and especially active roofs were before the start of the project nearly not available.

Only the following documents existed:
- Product standards and test methods for the products
- In some countries are coming up the first pre-standards (like in The Netherlands the *NVN 7250 Building integration of solar energy systems)*, but these pre-standards are written for the specific building situation in the concerning country.
- CEN CR 833: *General requirements for discontinuously laid roof covering*
- IFD Guidelines for specific roof coverings and applications e.g. *IFD Flat Roof Guidelines for the design and application of roof waterproofing*
- *IFD-Recommendation for solar technology at roof and wall,* 2002

On the European level the quality of active roof products as well as safety equipment for installation and maintenance is in many cases insufficient because there are no standards or legislation to assess their performance and to give guidance and guidelines. At the same time, good products get poorly installed by inexperienced roofers. This leads to significant numbers of (preventable) failures from rain- and snow water ingress, wind damage and condensation. Due to this, failure costs in the EU total approximately € 2.000 Million each year.

That's why there is a strong need for European-wide guidelines and performance requirements. Besides, without these guidelines and guidance documents there is an actual danger that roof-products will be introduced into the well regulated building environment, where the products are not fit for the intended use or are installed incorrectly.

10.2 Description of the activities and the achieved results

The following work has been done within the frame work of the project:

1. A critical review by the SME-Core Group and IAGs of the results of the work packages B - F on wind loading, rain and driving rain, snow and snowdrift, condensation effects and safety in installation, maintenance and Repair.

2. The evaluation of the work of WPs B to F was structured as follows: through the research of WPs A to F, intermediate reports were requested from the WP leaders. These reports were discussed during different meetings (where all WP leaders of A, B, C, D, E and F were present), and specific comments and actions have been taken.

3. Evaluating the resulting performance criteria and assessment methods by assessing the performance of PV systems and roof accessories of SMEs and PV-installers.

4. All participating IAGs and all members of the SME Core Group did contribute to this work and did work on the deliverables for this WP G.

5. The WP leaders of WP B to F also had the task to give advice and ideas what will be the best way to develop the guidance documents and guidelines.

6. Development of simplified rules for the design of Active Roofs based on the results of work packages B to F taking into account the different climatic zones and different roof types in the member states.

7. The documents from the work packages B, C, D, E and F have been examined, distributed, discussed and gave a basis for guidance documents and the final Guideline. After drafting some guidance a final guideline has been set up, of which the performance requirements and assessment procedures, the product characteristics and the application rules are an integral part. This document is European, under the IFD-mark, and passing relevant courses may lead to a marking for Active Roofs in the future ("EAR-Mark"). The system can/may include a proposal for product and system marking (Active Roofs), as well as marking of the process (Active Roofers). The product marking is related to the outcome of WP's B to E regarding the performance of the products. The process mark is related to WP A and WP F, regarding design, engineering and construction of Active Roofs.

8. The guideline is a basis for training courses. The input from workshops, seminars and information meetings gave input to finalize these documents for the project.

But these documents have to be updated regularly after the end of the project. This is a continuing task of IFD.

9. Gathering of best practice examples of Active Roofs in the different countries.

10. Publication of results through electronic media. A general power point presentation with the results and the Guideline has been developed and is available for all participants of EURACTIVE ROOF and all members of IFD and is used for dissemination of the project results at any occasions (congresses, seminars, workshops etc, *see for more information the Deliverable Overview*).

11. Establishing an Internet site on Active Roofs (www.euractiveroofer.org), including an internal site for dissemination of the project documents within the partners.

12. Additional electronical media are established for future information after the end of the project as part of the IFD internet site *(www.ifd-roof.eu).*

13. Preparation of Newsletters of some WPs and of WP G for all on Active Roofs for European Roofing Associations and their (SME) members. The Newsletters are available on the internet site of IFD also.

10.3 Overview of the Deliverable s and Milestones

List the deliverables and milestones and the final results (see main Deliverables Reports on the EU CIRCA site).

Nr.	**Month**	**Description work to be done**	**Results**	**Produced documents**
Deliverables				
DG1	13	The Eur-ActiveRoofer internet site	Available since October 2005	See *www.euractiveroofer.org*
DG2	19	Evaluation and feedback on the work packages B – F.	This was an ongoing task; input form the WPs came in and has been evaluated	See Guidelines for the design and application of Active Roofs, July 2008
DG3	13 19 25 31	Newsletters	No relevant information for a 1st Newsletter in month 13 available, so combined with 2nd Newsletter; Newsletter 1 (1 + 2) is available since June 2007. 2nd newsletter is available since February	Newsletter 1, June 2007 Newsletter 2, February 2008

Nr.	Month	Description work to be done	Results	Produced documents
			2008, the 3rd Newsletter in June 2008, and the 4th Newsletter since July 2008	Newsletter 3, June 2008 Newsletter 4, July 2008
DG4	31	Proposals for simplified rules and guidelines for active roofs on wind loading, rain and driving rain, snow and snowdrift, and condensation effects.	After drafting some guidance a final guideline has been set up, of which the performance requirements and assessment procedures, the product characteristics and the application rules are an integral part.	Draft 1: 09/07 Draft 2: 10/07 Draft 3: 02/08 Draft 4: 04/06 Draft 5: 06/08 Draft 6: 06/08 Final version July 2008: Guidelines for the design and application of Active Roofs, July 2008
DG5	33	Best practice examples, in the form of guidelines.	Input from the WPs, Database and Best Practice catalogues of WPA and WPF are taken up in the final Guidelines	Report: Guidelines for the design and application of Active Roofs, July 2008
DG6	19 31	Workshops at the yearly International Roofers Conference.	A General presentation was given and discussions were held on the IFD congress of 17 November 2006 at Krakow/Poland and detailed results of the WPs A to F are presented at IFD congress of 4-5 October 2007 in Siofok, Hungary	IFD Presentation Krakow, November 2006 IFD Presentation Siofok, October 2007
DG7	32	Presentations on national roofer meetings, to be planned on national level.	Presentations are given by IFD member organizations at their annual meetings, trade and federation events and other occasions	General power point presentation about the status and results of the project *See Presentation Overview in Chapter 15.4*
DG8	32	Publication of the (intermediate) results in national and international journals for the roofing trade; a minimum of 4 publications is	Publications are made by IFD members in national and international journals and magazines in the roof sector	*See Publication Overview in Chapter 15.5*

Nr.	Month	Description work to be done	Results	Produced documents
		foreseen		
DG9	32	Organization of 2 workshops about the project in 5 cities where interested roofers and technology supplying/ installing SMEs of the new members and candidate member states will be invited. Information days about the project at the CONSTRUMA annual building Fair in Budapest in 2006 and 2007. Invitations for SMEs from the new member states and candidates for the pilot training in the Roofer School of Veszprém	EMSZ organized five regional workshops in Hungary under the title " Regional Profession Days" *See for more information the concerning clause at the end of this Chapter* EMSZ presented also the EurActiveRoofer project at her stand in the International Building Trade Exhibition CONSTRUMA This exhibition was held from 4 to 8 April 2006, from 11 to 15 April 2007 and from 9 to 13 April 2008 in the HUNGEXPO Exhibition Centre in Budapest.	During the project 16 Regional Profession Days were organized by EMSZ in different cities and regions of Hungary. *See for more information the concerning clause at the end of this chapter* Eur-Active Roofer was also presented at the Seminar in UK by NEF on 12 June 2008 (see for more information: *http://www.nef.org.uk/energytraining/solar-roofs.htm*) And at 14 workshops and meetings in Poland *(see for more information the concerning clause at the end of this chapter)*
Milestones				
MG1	13	Start launching website for all participants; first newsletter; evaluation of WP B- F	Website was launched on the GA- meeting in Mayen/Germany No relevant information for 1st Newsletter available, so combined with 2nd Newsletter	See website *www.euractiveroofer.org* 1st Newsletter, June 2007 See also DG2
MG2	19	Workshop, discussing first outline of guidance documents at IFD '06, 2nd newsletter.	Held on the IFD congress on 17 November 2006 Combined 1st/2nd Newsletter issued in June 2007	Newsletter 1, June 2007
MG3	25	General meeting, discussion of WP preliminary results, third newsletter	Discussion are held at: 1st WP G meeting in September 2007, 2nd meeting, January '08, 3rd meeting in April '08; additional meeting and	Discussion results are integrated in the Guidelines for the design and application of Active Roofs, July 2008 and

Nr.	**Month**	**Description work to be done**	**Results**	**Produced documents**
			information at the GA-meeting and IFD congress in Siofok/ Hungary 2nd Newsletter is drafted and published in February 2008	General power point presentation Newsletter 2, February 2008
MG4	31	Presentation of guidance documents, fourth newsletter	Presentations of the guidance document *"Guidelines for the design and application of active roofs"* are presented and discussed. at various project meetings Especially has been made presentations to CEN TC 128 and TC 254 about the Guidelines and Pre-standard Active Roofs (see also WPH) 3th Newsletter is drafted published in June 2008	Various drafts and presentations of the "Guidelines for the design and application of active roofs", June 2008 are made (see also DG4). Presentations to TC 128 and TC 254 are available Newsletter 3, June 2008
MG5	33	End of WP G, all deliverables available (at their specific times indicated in the Deliverables Table), preparation of final Newsletter at end of project	All WPG deliverables are available Final Newsletter is drafting and published in July 2008 General power point presentation has been drafted and will be send to all IFD members *EAR-Mark:* The guideline document is European, under the IFD-mark and passing relevant courses can lead to a marking for Active Roofs in the future. The marking system can/may include a proposal for	Main deliverables (see also DG1 to DG 8) are: 4 Newsletters Report: Guidelines for the design and application of active roofs", July 2008 (paper document + presentation) General presentation of the Outline and results of the project is available for dissemination also after the end of the project And many publications

Nr.	Month	Description work to be done	Results	Produced documents
			product and systems (EAR-product), as well as marking of the process (EAR-Roofer).	and presentations are made (*see Overview in Chapter 15)*

Regional Profession Days in Hungary
Five regional workshop were organised in Hungary by EMSZ under the title “Regional Profession Days” . EMSZ has invited for these workshops contractors, private builders, experts, engineers, architects, vocational schools, university students and teachers living in the different regions concerned. Experts from neighbouring countries of Hungary have been invited as well *(see Figure 10.1)*
The Regional Professional Days were combined with IFD World Championship of Young Roofers 2007 held in Veszprem at Professional School of Roofers

Five Regional Profession Days (for engineers, architects contractors and experts) were organized by EMSZ on the following dates and regions of Hungary (between brackets: number of visitors):

- 5 May 2006: Hotel Forras – Szeged (42)
- 19 May 2006: Professional School of Medgyaszay Istvan – Veszprem (67)
- 9 June 2006: Hotel Korona – Eger (37)
- 6 October 2006: Educational Centre of Transylvania Trust – Cluj Napoca (43)
- 13 October 2006: Professional Structure School of Pechy Mihali – Debrecen (48)
- 22 October 2006: University of Szechenyi Istvan – Gyor (77)
- 26 October 2006: Proffesional Technical School of Pollack Mihali – Pecs (60)
- 11 May 2007: Bujtosi Szabadidő Csarnok - Nyíregyháza (51)
- 18 May 2007: Hotel Claudius – Szombathely (67)
- 1 June 2007 : ITC Székház - Miskolc (69)
- 3 October 2007: Vocational School of Medgyaszay Istvan –Veszprem (270)
- 19 October 2007: Hotel 3 Gúnár – Kecskemé (151)
- 25 April 2008 2008: Expo Center – Pecs (150)
- 23 May 2008: Hotel Forras – Szeged (119)
- 6 June 2008 Hotel Aquaticum – Debrecen (125)

Figure 10.1 Programme leaflet of one of the Workshops held in Hungary

Workshops held in Poland
The Polish Roofer Association (PSD) organised 14 different speeches about the EurActiveRoofer project during various workshops and meetings in Poland. The most important presentation was done during the Polish Building Fair BUDMA on January 24, 2008 (Figure 10.2) PSD organised there the 7th Congress of Polish Roofers and presented the EurActiveRoofer project to an audience of 480 people *(see Figure 10.2)*. Another very fruitful meeting with Polish Roofers took place in the city Spala on March 3, 2008.

Figure 10.2 Presentation of the EurActiveRoofer project at the 7th Congress of Polish Roofers in Poland

10.4 Short Evaluation of the project

The project was very important and helpful for the IFD and its members. It brought the collaboration between institutes and scientific persons together.

Roofers learned that tradition and experience is important but that scientific results coming from testing, calculation or research can give further, more important, contrary or supporting information.
Producers learned that products can only fulfil their task and are fit for purpose, if they are designed in such a way, that the products are in line with the scientific results, but respect the knowledge, experience and training of the roofers. The cheapest and easiest product is very seldom the best solution.
The researchers learned that their results have to be combined with workmanship and with the implementation in the daily work of the roofers.

Altogether it is learned and found out that the knowledge in the countries is very different. If there is more knowledge at the field of the producers and the roofers the amount of failures in Active Roofs can be minimised

All partners in the project agreed that the transfer of know how and knowledge is the most important for the future. That will be an ongoing task for all involved parties. IFD has here an important challenge.
The partners of the project realised that in countries with an established training for roofers and an organised roofer trade or federation the amount of failures in the roof is less and that it is easy and organised on national level to distribute new knowledge and scientific results.
Countries not having this tradition sometimes need help to improve the training and to advance the knowledge transfer.

But the partners realised also that there are countries in the European Community where roofing is not a specialised business and where no roofers are trained or have a trade federation. This results in the absence of knowledge, experience, and training as well there is no know how transfer at all.

It should be an important task (for the EU) to support countries to establish a trained roofer business maybe with establishing roofers federations first.

IFD is willing to support those federations or countries.

10.5 List of produced and reference documents

Reference documents
A draft revision of CR 833 *General requirements for discontinuously laid roof covering* with amendment regarding roof waterproofing has internally been developed and was basis for the first draft guideline. Input from IFD Guidelines for specific roof coverings and applications.

Available were also:
- Product standards and test methods for the roofing products
- IFD Flat Roof Guidelines for the design and application of roof waterproofing
- IFD Recommendation for solar technology at roof and wall

- prEN 15601 Hydrothermal performance of buildings – Resistance to wind-driven rain of roof covering with discontinuously laid small elements – Test method
- Pre-standards (like in the Netherlands the *NVN 7250 Building integration of solar energy systems)*

Produced document

- Newsletter 1 (including 1 and 2) June 2007
- Newsletter 2 February 2008
- Newsletter 3 June 2008
- Final Newsletter, July 2008
- WPG 001 Draft Document Guideline September 2007
- WPG 002 Draft Document Guideline October 2007
- WPG 003 Draft Document Guideline February 2008
- WPG 004 Draft Document Guideline April 2008
- WPG 005 Draft Document Guideline June 2008
- WPG 006 Draft Document Guideline June 2008
- Final Document Guideline July 2008

Presentations

- PP general for all
- PP for IFD 2006 Krakow
- PP for IFD 2007 Siofok
- PP for TC 128, 2008
- PP for TC 254, 2008
- PP for conference 2006, Warsaw
- PP for conference 2007 Stuttgart

Information: on www.euractiveroofer.org and on www.ifd-roof.eu.

11 Work Package H: Pre-Standardisation and Labelling

WP-Leader: TNO
Period: 21 July 2005 till 20 July 2007

11.1 Short Objectives/scope

The main objectives of work package H are laid down in the following three points:

1. The principal objective of this work package is to evaluate the work done in work packages A to F, and to draft pre-standardisation documents, which can be used by future code writers.
2. A second objective is to establish the relations with relevant CEN and EOTA committees in order to ensure effective dissemination of the results towards the new generation of building standards.
3. The third objective is to prepare a European (IFD) label for Active Roofs and for Active Roofers.

11.2 Description of the activities and the achieved results

The WP has started with its activities at the second part of 2007 based on a Start Document. This Start document has been presented and discussed at the General Assembly and the Coordination Group Meetings in Krakow in November 2006. In the CG meeting is decided to start –under the umbrella title of “Active Roof Component” - with a pre-standard on solar energy systems. In the first months of 2007 the process of collecting all the definitive test methods about the different relevant roof aspects produced by the different WPs was started.

Based on the collected information from the various WPs a first draft format of a pre-standard document is drawn up and presented and discussed in the General Assembly meeting in Trondheim in May 2007. Taking in account the comments of the GA-meeting members a final pre-standard format is defined and the activities to complete this pre-standard format with requirements and test methods of the different active roofs aspects is been started. Decided is to set up the pre-standard like an ‘umbrella’ standard on active roof components with the intention to fill in this standard with the first active components: Solar Energy Systems (thermal as well as photovoltaic meant for pitched, flat roofs and facades). In this way more standards on active roofs can be drawn up and brought under the umbrella Pre-standard Active Roofs.

At the mid of 2007 circa half of the contributions from the WPs were available and incorporated in the draft pre-standard on the solar energy systems. Based on this information a first draft pre-standard report with requirements and test methods were drafted and presented for comments and discussions at the CG and GA-meetings in October 2007 in Siofok. There is defined that the chapters Fire resistance and Thermal Behaviour will be kept empty because no information was foreseen to develop in the EurActiveRoofer project (no WPs on these aspect were contracted).

The final draft of the nearly completed Pre-Standard were composed and presented and accepted at the CG and GA-meeting in Athens in February 2008. And in July 2008 the final version was distributed to the WPH and WP leaders of the project.

The work that has to be done finalized in the following results (numbering refers to the objective indicated in the previous chapter):

1) The basic material for the composition of the Pre-standard is collected from WPB to WPF and evaluated by the WPH and Coordination Group members in several draft stages of the process. This finally resulted in a proposal for a Pre-standard on Active Roof Components – Solar Energy Systems (July 2008).

2) With the final draft version of this Pre-Standard (Version February 2008) the EOTA and CEN bodies were already contacted to search for possibilities to enter this pre-standard in the official European standard bodies. These contacts lead to the following results:

   EOTA: A meeting were arranged with the general secretary of EOTA Mr. Paul Culawaerts and he told us that the way to achieve an official mandate for the development of an ETAG on this item will cost a lot of time. He advised us therefore propose to co-operate with TZUS institute in the Czech Republic because this R&D Institute has already received a CUAP on a solar product for installation in the façade (Integrated façade kits with an active and/or passive solar elements). After contacting the mentioned institute (Mr. Sobola) they turned out to be very willing to co-operate and to search both for companies that will support this development of the mentioned CUAP with an enlargement to also solar systems for roof applications.

   CEN: Parallel to this EOTA procedure the chairman of the CEN TC 128 were contacted to have a first consultation if they were interested to incorporate the pre-standard as a work item in the TC 128 I order to achieve finally a EN status of the pre-standard. This turned out to be very successful because they were very keen to take up the pre-standard in the TC 128 activities (in cooperation with TC 254). Also the EC mandate for this kind of work is broad enough to cover it. It was a lucky situation that there was a TC meeting planned in the near future so this opportunity is used to make a work item proposal for assessment at the meeting (Vienna, June 2008). In this TC meeting were proposed to install an Ad Hoc grope “Active Roofs: to consider the development of standardisation activities upon the EIURACTIVEROOFer proposal for a Pre-standard on Solar Energy Systems. This proposal was laid down in two Resolutions. The first one to install the Ad Hoc group and the second one that IFD (Mr. Detlef Stauch) will became the chairman of this group. Both resolutions were adopted so the way is free for further development of the pre-standard to an official European Standard. Also the involvement of the roofer was secured by the commitment of IFD as chairman of this group. Parallel to this process Mr. Detlef Stauch has presented also the EurActiveRoofer project and the Pre-standard at the meetings of TC 128 (mainly pitched roof) and TC 254 (mainly flat roofs). In this way all the roof standard bodies are informed and involved.

Looking at both standardisation possibilities the CG meeting (June 2008, Amsterdam) has finally chosen for the CEN route because it leads in the end to an official and broad accepted EN standard. Besides, the CEN route has already a mandate for this work so preference above the EOTA route.

3) Concerning the preparation of a labelling system for Active Roofs in dialogue with WP H (direct under the supervision of IFD) agreed to set up the first outlines of this label in the Guidelines for Design and Application for Active Roofs because this document is special meant for installer that are the real stakeholders of the active roof label. In the proposed system the label will promoted as the EAR-Mark and the border conditions to use this label are based upon the requirements laid down in the Pre-standard and the mentioned Guidelines.

Finally we can conclude that the standardisation work within the EurActiveRoofer project turned out to be very successful and that the road for development of the pre-standard to an official European Standards is opened and the first steps are made.

11.3 Overview of the Deliverables and Milestones

List the deliverables and milestones and the final results (see main Deliverables Reports on the EU CIRCA site).

Nr.	month	Description work to be done	Results	Produced documents
Deliverables				
DH1	30	Pre-standardization documents on wind loads, related to EN 1991-1-4 and relevant product standards.	Documents are taken up in the final version of the Pre-standard on Solar Energy Systems	Final version of the Proposal for Pre-standard of Active Roof Components – Solar Energy Systems (TNO-report, July 2008)
DH2	30	Pre-standardization documents on seismic effects, with suggestions for EN 1998 and relevant product standards.	Documents are taken up in the final version of the Pre-standard on Solar Energy Systems	See DH1
DH3	30	Pre-standardization documents on wind driven rain, with suggestions to the relevant CEN TCs *)	Documents are taken up in the final version of the Pre-standard on Solar Energy Systems	See DH1,
DH4	30	Pre-standardization documents on	Documents are	See DH1

Nr.	month	Description work to be done	Results	Produced documents
		snow drift effects, with suggestions to the relevant CEN TCs *)	taken up in the final version of the Pre-standard on Solar Energy Systems	
DH5	30	Pre-standardization documents on prevention of condensation, with suggestions to the relevant subcommittees of the connected CEN TCs *)	Documents are taken up in the final version of the Pre-standard on Solar Energy Systems	See DH1
DH6	30	Pre-standardization documents on safety in installation, maintenance and repair, with suggestions to the relevant subcommittees of the connected CEN TCs *)	Documents are taken up in the final version of the Pre-standard on Solar Energy Systems	See DH1
DH7	30	The outline of the ACTIVE-ROOFer label	Taken up in the WPG activities	See WPG report: Guidelines of Design and Applications of Active roofs, July 2008
DH8	32	An elaborate concept of the EUR-ACTIVE ROOFer Label with already performed concrete steps, including all relevant participants	Taken up in the WPG activities	Idem DH7
		**) Contact and suggestions are made with the CEN TCs 128 and TC 254 are made (see also Chapter 11.2 (point 2)*		
Milestones				
MH1	13	Delivering input from WP B – F		See listed document under 10.6
MH2	19	Workshop on the first results of WP H at IFD ’06	The first results based upon information of WPs B-F were presented and discussed at the IFD congress on 17 November 2006	IFD-presentation
MH3	25	General meeting, discussion of WP preliminary results	The first draft of the pre-standard were presented	

Nr.	month	Description work to be done	Results	Produced documents
			in the GA-meeting in Siofok (October 2007)	
MH4	31	Workshop of outcome of pre-standardization at IFD ’07	The pre-standardization input of WPB-F on the various aspects are presented and discussed at the IFD congress in Siofok/Hungary (October 2008)	
MH5	33	End of WP H, all deliverables available (at their specific times indicated in the Deliverables Table)	All deliverables available (see DH1 to DH8	See produced documents of DH1-8 and in Chapter 11.5

11.4 Short Evaluation of the project

Looking back to the process and activities experienced during the project the following conclusions can be made:

1) Working together with on the one hand the research sector (Universities and R&D Institutes) and on the other hand the sector that deals with the day-to day praxis (roof and solar energy installers, roof associations etc.) turned out to be very successful because both sector can learn from their experience and incorporate this in the final standards and guidelines that are produced.

2) The preparation of the documents as input for standards have given a great boost to the formal standardisation process on active roof components.

3) The cooperation of small and medium enterprises is essential in having reached the final goals of the project because there the real experiences are made. In contradiction to this is showed that SMEs haven’t much time and employees available to give the maximum attention to the work that has to be done within the project. Finally the real installation work has the first priority caused by very strict economic demand of their company.

11.5 List of produced and reference documents

Doc.nr.	Title	Remarks
WPH-00	Start Document WPH	
WPH-01	NVN 7250: Solar energy systems –	Pre-standard published in

Doc.nr.	Title	Remarks
	Integration in roofs and facades – Building aspects	the Netherlands in June 2003; New edition is published at the first of August 2007
WPH-02	IFD Recommendation for solar technology at roof and wall fair, November 2002	
WPH-03	BPS 94: Danish guidelines for installation of solar thermal systems in roofs	In the Danish language and central parts in English
WPH-04	Best Practice Catalogue, draft version 2006-6-21	Input WPA
WPH-05	Earthquake loading of active roofs, draft version 28 September 2006	Input WPB
WPH-06	Wind loads on active roofs, 21 September 2006	Input WPB
WPH-07	Classification of Active Roof systems for rain and wind driven rain, 21 April 2006	Input WPC
WPH-08	Moisture distribution in selected types of roofs under different indoor conditions, June 2006	Input WPD
WPH-09	Condensation – Laboratory tests, 30 May 2006	Input WPD
WPH-10-1	Newsletter: Friction between Snow/Ice and Active Roof Installation Surfaces, September 2006	Input WPE
WPH-10-2	Measurements of Friction between Snow and Roofing, 18 July 2006	Input WPE
WPH-11	Relevant data of safety and maintenance	Input WPF
WPH-12	Basis for a CEN standard for a driving rain test on Active Roof elements (BRE 233 674)	Input WPC
WPH-13	Prototypes of mobile safety devices, Best Practice examples and Legislations proposals	Input WPF
WPH-14	Basis for CEN Test Methods on Condensation (BTI, February 2007)	Input WP D
WPH-15	Pre-standardization Document for Wind Loading (TNO 2007-D-R0835)	Input WPB
WPH-16	Draft test method for Uplift resistance (TNO-2007-D-R0836)	Input WPB
WPH-17	Pre-standard document for Active Roof Components – Solar Energy Systems – draft July 2007	Produced by WPH
WPH-18	Pre-standard document for Active Roof Components – Solar Energy Systems – draft August 2007	Produced by WPH
WPH-19	Pre-standard document for Active Roof Components – Solar Energy Systems – draft December 2007	Produced by WPH
WPH-20	Pre-standard document for Active Roof	Produced by WPH

Doc.nr.	Title	Remarks
	Components – Solar Energy Systems – draft February 2007	
WPH-21	Pre-standard document for Active Roof Components – Solar Energy Systems – draft April 2007	Produced by WPH
WPH-22	Pre-standard document for Active Roof Components – Solar Energy Systems – draft June 2007	Produced by WPH
WPH-23	Proposal for Pre-standard of Active Roof Components – Solar Energy Systems – final version July 2008	Produced by WPH

12 Work Package I: Training Activities

WP-Leader: ZVDH
Period: 21 July 2005 till 20 July 2008

12.1 Short Objectives/scope

The objectives of this work package are:

1. To increase the competitiveness and widening opportunities of the roofing trade and solar companies through information on Active Roofs developed in this project.
2. Development of a general training programme for Active Roofers in Europe.
3. Training of the national roofer associations on the application of this programme.
4. Development of national training programmes, based on the general training programme.

12.2 Description of the activities and the achieved results

In the Dow the start of this WP were planned for August 2007 (month 25) but since this WP has to do a lot of work the officially start of the activities of this WP is announced in May 2007 at the General Assembly meeting in Trondheim, but the real activities already started at the beginning of 2007 to evaluate the results of the other WPs.. At the GA meeting a short presentation is given by the Project leader to explain the goals and activities of this work package.

Since this WP has a great number of members the WP leader proposed to work with a smaller core group for the 'daily' activities (ZVDW, EMI, SVDW and HHD. Important questions should be discussed of course with the whole group and also the other involved partners should be request to give input of the developed training material if necessary. This proposal where adopted.

In order to meet the objectives of WPI the following activities were carried out (the numbering refers to the objectives):

1. To increase the competitiveness and widening opportunities of the roofing trade and solar companies through information on Active Roofs developed in this project.
At this moment the full extent of the increase of the competitiveness and widening opportunities of the roofing trade can not be evaluated and assessed because the number of participants of the seminars how gives their final assessment were to small. But those companies, who took part in the seminars, attested in their documented assessment of the seminars a great support of their competitiveness.

2. Development of a general training programme for Active Roofers in Europe.

The following modules of training programme were developed and presented at the final General Meeting in Amsterdam (June 26, 2008) referring to the WP I training documentation (presented also on a CD Training Activities).

Within the project the following systems consisting of modules on 3 levels and key points were developed:

Module I: Euractive Roofer

- Systems I: Systems and their installation
- Penetrations I
- Structural physics/Structural analysis I
- Safety I

Module: II Euractive Roof Manager

- Systems II: Assessment of suitable systems and methods of installation
- Penetrations II
- Structural physics/Structural analysis II
- Safety II
- Project management
- Career and occupational teaching I

-Module III: Euractive Roof Contractor/Consultant

- Climate protection/Energy efficiency I-III
- Legal environment for power engineering activities
- Systems III: Integration of active elements

And with the following content and duration:

Module I	
Title	**Euractive Roofer**
Skills	To professionally and safely install, maintain and repair active and intelligent building envelope elements.
Verification of skills	Practical implementation, written test
Learning objectives	To specify and describe active and intelligent building envelope systems (understanding, explanation and description). To understand and reproduce simple structural, thermal

Module I	
	and power engineering calculations (knowledge, understanding and transfer for practical use). To install active and intelligent building envelope elements correctly in terms of the technical forces exerted by wind, snow, ice and seismic effects. To professionally install active and intelligent building envelope elements and, if necessary, to provision any requisite circuit/pipeline systems as interfaces for other trades. Execution in compliance with the rules of all requisite connections, closings and penetrations, taking into consideration the aspects of energy efficiency, condensation, convection, wind, rain, snow and ice. Committed conformity with the occupational safety and health protection regulations during installation, maintenance and repair work.
Level EQR-LLL	3 - 4
Duration	5 years

Module II	
Title	**Euractive project Manager**
Skills	To professionally plan, prepare and realise active and intelligent building envelope elements.
Verification of skills	Project work with presentation and expert discussion.

Module II	
Learning objectives	To know and understand active and intelligent building envelope systems. To perform common structural, thermal, condensation and energy engineering calculations. To competently plan and prepare the installation and reinforcement of active and intelligent building envelope elements in terms of the technical forces exerted by wind, snow, ice and seismic effects. To define detailed solutions for the correct implementation of all requisite sealing, energy, thermal and insulation engineering connections and closings, taking into consideration the aspects of energy efficiency, condensation, wind, rain, snow and ice. Competent construction management for the building envelope-specific realisation of active and intelligent building envelope systems (project management). The committed planning, preparation and acquisition of country specific occupational safety and health protection regulations for installation, maintenance and repair work.
Level EQR-LLL	4 - 5
Duration	5 years

Module III	
Title	**Euractive Contractor / Consultant**

Module III	
Skills	Competent consultation for climate-relevant and energy efficient building envelope systems.
Verification of skills	Case study with documentation, presentation and expert discussion.
Learning objectives	Knowledge and understanding of climate protection and energy efficiency. Extensive knowledge and understanding of consulting, planning, calculation and management of power engineering activities pertaining to building envelopes and technical facilities. Understanding of the legal environment pertaining to power engineering activities. Understanding of and capability to evaluate local and national promotional programmes relating to power engineering activities.
Level EQR-LLL	5 - 6
Duration	5 years

The 4 roofing contraction associations – EMSZ/Hungary, SVDW/Switzerland, HHD/The Netherlands and ZVDH/Germany – worked out the following various themes at their national training centres:

The Netherlands:

- Techniques: Euractive Roof Systems I
- Techniques: Euractive Roof Systems II

Switzerland:

- Techniques: Euractive Roof Systems I
- Techniques: Euractive Roof Safety I
- Techniques: Euractive Roof Penetrations I
- Structural physics/Structural analysis I

Hungary:

- Techniques: Euractive Roof Safety I
- Techniques: Euractive Roof Safety II

Germany:

- Climate protection/Energy efficiency I-III
- Structural physics/Structural analysis II
- Legal environment for power engineering activities

The main problem in reaching the objectives was the different training systems in the countries. In Germany there is a system of so called "Dual education" between training in the companies and education in state controlled schools. Beyond that there is installed a system of private roofer schools under the responsibility of the German roofers association, were the apprentices are trained in order of the companies. At the end of three years during period of learning the apprentices will get a final grade certificate – under the condition of positive exam passing. A lot of the content of training for active roofers is subject matter of the "Dual education".

The Netherlands and Switzerland have a well-established system of education and training in respectively Uzwil and Boxtel which supports in the acceptance of the companies.

The Hungarian association has installed a roofers school were the companies are able to train and educate their apprentices.

Therefore WP I decided, to install a system of modules that can be used in all four countries, which took part in the evaluation phase of WP I.

The concrete methodical and didactic approach can be read in the WP I training documentation. For further papers and presentations *see Chapter 12.5*

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3. Training of the national roofer associations in the application of this programme.
In consideration of the short time between week 25 and 36 the WP decided to perform the different modules and seminars distributed on the 4 directly countries.

The modules in the WP I-training documentation (page 13 till page 52) were exposed. The concrete strategy stood on a four-step method.

Firstly the roofer associations trained a selected number of teachers in the nation roofing schools in the application of this programme.

Secondly the teachers had to plan concrete seminars under consideration of this programme and the national specifics.

Thirdly the national seminars were planned in the specific language and in the specific needed time. For example the seminar "Energy consultant in the roofing trade" of this programme is planned with duration of 90 hour. The specific German seminar called "Energieberater" has duration of 120 hours.

And finally the fifth step the seminars were conducted and evaluated. The evaluation was done by the trainer, the teacher and the students.

4. *Development of national training programmes based on the general training programme.*
In the application of the results of this project Training of roofers and solar companies were conducted in their native language. Therefore, the training activities are carried out on two levels. The first level involves training the trainers, i.e. training of the national roofing associations. The second level involves training by the roofing associations and their roofer schools of the roofing companies that they represent. The latter is not part of this project and will be covered at a later stage.

The activities concerning the development of training programmes were divided into four work items:

- *Work Item 1: Development of a general training programme.*
  A general training programme was developed in order to make the first level of training possible. This was realised in close cooperation with those SME core group members who have experience in educating their national roofing schools. Translation of the outcomes of the WP's A to F into practical training is the key to success. This were carried out by the IAGs.

- *Work Item 2: Pilot*
  A pilot of this programme was started under the responsibility of four major roofing contracting associations (in Hungary, Germany, Switzerland and the Netherlands). SME core group members who have already worked together with their IAGs in developing national training programmes were involved in this task. The SME core group members built active training roofs, including active roof products.

- *Work Item 3: Evaluation of the pilot*
  The evaluation of this pilot marks the finalisation of the general programme. This general training programme until now is made available in languages

English, and German, but not in the French language because no French participants were involved in the project. DVDs and Internet sites for providing these programmes are developed by the German roofer association, including instructional material that will be language-independent. The IFD will coordinate these activities, assisted by some of the leading RTD performers in the project, in order to achieve the same level of knowledge in all countries involved afterwards.

- *Work Item 4: National training programmes*
  The national associations are responsible for the further adaptation and translation of the European training programme for their members. The associations have incorporated till now parts of these training programmes into their courses held at the national roofer schools.

12.3 Overview of the Deliverables and Milestones

List the deliverables and milestones and the final results (see main Deliverables Reports on the EU CIRCA site).

Nr.	Delivery month	Description work to be done	Results	Produced documents
Deliverables				
DI.1	planned 25 done 28	A pilot version of the training programme	A first pilot version is prepared	See doc WPI-1
D1.2	planned 31 done 32	An evaluation of the pilot by four major roofing contracting associations	Evaluation done in WPI meeting in Budapest March 20, 2008	See doc. WPI-2
D1.3	planned 36 done 36	A final version of the training programme in English, German and French	Available in German and English. There was no French version needed while no French partner participated in the project	See docs WPI-3 WPI-4
4	planned 33 done 28 - 34	National versions of training programmes in native languages	National versions are produced in the field of building	WPI-5 WPI-6 WPI-7 WPI-8 WPI-9

Nr.	Delivery month	Description work to be done	Results	Produced documents
			physics, solar products and installation, safety, ventilation and energy consulting,	WPI-10
Milestones				
MI.1	planned 25 done 28	The first draft of the training programme in English, start of the pilot	done	see DI.1
MI.2	planned 31 done 32	Evaluation of the pilot, commencement on development of versions in English, German and French	done, available in English and German	see D1.2
MI.3	planned 33 done 28 - 34	Start of drafting national programmes in native languages of participating IAGs	done	see D1.4
MI.4	planned 36 is to continue	End of project, end of WP I, availability of all deliverables	All deliverables are available, however the system is to see as an continuous system, that must be transferred to the other participant countries	see all deliverable results see also a list with additional documents in Chapter 12.5

12.4 Short Evaluation of the project

The following core problems were identified within the framework of the Train-the-Trainer seminars:

- Language
- Specific laws in the different countries
- Level of standards and regulations in the different countries
- Different climates and climatic zones
- Level of training (vocational basic training)

The following core approaches have been identified as solutions:

- Three standard languages (English, German and French)
- Legally compliant definitions

- Development of European standards
- Climate-independent definitions as basic definitions
- Definition of a basic level of competence

It was necessary to transfer the EurActive roof standard to the local standard. Therefore all seminars have to be checked for the national relevance of standards and rules.
For example in installation PV and thermal systems for hot water (PV and TS) there should be used interfaces to other professions. New systems should be developed for an uncomplicated fitting of elements, which can solve the problem of needed interfaces.

In order to guarantee the applicability of the training concepts, the following measures should be ensured for the future:

- A database should be made available on the Internet that allows the lecturers and training institutions to access the respective measures.
- Additional seminars/training activities should be planned, the corresponding documentation drawn up and made available via the above-mentioned database.
- Long-term updating of the database content and ensuring that the state of the art is complied with (e.g. via a new committee or working group in the IFD)
- Approval for inclusion in the database to be defined via concrete specified rules.
- Assignment of images to the modules/seminars/advanced training activities (best-practice examples) in the existing database.
- Provisioning of the data/images in the database in a way in which they can be downloaded.

12.5 List of produced documents

Referring to the deliverables
WPI-1 Pilot version of the training programme
WPI-2 Evaluation Protocol Budapest March 20 2008
WPI-3 Training Programme (English version) [1]
WPI-4 Training Programme (German version)
WPI-5 Training Programme Building Physics (SVDW)
WPI-6 Training Programme Solar products (ZVDH)
WPI-7 Training Programme Solar installation (HHD)
WPI-8 Training Programme Safety (HHD)
WPI-9 Training Programme Ventilation (ZVDW)
WPI-10 Training Programme Energy Consulting (part 1, 2 , 3 and 4, ZVDW)

Additional documents:

- Conception of training, represented in Krakau by J.Rühle
- Conception of training, represented in Krakau by Beat Hanselmann
- Presentation of Beat Hanselmann in Trondheim
- Presentation of J. Rühle in Trondheim
- Euractive roof module V 2 by Beat Hanselmann
- 3-Level concept by Beat Hanselmann
- Conception of training, represented in Siofok by J. Rühle
- Conception of training, 03.12.07
- Example 1, conception of training by Beat Hanselmann

[1] Also available in booklet and CD

- Example 2, conception of training by Beat Hanselmann
- Example 3, conception of training by Beat Hanselmann
- Minute “Ausbildungsdrehbuch” by Beat Hanselmann
- Forms of module-planning
- Module-planning Energieberater
- Module-planning Bauphysik
- Module-planning Durchdringungen
- Module-planning Energieberater
- Training-programmes version 1
- Education folder, overview
- Education folder part 1
- Education folder part 2
- Education folder part 3
- Various minutes of meetings
- Various input documents from the WPs

13 Work Package J: Management

WP-Leader: TNO
Period: 21 July 2005 till 20 July 2008

13.1 Short Objectives/scope

The objectives of this work package are:

- General coordination of the project.
- Coordination of the research related activities.
- Organisation of meetings relevant for the project.
- Coordination of activities between the group of RTD performers, the SME Core Group and the IAGs.
- Liaison to the EU Commission Services
- Coordination of training and dissemination

13.2 Short description of the activities undertaken in the project period

In the project period the following actions are undertaken (see Chapter 2.5 for dates and locations):

- General coordination of the whole project
- Organisation and chairing of 7 Executive Board meetings
- Organisation and chairing of 7 Coordination Group meetings
- Organisation of 7 General Assembly meetings
- Producing the Activity and Management reports (1st, intermediate, second and third/final)

13.3 Overview of the Deliverables and Milestones

Nr.	month	Description work to be done	Results	Produced documents[2]
Deliverables				
DJ.1	18 (and yearly reports 13, 25, 37)	Provision of yearly and midterm reports of the project to the commission.	The following reports are produced en submitted to the EC: - 1st Year Management, Activity and Financial Report (September 2006) - Intermediate report (February 2007) - 2nd Year Activity Report	 WPJ-12 WPJ-16 WPJ-20

[2] The numbers refer to chapter 12.6 List of produced documents

Nr.	month	Description work to be done	Results	Produced documents[2]
			(October 2008) - 2nd Year Management Report (October 2007) -3th Year Management report - 3th Activity Report is included in the Final Project Report	 WPJ-21 WPJ-32 See DJ.4
DJ.2	PM	Organisation of necessary meetings to coordinate.	The following meetings are organized: 7 EB-meetings 7 CG meeting 7 GA-meeting	See Minutes: WPJ-5 to11 WPJ-13 to 15 WPJ-17 to19 WPJ-22 to 30
DJ.3	PM	Organisation of two workshops in which the main results of the project will be presented to the members of the IAGs.	- 1st workshop: at the IFD congress November 2006 in Krakow - 2nd workshop :at the IFD congress in October 2007 in Siofok	
DJ.4	36	Final Report covering the work, objectives, results and conclusion, in a form suitable for publication and including sufficient information on new developments.	- Final Project Report	WPJ-33
DJ.5	36	Plan for using and disseminating knowledge generated during the project, and the use plans (future research or exploitation) for the results for the consortium as a whole, or for individual participants or groups of participants.	see Chapter 15 for a detailed description	See list of presentation and publication in chapter 15.4 and 15.5
DJ-6	6	A Project Presentation in English (and German) of approximately two to three pages.	A leaflet of the project is produced in the following languages: English, German Dutch and Hungarian	WPJ-1 WPJ-2 WPJ-3 WPJ-4

Milestones				
MJ-1	18	Mid-term review analysis (month 18).	Produced reports: - 1st Year Report - Mid Term Report	 WPJ-12 WPJ-16
MJ-1	36	End of project, all deliverables available and general closure meeting at Dach und Wand '08	- All deliverables available - Instead of an general closure meeting at Dach und Wand there were organized a final Active Roof Conference in Amsterdam/Netherlands for dissemination of the project results (June 2008) Additionally: - a general presentation is made with all the project results for future use. - A CD with all the project documents is produced and handed over to all the participants	See DJ1 to DJ6 General presentation about the status and results of the project for future use CD with all the project documents (WJ-31)

13.4 List of produced documents

The following document are produced (all uploaded to the EU CIRCA site)

Doc.nr.	Title
WPJ-1	Leaflet of the project in English
WPJ-2	Leaflet of the project in Dutch
WPJ-3	Leaflet of the project in German
WPJ-4	Leaflet of the project in Hungarian
WPJ-5	Minutes of 1st EB meeting in Cologne/Germany (21 July 2005)
WPJ-6	Minutes of 1st CG meeting in Mayen/Germany (12 October 2005)
WPJ-7	Minutes of 1st GA-meeting in Mayen/Germany (12-13 October 2005
WPJ-8	Minutes of 2nd EB meeting in Delft/(Netherlands (11 January 2006)
WPJ-9	Minutes of 2nd CG meeting in Watford/UK (9 March 2006)
WPJ-10	Minutes of 2nd GA meeting in Watford/UK (9-10 March 2006)
WPJ-11	Minutes of 3rd EB meeting Veszprem/Hungary(7 July 2006)
WPJ-12	1st Year Management, Activity and Financial Report (TNO 2006-D-R0752/B, September 2006)
WPJ-13	Minutes of 3rd CG meeting in Krakow/Poland (14 November 2006)
WPJ-14	Minutes of 3rd GA meeting in Krakow/Poland (14-16 November 2006)
WPJ-15	Minutes of 4th EB meeting in Vienna/Austria (2 February 2007)
WPJ-16	Mid Term Report (2007-D-R0170/B, February 2007)

Doc.nr.	Title
WPJ-17	Minutes of 4th CG meeting in Trondheim/Norway (23 May 2007)
WPJ-18	Minutes of 4th GA-meeting in Trondheim/Norway (24-25 May 2007)
WPJ-19	Minutes of the 5th EB meeting in Cologne/Germany (29 July 2007)
WPJ-20	2nd Year Activity Report (TNO 2007-D-R1009/A, October 2007
WPJ-21	2nd Year Management Report (TNO 2007-D-R1010/A, October 2007
WPJ-22	Minutes of the 5th CG meeting in Siofok/Hungary, 2 October, 2007
WPJ-23	Minutes of the 5th GA meeting in Siofok/Hungary, 2-3 October, 2007
WPJ-24	Minutes of the 6th EB meeting in Dublin/Ireland (23 November 2007)
WPJ-25	Minutes of the 6th CG meeting in Athens/Greece (14 February 2008)
WPJ-27	Minutes of the 6th GA meeting in Athens/Greece (14-15 February 2008)
WPJ-28	Minutes of the 7th EB meeting in Budapest/Hungary (22 April 2008)
WPJ-29	Minutes of the 7th CG meeting in Amsterdam/Netherlands (25 June 2008)
WPJ-30	Minutes of the 7th GA meeting in Amsterdam/Netherlands (26 June 2008)
WPJ-31	EURACTIVEROOFER CD with all the produced project documents *(see figure 13.1)*
WPJ-32	3rd Year Management Report TNO 2008-D-R0851/B
WPJ-33	Final Project Report TNO 2008-D-R0851/B *)

*) *Including 3rd Year Activity Report*

Figure 13.1 Cover of the Eur-ActiveRoofer CD

14 Evaluation

14.1 Problems and solutions occurred the project

The following problems were encountered during the first half of the project:

Generally

- Some deliveries of samples were delayed. This is caused by a hold-up in achieving usable results in the full scale tests on active roofs since the winter 2006/2007 was too mild for a good assessment of the tested systems and delivery problems in the laboratory tests. Therefore EU is requested[3] to enlarge the lead time of all the WPs to the end of the project (month 36) in order to make use of the coming (hopefully cold winter) and finalize the deliverables and use the results for the concerning activities in the various WPs.
- Because of the fact that many of the 32 participants do not have experience with an EU-project it takes a lot of time to manage the project in a proper way, especially it focussed on the collection of the correct completed financial forms. This has cost a lot of management time. Therefore the EU is asked admission to shift the budget for the 1st year audit of the partners (that was not used) to the project coordinator to cover the extra costs for the management. This is sustained by the EU as well as by the (nearly) all of the partners.
- For the same reason only limited information has been given as input for the database In the recent Executive Board meeting is decided therefore to appoint special persons for from the involved associations the provide the needed information for completion of the database. And in the spring of 2008 a final boost is given to structure as well as the contents of the database.
- During the development of the training programmes (training to trainer seminars) some problems are encountered, especially concerning various languages, the specific laws, the level of standards and regulations in the different countries, and additionally the different climates and level of training.
  The following core approaches have been identified as solutions:
  > Identify three standard languages (English, German and French)
  > Legally compliant definitions
  > Development of European standards
  > And Climate-independent definitions as basic definitions

Technically

- In general the precise measurement of the absolute humidity of roofing materials and the insulation was a problem. The solution was to substitute the direct measurements by indirect methods and to find the data by additional calculations. Besides we are testing equipment to get the precise data.
- A barrier with full scale models is to get precise and comparable data. The solution to this problem is the arrangement with the performers. Another problem is that the periods of data collection of especially full scale models needs to be very long to get

[3] This request is meanwhile by email sustained by the EU Scientific Officer on September 10, 2007

significant results. Additionally the mild climate in winter 2006/2007 did not raise serious problems. Therefore the full scale tests have been continued until spring 2008 and therefore EU is requested for an extension of the working period.
- There have been difficulties getting partners to provide the Active Roof specimens required for testing and therefore have been found far time-consuming and difficult than first anticipated. Although not all the needed samples are received this has been improved during the project and the partners are started to actively participate and provide test specimens.

14.2 Final evaluation of the project

14.2.1 General remarks

1) Co-operation and involvement
No major problems have been encountered during this work concerning the co-operation between the partners. The atmosphere within the project was very good, and people were all open to share experiences and knowledge. Minor problems were encountered in the initial stages of the project trying to get the participants to become fully involved in the project and to realize the benefits of their input to the successful outcome of the work. Once partners started to understand the benefits and developed a good working relationship with the task leaders and with other members of the work packages their involvement and commitment improved and a strong team spirit was developed which led to focused outputs which benefited all participants and the wider Active Roofing industry.

2) Coordination of so many and various partners
The project with all its participants has been handled by the project leader TNO. In the first year of the project it came out that the coordination of 32 partners with many SMEs and Association (with minor experiences in EU projects) was very difficult and time consuming. Especially in a research driven project it is hard to get full commitment from all these partners The cross fertilization approach of the General Assembly meetings have been very worked out good to involve all the participants and to getting known each other. Due to the good general management and personal contacts in the meetings we learned to trust each other and it was no problem to acts in such a big and inhomogeneous team.

3) Budget
Two serious budget problems came clear during the project. In the first place the extra managements cost to coordinate such a large group of partners. And in the second place the costs of the General Assembly meeting that turned out to be much higher than the estimated budget at the start of the project. Besides is was for some partners very difficult to get the financing these meeting, e.g the GA meeting in Trondheim hosted by SINTEF was not planned in their original budget.
Also some budget reallocations have been made (with approval of the EC) to be able to carry out all the work that has been foreseen in the Description of Work.

3) Lessons learned

The involved roofers in the project learned that tradition and experience is important but that scientific results coming from testing, calculation or research can give further, more important, contrary or supporting information.

Producers learned that products can only fulfil their task and are fit for purpose, if they are designed in such a way, that the products are in line with the scientific results, but respect the knowledge, experience and training of the roofers. The cheapest and easiest product is seldom the best solution.

The researchers learned that their results have to be combined with workmanship and with the implementation in the daily work of the roofers.

Concerning the tests we have learned that he comparison between laboratory tests or calculation methods and in situ show differences in the general conditions. We always should have in mind that there are simplifications and we can not trust these results for 100%.

5) Final results

In the end, we have a nice set of research results available, which can be applied on various levels in codes, guidelines and training programs, both European and nationally. This would not have been possible without this EU project.

14.2.2 Technical remarks

1) Delivering samples

The process of obtaining various solar cell samples, including BIPV systems, has been found to be far more time-consuming and difficult than first anticipated. After countless inquiries and reminders both by WP-leaders and TNO, very view samples have been received. Finally the real installation work has the first priority caused by very strict economic demand of their company.

2) Energy savings

Due to energy savings with big insulations and air tight construction, the knowledge of condensation gets more important than in the past. And the examples from Spain and Poland showed that there is a lack of know how and an improvement of workmanship is necessary.

3) Full scale tests

To carry out all the foreseen full scale tests (caused by the mild winter 2006/2007) and performs all the measurements took more time then planned in the original work plan. Therefore an extension of the deadlines for this WP was needed until about May 2008.

Especially the innovative safety devices which were introduced and tested are interesting in the future further development, basically because they are affordable. For failure detection system field only two best practice examples were found in the literature, more investigation could be recommended. Pilot project for failure detection system has problems if real roof should be artificially leaked, models are more recommended for investigation, as made in Ireland.

4) Standardization

The preparation of the documents as input for standards have given a great boost to the formal standardisation process on active roof components in the building surrounding. The acceptance of this work item by the CEN is to qualify as very successfully. It proofed that working together with on the one hand the research sector (Universities and R&D Institutes) and on the other hand the sector that deals with the day-to day praxis (roof and solar energy installers, roof associations etc.) is a very successful combination because both sectors can learn from their knowledge and experience.

14.2.3 Final remarks

The cooperation of small and medium enterprises was essential in having reached the final goals of the project because there the real experiences are made. In contradiction to this is showed that SMEs haven't much time and employees available to give the maximum attention to the work that has to be done within the project.

The project was very important and helpful for the IFD and its members. It brought the collaboration between institutes and scientific persons together. All partners in the project agreed that the transfer of know how and knowledge is the most important for the future. That will be an ongoing task for all involved parties. IFD has here an important challenge.

The partners of the project realised that in countries with an established training for roofers and an organised roofer trade or federation the amount of failures in the roof is less and that it is easy and organised on national level to distribute new knowledge and scientific results.

But the partners realised also that there are countries in the European Community where roofing is not a specialised business and where no roofers are trained or have a trade federation. This results in the absence of knowledge, experience, and training as well there is no know how transfer at all. Countries not having this tradition sometimes need help to improve the training and to advance the knowledge transfer.

It should be an important task (for the EU) to support these countries to establish a trained roofer business maybe with establishing roofers federations first.

IFD is willing to support those federations or countries.

15 Knowledge use and dissemination

15.1 Plan for using and disseminating knowledge

The use and dissemination of knowledge was organised on four different levels:

- In every WP, one or more of the SME Core Group partners were directly involved. This ensured a continuous link between the stakeholders of the project and the research done.
- Guidelines, best practice examples of integrated approaches, standardised solutions and the European catalogue of recommended solutions to assist the work of designers, roofers, solar companies and other related SMEs has been made available through the national roofing associations and the solar trade association.
- Training courses are developed in the native languages of the participating IAGs. These courses assist designers and consultants, roofers and system installers via the national federations. Translations will be carried out under the responsibility of the participating IAGs with help of the respective RTD performers.
- An outline of a European label has been developed in this project.

The international federation of roofers, IFD, and its largest national member, ZVDH, have fulfilled a coordinative role in dissemination (WP G) and training (WP I). They have not only focussed on roofs but also on solar energy systems, which are becoming increasingly important for their roofers. Conferences and workshops are organised for disseminating the results to the professional stakeholders while a website, publications and best practice examples have been contributed to raise the public's awareness. The results are aslo disseminated through the existing networks in the consortium and on the websites of the RTD performers and participating IAGs. The organisation of the dissemination of knowledge is illustrated in the following scheme *(Figure15.1)*.

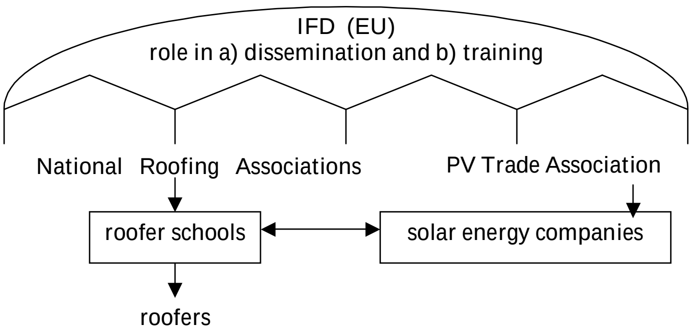

Figure15.1: Dissemination scheme

15.2 Adaptations to the dissemination plan

During the project no main adaptations are made to the proposed plan. The activities and first results of the EurActiveRoofer project have been published in different ways such as a website, presentations at conferences and publications in the relevant journals in the different countries (see Overviews in table 15.4 and 15.5). The following paragraphs list the concrete dissemination facts during the whole project. Guidelines, training courses and development of a European label are developed in the last project year.

In order to promote the results of the EurActiveRoofer project on a special and effective way there is organised in June 2008 a final conference with (external) building and roof parties in The Netherlands.

15.3 Websites

A publicly accessible website has been developed (*see http://www.euractiveroofer.org)* with general information about the project. Also project sheets have been produced in different languages that can be downloaded directly. The active roof database is publicly available (*see http://sts.bwk.tue.nl/activeroof/*). And also on the website of the IFD news and information is incorporated about the EurActiveRoofer project (*www.ifd-roof.eu/eur-active-roofer).*

For a good internal communication within the protected an internal project site is used with the relevant documents of all the WPs (this website is connected tot the *//www.dachdecker.de/*)

15.4 Presentations

At various events the following presentations have been performed:

Nr.	Title	Event	By	Date
1	EUR-ACTIVE ROOFER EU Collective Research Project	NEN-commission Building integration Solar components, Utrecht, The Netherlands	TNO	June 15, 2005
2	Integral Design Method for Sustainable Built Environment	CLIMA 2005, Lausanne, Switzerland	TU/e TNO	9-12 October 2005
3	EUR-ACTIVE ROOFER EU Collective Research Project	IFD Congress, Cape Town, South Africa	IFD	November 17-19, 2005
4	EUR-ACTIVEROOFER European Collective Research Project	NFRC Southern Countries Technical Seminar	BRE	March 15, 2006
5	Design Methodology for Innovative Roofs	International Postgraduate Research Conference in the Built and Human	TU/e, TNO	April 6-7, 2006

		Environment, Delft, The Netherlands		
6	Integral Design of Active Energy Roofs	17th Air-Conditioning and ventilation conference 2006, Prague, Czech Republic	TU/e , TNO	May 17-19, 2006
7	New Typologies for Active Roofs; an Integral Approach	Healthy Buildings 2006, Lisbon, Portugal	TU/e, TNO	June 4-8, 2006
8	EurActiveRoofer Collab. Design: an integral approach to Sustainability	Symposium TU/e & TVVL/ Eindhoven, The Netherlands	TU/e	June 14, 2006
9	EurActiveRoofer	ECCREDI Conference	EMI	June 16, 2006
10	EUR-ACTIVE ROOFER EU Collective Research Project	1st pre-conference on Craft and Small Enterprises in Warsaw	IFD	June 28-30, 2006
11	Challenges for the successful integration of crafts and small enterprises from the new Member States into the single market by 2010,	First pre-conference on crafts and small businesses Warsaw, Poland	IFD	June, 2006
12	Adaptable Typology for Active Roofs	International Conference on Adaptables Building Structures, Eindhoven, The Netherlands	TU/e	July 3-5, 2006
13	Integral design methodology for sustainable design	World Renewable Energy Conference	TU/e, TNO	19-25 August 2006
14	Integral Design Methodology for Collaborative Design of Sustainable Roofs[1)]	23rd International Conference on Passive and Low Energy Architecture, Geneva, Switzerland	TU/e, TNO	September 6-8, 2006
15	EUR-ACTIVE ROOFER EU Collective Research Project	NFRC Midlands Region Technical Seminar	BRE	September 26, 2006
16	Presentation about the goals, activities and results of the EurActiveRoofer project	IFD Congress in Krakow, Poland	TNO	November 17, 2006
17	EURACTIVEROOFER project	Regional Preferences Days (7 events)	EMSZ	During 2006
18	Active Roofs for Trade Members	Southern Countries Business Meeting in London	NFRC	February 1, 2007

19	EUR-ACTIVE ROOFER EU Collective Research Project	4th European Conference on Craft and Small Enterprises in Stuttgart	IFD	April 16-17, 2007
20	Info stand CONSTRUMA (including Euractive Roofer)	HUNGEXPO Exhibition Budapest, Hungary	EMSZ	April 11-15 , 2007
21	Info stand EUR-ACTIVE ROOFER	RENEXPO Conference for SME, Budapest	EMI	April 19-21, 2007
22	EurActiveRoofer Project	4th European Conference on Craft and Small Enterprises, Stuttgart, Germany	IFD	April 2007
23	Collaborative Design of Active Roofs	CLIMA 2007	TU/e, TNO	1-14 June ,2007
24	Collaborative Design of Sustainable Roofs 2005-2008	International Conference on Design Education,	TU/e TNO	9-12 June 2007
25	Research Methodology for integral design in the context of Collaborative engineering for Active roofs	International Conference on engineering Design, ICED '07, Eindhoven, Netherlands	TU/e	28–31 August 2007
26	EURACTIVE ROOFER project	Speeches at workshops and meetings (13x)	PSD	During 2007
27	EURACTIVEROOFER project	Regional Preferences Days (5 events)	EMSZ	During 2007
28	EURACTIVE ROOFER project, the guideline and the pre-standardisation,	CEN/TC 128 Vienna, Austria	IFD	5-6 June 2008
29	EURACTIVE ROOFER project, the guideline and the pre-standardisation,	CEN/TC 254, Istanbul, Turkey	IFD	8-9 May 2008
30	EURACTIVE ROOFER project	7th Congress of Polish Roofers	PSD	January 24, 2008
31	Building integration of Solar Energy	EPIA Workshop at EU Sustainability Week	TNO	January 31, 2008
32	Collaborative Active Roof Design (a.o.)	International Design Conference Dubrovnik, Croatia	TU/e	10-22 May, 2008
33	Presentations of the findings of EURACTIVE ROOFER project	Seminar EURACTIVE ROOFER London, UK	NEF	June 12, 2008
34	Results EURACTIVE ROOFER project	Active Roof Conference Amsterdam, Netherlands	HHD/ TNO	June 27, 2008
35	Wind Loads on Roof Mounted PV modules	UK Wind Engineering Society Conference	BRE	July 14, 2008
36	Storm resistance design for solar energy systems	23th PV Conference Valencia, Spain	TNO	September 1-5, 2008

37	EURACTIVEROOFER project	Regional Preferences Days (3 events)	EMSZ	During 2008
38	Neue Erkenntnisse zur Solarnutzung auf dem Steildach	Seminar Marburg Solar Applications	IFD/ TNO	8-9 October, 2008

15.5 Publications

The following articles have been published:

Nr.	Title	Journal	Issue
1	Europese dakdekkers bundelen hun krachten	De Dakdekker	Summer 2005
2	EUR-ACTIVEROOFer officieel van start	Gebouwflitsen	November 2005
3	We moeten het dak als aparte component zien	Gevel&Dak Journaal	January 2006
4	Europees project helpt dakdekkerbranche met aansprakelijkheid	Cobouw	January 6, 2006
5	Raising the roof profile	EU-site	February, 2006
6	Dakdekkers werken aan vernieuwing	Stedebouw & Architect.	April 2006
7	Die Welt der Dächer (concerning IFD congress and EurActiveRoofer project)	Das Dachdecker-Handwerk	Heft 24/2006
8	Het Nieuwe leren	TVVL	Nr. 3, 2006
9	Innovatieve daktoepassing/EurActiveRoofer project	Newsletter Holland Solar	March 3, 2007
10	Windbelasting op daken	Heron	May 2007
11	1ste Newsletter EuActiveRoofer	IFD	June 2007
12	GA Ontwerpers samen op weg naar beter bouwen	GAZET	July 2007
14	Eur-ActiveRoofer project: Cooperation between SME and TNO	MKB and TNO	October 2007
13	Windlasten an Solardachern	WTG Mitteilungen	Mid November 2007
15	Wind Loads on Solar Energy Roofs	Heron	Vol. 52, (2007), No. 3
16	Europäische Dächer im Blick	DDH	February 1, 2008
17	2nd Newsletter EurActiveRoofer	IFD	February 2008
18	Project EUR-ACTIVER ROOFer komt nu goed op gang	Cobouw	March, 2008
19	Verbetering Dakkwaliteit op Europees Niveau	Roofs	March, 2008
20	3rd Neweletter EurActiveRoofer	IFD	June 2008
21	EUR-ACTIVEROOFer	Nieuwsbrief Holland Solar	July 2008

22	4th and final Neweletter EurActiveRoofer	IFD	July 2008
23	European standards for ’Active Roofs’	TNO International Magazine	September 2008
24	Europees project voor verdere ontwikkeling ‘active daken’	Roofs	September 2008
25	EurActiveRoofer, short description of the results	Uitgelicht, internal magazine of TNO B&I	October 2008

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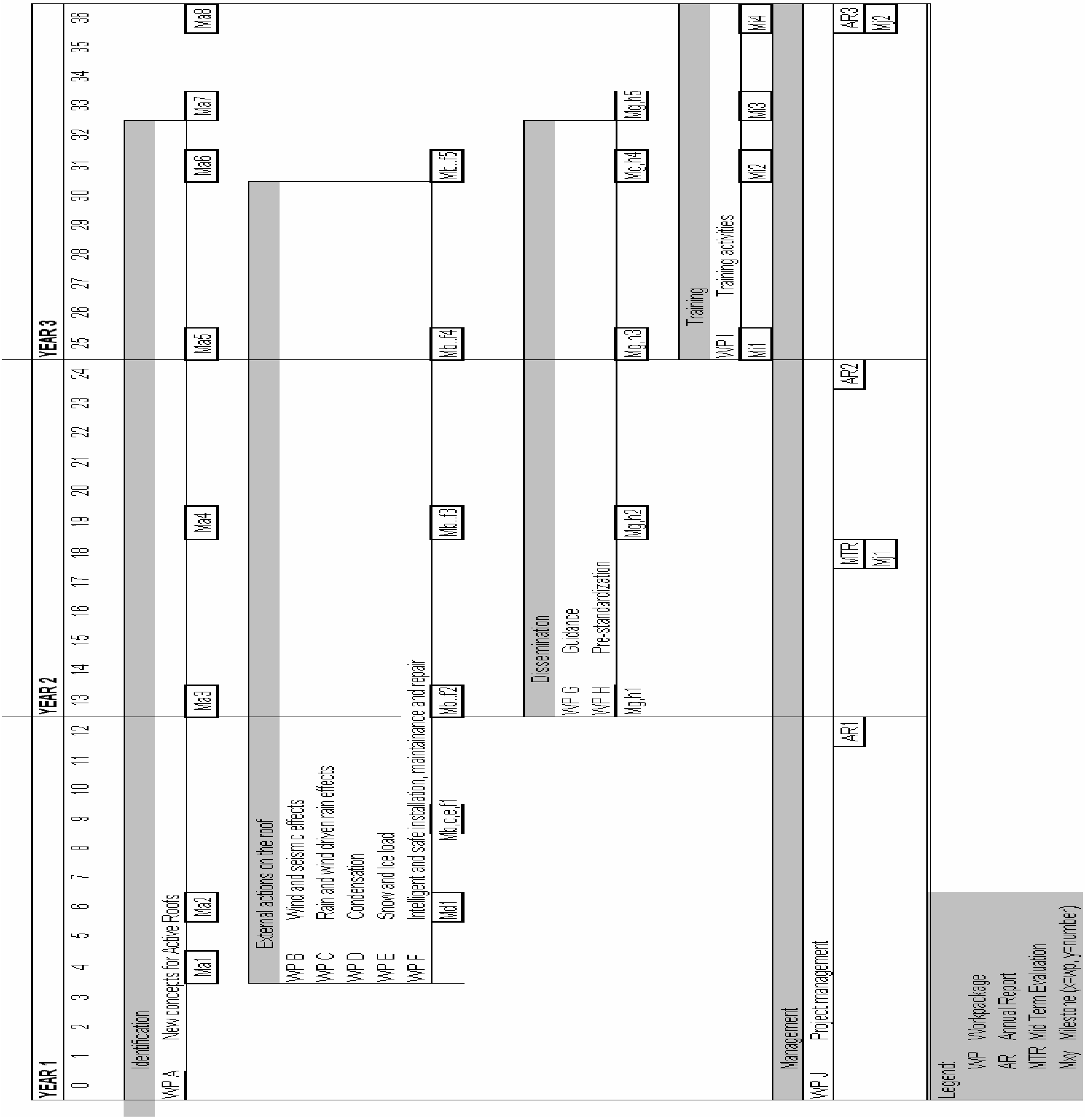
B Work Planning and Timetable



EUR-ACTIVE ROOFer

HORIZONTAL ACTIVITIES
INVOLVING SMEs