



Agenzia Nazionale per le Nuove Tecnologie,  
l'Energia e lo Sviluppo Economico Sostenibile



*Ministero dello Sviluppo Economico*

## RICERCA DI SISTEMA ELETTRICO

Relazione sulle attività del task 38 solar air-conditioning and  
refrigeration del "Solar Heating and Cooling" programme - Agenzia  
Internazionale dell'Energia (AIE)

*Mario Motta*



RELAZIONE SULLE ATTIVITÀ DEL TASK 38 SOLAR AIR-CONDITIONING AND REFRIGERATION  
DEL "SOLAR HEATING AND COOLING" PROGRAMME - AGENZIA INTERNAZIONALE  
DELL'ENERGIA (AIE)

Mario Motta (Dipartimento di Energia - Politecnico di Milano)

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Report Ricerca di Sistema Elettrico

Accordo di Programma Ministero dello Sviluppo Economico - ENEA

Area: Usi Finali

Tema: Sistemi di climatizzazione estiva ed invernale assistita da fonti rinnovabili

Responsabile Tema: Nicolandrea Calabrese, ENEA



**RELAZIONE SULLE ATTIVITÀ DEL *TASK 38 SOLAR AIR-  
CONDITIONING AND REFRIGERATION* DEL “SOLAR  
HEATING AND COOLING” PROGRAMME - AGENZIA  
INTERNAZIONALE DELL'ENERGIA (AIE)**

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Paesi partecipanti dal Task38:

Australia, Austria, Canada, Danimarca, Francia, Germania, Italia, Messico, Portogallo, Spagna e Svizzera.

Persone responsabili della direzione dei Subtask del TASK 38:

Subtask A: Dagmar Jähniq (AEE INTEC, Austria)

Subtask B: Wolfram Sparber (EURAC research, Italia)

Subtask C: Etienne Wurtz (INES, Francia)

Subtask D: Mario Motta (Politecnico di Milano, Italia)

Prodotto dal Dipartimento di Energia, Politecnico di Milano, Milano, Italia

## **PREFAZIONE**

### ***Agenzia internazionale dell'energia***

L'Agenzia internazionale dell'energia (AIE) è un'organizzazione internazionale intergovernativa fondata dall'Organizzazione per la cooperazione e lo sviluppo economico (OECD) nel 1974 per stabilire un programma di energia internazionale. Uno degli obiettivi di base dell' IEA è il promuovere la cooperazione tra i 24 paesi partecipanti dall'IEA ed incrementare la sicurezza energetica per via della conservazione, lo sviluppo delle energie alternative e la ricerca energetica, lo sviluppo e la dimostrazione.

### ***Task38***

L'obiettivo principale del Task38 è la implementazione di misure per la introduzione accelerata nel mercato di sistemi di raffreddamento e condizionamento dell'aria elio-assistiti, puntando sul miglioramento dei componenti e dei "concept" di sistema. L'introduzione nel mercato va supportata attraverso le seguenti attività:

- attività di sviluppo e test di sistemi di condizionamento dell'aria per i settori residenziale e terziario;
- sviluppo di sistemi chiavi in mano per impianti di piccola e media taglia e sviluppo di schemi ottimizzati e standardizzati per sistemi su misura;
- relazioni sulle esperienze con nuovi impianti pilota e dimostrativi e sulla procedura di collaudo e di valutazione delle prestazioni;
- redazione di documenti a supporto della progettazione, installazione e collaudo di impianti solari di condizionamento dell'aria;
- analisi di concetti innovativi e tecnologie prestando particolare attenzione ai principi termodinamici e alla ricerca bibliografica;
- confronto tra i risultati degli strumenti di simulazione disponibili e loro applicabilità nella pianificazione e nell'analisi di sistemi;
- attività di *market transfer*, le quali includono lettere informative, work-shop, materiali di esercitazione, e la seconda edizione del manuale *Handbook for Solar Cooling for Planners*.

Per raggiungere questi obiettivi, il Task38 svolge la sua ricerca e sviluppo secondo i seguenti Subtask:

- Subtask A: Sistemi compatti per applicazioni residenziali e piccolo terziario
- Subtask B: Sistemi progettati su misura per applicazioni di grandi dimensioni non-residenziali e industriali
- Subtask C: Analisi fondamentali e di modellazione
- Subtask D: Attività di sensibilizzazione degli operatori del mercato (produttori, progettisti, installatori)

Ogni Subtask è formato da vari *work package* con dei punti di interesse e dei risultati specifici.

La durata del progetto è di 4 anni, con data d'inizio l'1 settembre 2006 e fine il 31 agosto 2010.

Il Task38 è una iniziativa internazionale condotta da 51 organizzazioni in 11 paesi:

Australia	<ul style="list-style-type: none"> <li>• CSIRO Division of Energy Technology</li> <li>• University of South Australia, Division of Information Technology, Engineering and the Environment</li> <li>• ClimateManagers</li> <li>• Energy Conservation Systems</li> </ul>
Austria	<ul style="list-style-type: none"> <li>• AEE INTEC, AEE - Institute for Sustainable Technologies</li> <li>• Arsenal Research, Business Field Sustainable Energy Systems</li> <li>• ASIC- Austria Solar Innovation Center</li> <li>• S.O.L.I.D. Gesellschaft für Solarinstallation und Design m.b.H.</li> <li>• Institute of Thermal Engineering, Graz University of Technology</li> </ul>
Canada	<ul style="list-style-type: none"> <li>• Queens University - Department of Mechanical and Material Engineering</li> </ul>
Danimarca	<ul style="list-style-type: none"> <li>• Ellehauge &amp; Kildemoes</li> <li>• Danish Technological Institute, Refrigeration and Heat Pump Technology</li> <li>• AC-Sun</li> <li>• PlanEnergi</li> </ul>
Francia	<ul style="list-style-type: none"> <li>• INES - Université de Savoie</li> <li>• EDF R&amp;D, Department EnerBat</li> <li>• TECSOL SA.</li> <li>• LEPTAB - University of La Rochelle</li> <li>• CETHIL - UCBL/INSA Lyon/CNRS</li> </ul>
Germania	<ul style="list-style-type: none"> <li>• Fraunhofer Institut für Solare Energiesysteme</li> <li>• Technische Universität Berlin, Institut für Energietechnik</li> <li>• Solarnext AG</li> <li>• Institute of Thermal Engineering, University of Kassel</li> <li>• ZAE Bayern</li> <li>• Fraunhofer Umsicht</li> <li>• ILK Dresden GmbH</li> <li>• Universität Stuttgart, Institut für Thermodynamik und Wärmetechnik (ITW)</li> </ul>
Italia	<ul style="list-style-type: none"> <li>• Politecnico di Milano - Dip. Energia</li> <li>• Ambiente Italia srl</li> <li>• EURAC Research - European Academy Bolzano</li> <li>• University of Palermo</li> <li>• OLYMP ITALIA SRL</li> </ul>

	<ul style="list-style-type: none"> <li>• Politecnico di Milano - Dept. Building Environment Sciences &amp; Technology (BEST)</li> <li>• Università di Catania - Dipartimento di Ingegneria Industriale e Meccanica (DIIM)</li> <li>• AMG Energia SpA</li> <li>• Università di Firenze (CREAR)</li> <li>• University of Rome La Sapienza - Dipartimento di Meccanica e aeronautica</li> </ul>
Messico	<ul style="list-style-type: none"> <li>• CIE-UNAM (Centro de Investigacion en Energia - Universidad Nacional Autonoma de Mexico)</li> </ul>
Portogallo	<ul style="list-style-type: none"> <li>• DER/INETI</li> </ul>
Spagna	<ul style="list-style-type: none"> <li>• Fundación CARTIF - Energy Division, Renewable Energies Area</li> <li>• AIGUASOL ENGINYERIA - Sistemes Avançats d'Energia Solar Tèrmica SCCL</li> <li>• Instituto de Ciencias de la Construcción Eduardo Torroja (CSIC)</li> <li>• Universidad Miguel Hernández - Área de Máquinas y Motores Térmicos</li> <li>• Universidad Carlos III de Madrid - Dpto. de Ingeniería Térmica y de Fluidos</li> <li>• I KERLAN - Centro de investigation tecnològicas</li> <li>• Centro Tecnológico Tekniker - Renewable Energy Unit</li> <li>• CIEMAT - Unidad de Eficiencia Energética en la Edificación</li> <li>• INTA</li> <li>• Acciona Infraestructuras - Departamento de Investigación, Desarrollo e Innovación</li> </ul>
Svizzera	<ul style="list-style-type: none"> <li>• HEIG-VD - School of Business and Engineering - Laboratory of Solar Energetics and Building Physics (LESBAT)</li> <li>• Institut für Solartechnik SPF - Hochschule für Technik Rapperswil HSR</li> </ul>

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## 1 INTRODUZIONE

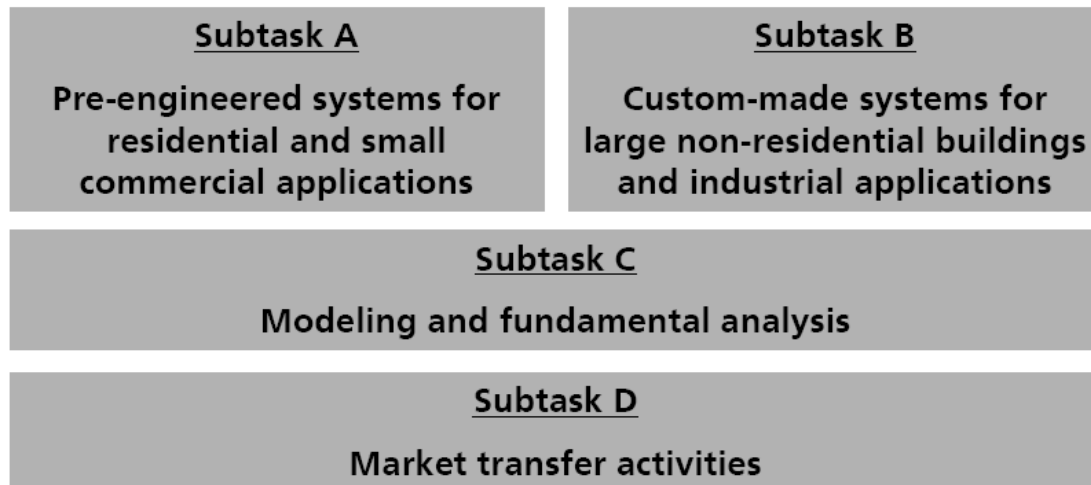
L'ambito del Task 38 si colloca nel settore delle tecnologie per la produzione di acqua fredda o di aria condizionata alimentate termicamente attraverso calore solare, cioè, sono oggetto del Task i componenti che trasformano la radiazione solare che arriva al collettore in acqua fredda e/o aria condizionata fornita all'applicazione.

Nonostante il sistema di distribuzione sia un elemento chiave, l'edificio e la interazione dello stesso con l'impianto non è l'argomento principale del Task38; tuttavia, questa è trattata là dove necessario. In particolare, per impianti di piccola taglia, che possono fare uso dei collettori solari come unica fonte unica di calore, il sistema complessivo edificio impianto è esaminato in modo da ottimizzarne il rendimento complessivo del sistema. Il Task comprende anche il raffreddamento solare per applicazioni diverse da quelle che riguardano la climatizzazione dell'aria, cioè, per processi industriali e altre applicazioni (ad esempio, conservazione di alimenti).

Il 7° e 8° meeting di esperti del task si sono tenuti rispettivamente a Palermo (Settembre 2009) e Aarhus (Aprile 2010) e hanno coinvolto fino a circa un centinaio di esperti.

## 2 I SUBTASK. DESCRIZIONE E I WORK PACKAGE

I *Subtask* includono attività denominate verticali ed orizzontali, come mostrato nello schema seguente:



Una visione più dettagliata di ogni *Subtask* e dei vari *work package* compresi in ognuno di essi, è descritta nei seguenti sottocapitoli.

### ***2.1 Subtask A: Sistemi compatti per applicazioni residenziali e piccolo terziario***

Paese leader del Subtask: Austria

Leader del Subtask: Dagmar Jähnig, AEE INTEC

Il lavoro del Subtask A comprende i seguenti work package (WP). Le persone/istituzioni responsabili sono indicati tra parentesi:

- A1 Market overview
- A2 Raccolta di schemi di sistemi selezionati (sistemi generici) (ZAE)
- A3 Relazione tecnica sulle attività impostate sperimentali e di monitoraggio (AEE INTEC)
- A4 Raccolta di proposte sulle procedure di valutazione di sistemi (AEE INTEC, CIEMAT)
- A5 Linee guida di installazione e manutenzione per sistemi compatti (ancora non definite)

I prodotti del sub task realizzati fino alla fine di Aprile 2010 sono (in parentesi le istituzioni responsabili in seguito al titolo di ogni rapporto):

- Rapporto sullo stato dell'arte delle macchine di raffreddamento e smaltimento del calore di idonea capacità disponibili sul mercato, comprensivo di standard per il confronto tra diverse tecnologie (ISE).
- Una visione d'insieme sui sistemi "combi" disponibili sul mercato (AEE INTEC) e dei serbatoi di freddo (Fraunhofer UMSICHT).
- Una visione d'insieme sui sistemi convenzionali tipici in ogni paese partecipante (Queen's university).

## ***2.2 Subtask B: Sistemi progettati su misura per applicazioni di grandi dimensioni non-residenziali e industriali***

Paese leader del Subtask: Italia

Leader del Subtask: Wolfram Sparber, EURAC

I lavori del Subtask B comprendono i work package descritti in seguito (le persone/istituzioni responsabili sono indicati tra parentesi):

- B1 Visione d'insieme del mercato (Università di Palermo, DREAM: Marco Beccali)
- B2 Progettazione e controllo di sistemi (arsenal research: Tim Selke)
- B3 Procedura per la valutazione dei risultati di monitoraggio (Eurac research, Wolfram Sparber)
- B4 Metodo di pre-progettazione (tecsol, Daniel Mugnier)
- B5 Linee guida per l'installazione (ILK Dresden, Uwe Franzke)
- B6 Linee guida per i capitolati di appalto (checklists) (TU Berlin, Jan Albers)

Una versione aggiornata dell'indagine sui sistemi di raffreddamento solari progettati su misura e sui sistemi di piccola taglia (pre-ingegnerizzati) ha rivelato che attualmente esistono circa 254 impianti in Europa e si stima 350-400 in tutto il mondo; di cui 13 Asia, 4 America, 3 Australia, 2 Africa.

I sistemi progettati su misura (LS) sono per: 71% ad assorbimento, 13% adsorbimento, 16%, desiccant cooling - DEC“ (solid 14%). Per i sistemi pre-ingegnerizzati (SS): 90% ad assorbimento, 10% adsorbimento. La media della superficie captante per capacità frigorifera installata è di 3,3 m<sup>2</sup>/kWfr (4,18 per SS e 2 m<sup>2</sup>/kWfr LS), 10 m<sup>2</sup> per 1000 m<sup>3</sup>/h per sistemi DEC. La vasta maggioranza di questi sistemi è impiegata per il condizionamento dell'aria, solo due impianti sono usati nella refrigerazione industriale.

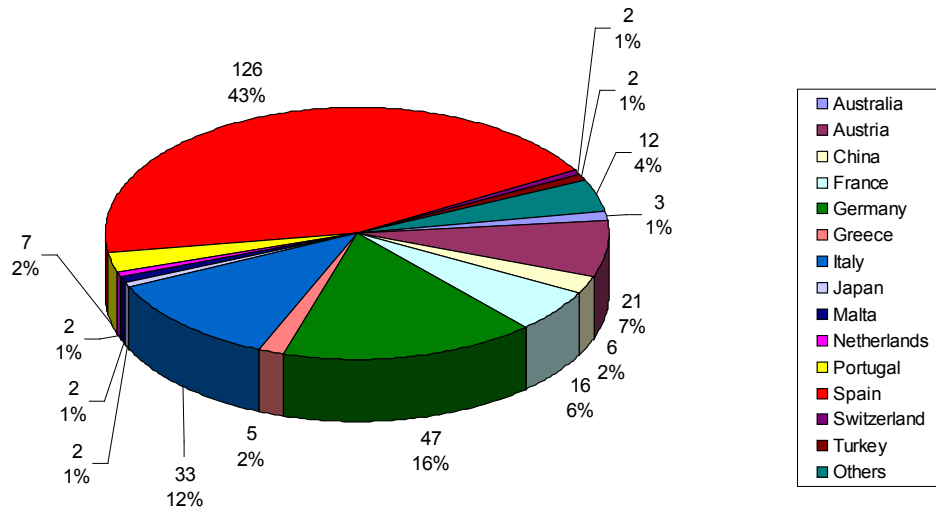


Figura 1. Distribuzione dei sistemi di raffreddamento solare per usi.

### 2.3 Subtask C: Analisi fondamentali e di modellazione

Paese leader del Subtask: Francia

Leader del Subtask: Etienne Wurtz, INES

Questo Task è organizzato in 5 work package ed per ogni sottogruppo ci sono due relatori. La situazione attuale è:

- C1 Stato dell'arte: Lucio Mesquita (Queen's university) assistito da Michael Krause (Kassel Univesität)
- C2 Simulazioni: Edo Wiemken (Fraunhofer ISE) assistito da Paul Bourdoukan (INES)
- C3 Analisi termodinamica: Luigi Marletta (università ci Catania) assistito da Nolwenn Le Pierres (INES)
- C4 Criterio di rendimento: Maria-Jose Jimenez e Jose Antonio Ferrer (CIEMAT) assistiti da Maurizio De Lucia
- C5 Rigetto di calore: Harald Moser (IWT, Technische Universität Graz) assistito da Lars Reinholdt

Da alcuni risultati di simulazione discendono le seguenti conclusioni per i diversi sistemi ad aria condizionata :

Per sistemi ad acqua fredda:

- I chiller a singolo effetto a LiBr/H<sub>2</sub>O richiedono un minor investimento in collettori solari rispetto agli altri sistemi.
- I chiller a doppio effetto a LiBr/ H<sub>2</sub>O hanno efficienza maggiore ma richiedono costi eccessivi per i collettori solari, se l'applicazione è la climatizzazione estiva (convenzionale).
- I chiller a metà effetto a LiBr/ H<sub>2</sub>O non possono competere coi chiller a singolo effetto a LiBr/ H<sub>2</sub>O sia in termini di costi iniziali sin in termini di costi operativi.
- I chiller a NH<sub>3</sub> / H<sub>2</sub>O alimentato da collettori solari a concentrazione sono l'unica soluzione sensata per la refrigerazione industriale a temperature che approssimano o superano 0°C.

Per i sistema ad aria fredda:

- I chiller a metà effetto a LiBr/ H<sub>2</sub>O richiedono un minor investimento in collettori solari.
- I chiller tipo GAX a NH<sub>3</sub>/ H<sub>2</sub>O possono produrre in modo efficiente se accoppiati a collettori solari per media temperatura, dai costi maggiori.

## **2.4 Subtask D: Attività di Market transfer**

Paese leader del Subtask: Italia

Leader del Subtask: Mario Motta, POLIMI

I lavori del Subtask D sono di seguito elencati:

- D1 Metodologia di misura del rendimento (ISE)
- D2 Certificazione e standard - Da definire (Università di Firenze)
- D3 Analisi del ciclo di vita - DREAM (Uni Palermo) e Uni Catania
- D4 Seconda edizione del Manuale (POLIMI, ISE)
- D5.1 Rapporto sulle Policy (ISE, Polimi, ECN)
- D5.2 Materiale di training (Ambiente Italia)
- D5.3 Workshop per le Industrie (All participants)
- D5.4 E-newsletter ( ISE, All participants)

## **3 RISULTATI PRELIMINARI E ULTERIORI LAVORI**

Questo capitolo è un sommario dei risultati raggiunti fino all'ultima riunione di esperti (*expert meeting*), tenutasi a Aarhus nell'Aprile 2010. I risultati corrispondenti nello specifico ad ognuno dei quattro Subtask sono descritti nei seguenti sottocapitoli. La versione più estesa e ufficiale di questo documento è stata presentata ed approvata dalla commissione esecutiva del programma e si trova negli Allegati 1 e 2.

### 3.1 Subtask A

I risultati più notevoli raggiunti dal Subtask A fino ad oggi sono i seguenti:

- Il monitoraggio di 20 installazioni di sistemi di raffreddamento solare di piccola taglia è quasi terminato. Le misure saranno registrate anche per l'estate 2010, dando la possibilità a chi gestisce gli impianti di beneficiare dei risultati della stagione di condizionamento precedente per effettuare migliorie ai sistemi.
- I primi risultati del monitoraggio della stagione estiva 2009 sono stati presentati alla riunione degli esperti.
- E' stata migliorata la procedura del monitoraggio congiunta con il Subtask B. Si è arrivati alla 5.11 che include la possibilità di monitorare tutti i sistemi oggetto di studio.
- Sono stati presentati i primi risultati della procedura di valutazione a 3 livelli per il monitoraggio in campo di prove in cooperazione col Subtask B e la definizione di uno schema di riferimento per la valutazione del risparmio energetico conseguibile
- Il gruppo di lavoro "Linee guida di installazione e manutenzione per sistemi compatti" ha prodotto il rapporto che è stato presentato dal Subtask leader.

Gli ulteriori lavori sviluppati all'interno del Subtask A sono elencati nel seguito, in corrispondenza ad ognuno dei work package del Task:

#### WP A1: Visione d'insieme del mercato (Market Overview)

Visione d'insieme del mercato comprendente componenti esistenti e in fase di sviluppo adatti a sistemi combinati per la produzione di acqua calda e fredda con potenze di freddo < 20 kW. Il rapporto finale è stato completato e consegnato alla commissione esecutiva del programma (ExCo). Il rapporto include i seguenti argomenti: macchine frigorifere alimentate ad energia termica, tecnologie di smaltimento dell'energia termica in ambiente (condensatori), serbatoi freddi e sistemi solari combinati.

#### WP A2: Sistemi generici

Questo work package riguarda l'individuazione delle varie soluzioni tecniche che sono alla base di un generico sistema di raffrescamento solare, tra cui : sottosistema di alimentazione del calore, sistema di smaltimento del calore, sistema di produzione del freddo e circuiti idraulica.

Nel rapporto un nuovo sistema modulare per disegnare schemi di impianto di sistemi di solar cooling (*Generic System Schemes*) è presentato unitamente ad alcuni esempi di applicazione. Il rapporto finale è stato completato e consegnato alla ExCo.

#### WP A3: Monitoraggio

Le attività di monitoraggio stanno proseguendo e la lista di sistemi monitorati è stata aggiornata. In tutto sono 12 i sistemi in funzione monitorati i cui dati sono stati immessi nel "Task 38 – Monitoring Excel Tool".

Un modello per riportare in modo condiviso le valutazioni sui risultati di monitoraggio è stato sviluppato in collaborazione con il Subtask B. Per quanto riguarda la procedura di valutazione a 3 livelli, questa è stata concordata e un foglio Excel (reso applicabile anche alle soluzioni di tipo DEC) è stato fornito a tutti i partner partecipanti. Il rapporto include il modello e una descrizione breve degli impianti monitorati.

#### WP A4: Procedure di valutazione

Il lavoro di questo Subtask va unito alle attività di monitoraggio del WP 3, a causa di una comunanza degli argomenti. Il calcolo della frazione solare si baserà sulla procedura del Task 32. Ulteriori procedure teoriche (simulazioni) verranno svolte nell'ambito del Subtask C3.

#### WP A5: Installazione e linee guida per la manutenzione

Le precedenti esperienze sono state riassunte in forma di linee guida per la installazione e la manutenzione. Si sta elaborando un documento di lavoro che tratterà i seguenti argomenti: definizione di un sistema compatto, analisi degli oneri di manutenzione a carico dell'utente finale e procedure di controllo necessarie per assicurare il funzionamento appropriato degli impianti. I risultati verranno usati per dare un contributo all'handbook. E' stata redatta una lista di installazioni di piccola capacità che include più di 150 impianti. Sulla base del questionario sviluppato (vedi allegato 3), sono state realizzate 16 interviste con utenti finali e operatori in 6 paesi. Questa attività è ancora in corso.

## **3.2 Subtask B**

I risultati più notevoli raggiunti dal Subtask B fino ad oggi sono i seguenti:

#### WP B1: Visione d'insieme del mercato

Il rapporto finale è stato completato e consegnato alla commissione esecutiva del programma (ExCo). Partendo dal quadro generale di tutti i sistemi di solar heating & cooling installati a livello mondiale, si è discusso con maggiore dettaglio relativamente agli schemi idraulici di 20 specifici impianti. I risultati sono stati riportati in una pubblicazione per Eurosun 2010, e le informazioni principali sono state ulteriormente elaborate per essere incluse nel capitolo 11 dell'Handbook.

#### WP B2: Selezione e progettazione del sistema di controllo

Si è deciso di concentrare il lavoro sulle questioni relative al controllo dei sistemi SAC, che sono state analizzate e discusse sulla base di sistemi installati e informazioni fornite dai partecipanti al Task 38. Il rapporto finale è stato completato e consegnato alla commissione esecutiva del programma (ExCo), il relativo paragrafo dell'Handbook è in fase di elaborazione. Inoltre è stata preparata una pubblicazione per Eurosun 2010

#### WP B3: Monitoraggio di progetti dimostrativi e proposta di procedure di valutazione

La versione 5.8 della procedura di monitoraggio, che include significative modifiche nei calcoli relativi ai sistemi DEC, è stata inviata ai partecipanti al Task 38. Un documento esplicativo della procedura che

presenti gli impianti monitorati è in fase di elaborazione, i dati di 10 impianti e un report saranno disponibili per l'autunno 2010, i risultati principali saranno riportati in un paragrafo del capitolo 11 dell'handbook.

#### WP B4: Metodo per la pre-progettazione di progetti di successo

E' stato elaborato un metodo di pre-progettazione del tipo "checklist", basato su una serie di domande con risposte multiple predefinite. La checklist è stata sviluppata sotto forma di file excel, e considera aspetti tecnici, economici e organizzativi.

Parallelamente è stato sviluppato un tool di pre-progettazione, di cui una prima versione è stata distribuita ai membri del relativo gruppo di lavoro.

Un breve report e la versione finale della checklist sono stati distribuiti e saranno parte dell'Annex dell'Handbook.

#### WP B5 + B6: Linee guida per la installazione, la valutazione e la redazione di capitolati di appalto

Una lista dettagliata di attività di collaudo, che considera le differenti aree di un sistema SHC, è stata elaborata sotto forma di documento excel. E' stato completato un report esplicativo sul processo del collaudo, che sarà incluso con la lista nell'annex dell'Handbook.

### **3.3 Subtask C**

I risultati più rilevanti raggiunti dal Subtask C fino ad oggi sono qui di seguito elencati.

#### WP C1: Stato dell'arte – Indagine sui nuovi sviluppi nell'ambito del raffreddamento solare

Il report finale, comprendente le seguenti tecnologie, è stato completato:

- Processi liquidi di ad-assorbimento a ciclo chiuso (ammoniaca-acqua, LiBr- acqua)
- Processi solidi di ad-assorbimento a ciclo chiuso (silica gel – water, zeolite – water, salt – water)
- Tecnologia dei dessiccanti liquidi
- Tecnologia dei dessiccanti solidi
- Tecnologia Steam jet

#### WP C2: Strumenti di Simulazione

Diversi lavori sono stati sviluppati per la modellazione di tecnologie DEC solide e liquide attraverso strumenti software TRNSYS, Insel, Spark e Mathcad. Il Politecnico di Milano ha partecipato a questa attività effettuando simulazioni in Trnsys relativamente ai "solar driven desiccant systems".

I seguenti report sono stati completati:

- *Description of simulation tools used in solar cooling - New developments in simulation tools and models and their validation (Solid desiccant cooling, Absorption chiller)*
- *Benchmarks for comparison of system simulation tools – Absorption chiller simulation Comparison*

WP C3: Analisi termodinamica / Exergetica

I vari report intermedi sui seguenti argomenti sono stati inclusi nel report finale, la cui approvazione definitiva è prevista per la fine dell'estate 2010:

- Exergia nel contesto del solar cooling
- Analisi energetica dei sistemi DEC
- Analisi entropica dei sistemi DEC
- Analisi energetica di due tipi di refrigeratori ad assorbimento acqua/ammoniaca
- Analisi exergetica del ciclo DEC tipo "ECOS"
- Exergia della radiazione solare
- Analisi entropica dei collettori solari
- Considerazioni circa la temperatura esterna nelle analisi energetiche

WP C4: Valutazione del rendimento/Criteri di rendimento

Nell'ambito della procedura di monitoraggio unificata, era stata formulata una proposta sul metodo FSC applicato al raffreddamento solare. Tale metodologia è stata applicata con successo nella procedura di monitoraggio dei sub task A e B.

WP C5: Smaltimento di calore

Diversi report e risultati intermedi sono stati preparati ad oggi e verranno inclusi nel report finale "*Heat Rejection Technologies*". I risultati raggiunti ad oggi sono:

- Raccolta e analisi delle differenti configurazioni possibili per i sistemi di raffreddamento
- Report sul rispetto delle norme igieniche nelle torri di raffreddamento di piccola taglia
- Report su pre-raffreddamento adiabatico nelle torri di raffreddamento di tipo "dry"
- Test degli scambiatori interrati di tipo orizzontale

### **3.4 Subtask D**

I risultati più rilevanti raggiunti dal Subtask D fino ad oggi sono i seguenti:

- Relazione sulla metodologia LCA (analisi del ciclo di vita) e un foglio per la raccolta dei dati.
- Bozza finale della prima parte del "*New handbook of solar cooling*".
- Versione finale della prima e-newsletter completata e tradotta in 5 lingue

Le attività del subtask D sono coordinate dal Politecnico di Milano e le presentazioni ai vari Expert Meeting sono riportate nel CD allegato.

I lavori futuri del Subtask D corrispondenti ad ognuno dei work package sono descritti di seguito:

WP D1: Metodologia per la misurazione del rendimento



L'obiettivo è lo sviluppo di una chiara Metodologia di misurazione del rendimento, la quale intende valutare il rendimento complessivo di diversi sistemi in termini di energia e costi. La base del lavoro sui sistemi SAC si svolgerà nell'ambito dei Subtask A e B e il risultato finale verrà fornito al Subtask D.

#### WP D2: Certificazione e schemi di standardizzazione

Questa categoria di attività è stata interrotta.

#### WP D3: Analisi del ciclo di vita dei sistemi di raffreddamento solare

Il rapporto della metodologia è stato concluso. Anche se i lavori su questo tema si sono riaperti dopo aver trovato una sinergia di intenti tra il DREAM di Palermo e HEIG-VD (Svizzera). Questo ha permesso un ampliamento della base dati con l'inserimento dei dati relativi ai sistemi convenzionali (di riferimento) e ai sistemi innovativi.

#### WP D4: Seconda edizione del Manuale di Solar Cooling per progettisti

Nella 7° e 8° riunione di esperti si sono effettuati delle riunioni di gruppo sul manuale che risulta essere uno dei principali prodotti del Task. Si è effettuata la stesura della prima parte del libro e al momento gli autori responsabili stanno curando la stesura della seconda parte. Questa dovrà includere i risultati delle misure effettuate sui sistemi monitorati nell'estate del 2010. Il libro verrà pubblicato da Springer nel 2011.

#### WP D5: Disseminazione dei risultati

##### WP D5.1 Policy paper

Una prima bozza del policy paper è stato prodotto in base all'evoluzione dell'ambito politico a livello della EU e considerando le iniziative a livello nazionale. Si è deciso di non sviluppare una versione finale dello stesso ma sviluppare un position paper che è stato realizzato dal Dr. Henning e presentato alla commissione esecutiva del programma.

##### WP D5.2 Materiali di training per installatori e progettisti

La versione finale dei materiali didattici del Task 38 è stata realizzata. Prossimamente verranno anche inseriti altri materiali che includano i principali risultati dei diversi Subtask.

##### WP D5.3 Workshop con le Industrie Nazionali

Sono stati organizzati due workshop con le industrie nazionali: Orlando (USA) nel Gennaio 2010, Aarhus (Denmark) nell'Aprile 2010. I programmi dei due eventi si trovano negli allegati 4 e 5

##### WP D5.4 E-newsletter semestrale per l'industria

E' stata realizzata la versione finale della e-newsletter, che è stata tradotta in cinque lingue e distribuita nei diversi paesi dai partecipanti.

## **Semi-Annual Status Report**

**to be presented at the 66<sup>th</sup> ExCo meeting  
November 16-18, 2008, Nice, France**

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# 1 Short description of Task 38

## 1.1 Task Objectives

The main objective of the Task is the implementation of measures for an accelerated market introduction of solar air conditioning and refrigeration with focus on improved components and system concepts. The market introduction will be supported through

- activities in development and testing of cooling equipment for the residential and small commercial sector;
- development of pre-engineered system concepts for small and medium size systems and development of optimized and standardized schemes for custom made systems;
- reports on the experiences with new pilot and demonstration plants and on the evaluation and performance assessment procedure;
- provision of accompanying documents supporting the planning, installation and commissioning of solar cooling plants;
- analysis of novel concepts and technologies with special emphasis on thermodynamic principles and a bibliographic review;
- performance comparison of available simulation tools and applicability for planning and system analysis;
- market transfer and market stimulation activities, which include information letters, workshops and training material as well as the 2nd edition of the Handbook for Solar Cooling for Planners.

## 1.2 Scope

The scope of the Task are the technologies for production of cold water or conditioned air by means of solar heat, i.e., the subject which is covered by the Task starts with the solar radiation reaching the collector and ends with the chilled water and/or conditioned air transferred to the application. However, although the distribution system, the building and the interaction of both with the technical equipment are not the main topic of the Task this interaction will be considered where necessary. In particular, for small scale systems which may use the solar collector as the only heat source the overall system including the building and its thermal mass is focused in order to optimize the overall performance. The Task also covers solar refrigeration for other than comfort air-conditioning applications such as industrial processes and other applications (e.g. food conservation).

## 1.3 Means

The work in this Task is organized in four Subtasks:

- Subtask A: Pre-engineered systems for residential and small commercial applications
- Subtask B: Custom-made systems for large non-residential buildings and industrial applications
- Subtask C: Modeling and fundamental analysis
- Subtask D: Market transfer activities

Each Subtask consists of several work packages with specific focus and results.

## 1.4 Duration

Start date: September 1, 2006

Completion date: December 31, 2010

## 2 Status of participation

Participating countries are: Australia, Austria, Canada, Denmark, France, Germany, Italy, Mexico, Portugal, Spain, Sweden and Switzerland.

Still missing is the National Participation letter from Mexico.

The responsible persons for Subtask leadership in Task 38 are:

- Subtask A: Dagmar Jähnig (AEE INTEC, Austria)
- Subtask B: Wolfram Sparber (EURAC research, Italy)
- Subtask C: Etienne Wurtz (INES; France)
- Subtask D: Mario Motta (Politechnico di Milano, Italy)

During the 7<sup>th</sup> expert meeting 67 experts from the following countries participated: Australia, Austria, Canada, Denmark, France, Germany, Italy, Malta, Mexico, Portugal, Spain and Switzerland. About one quarter of experts participating in the meeting came from companies.

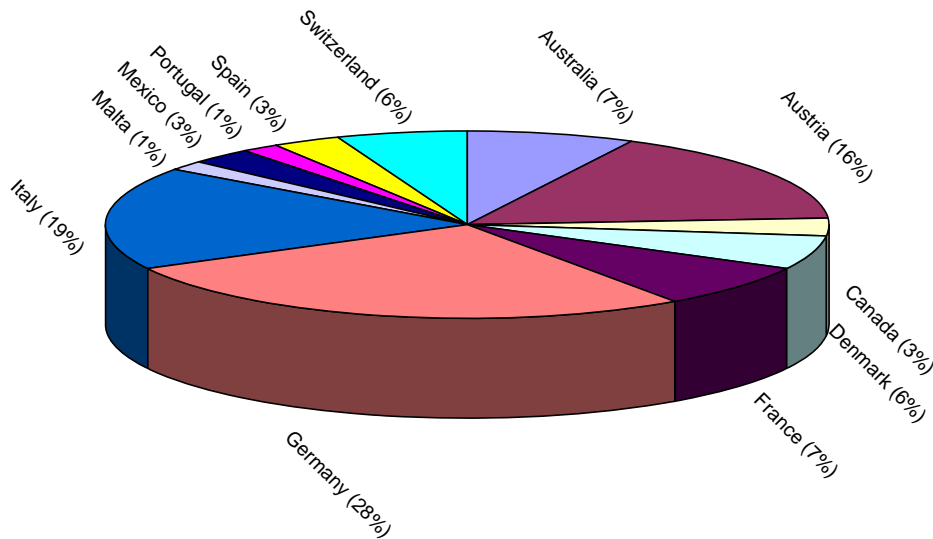


Fig. 1: Distribution of participants at the 7<sup>th</sup> expert meeting per countries

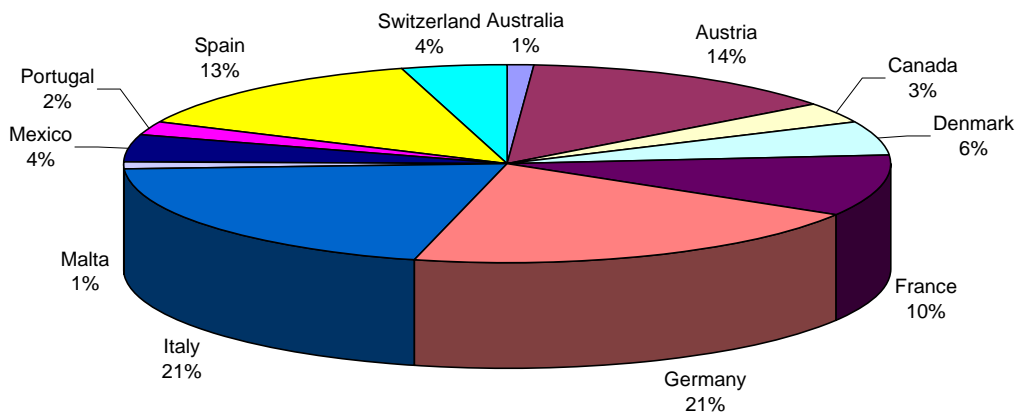


Fig. 2: Distribution of participants in the Task per countries (status May 2008)

The meeting was structured – like the meetings before – by dividing in plenary blocks and in parallel blocks with working groups on specific items.



Fig 3: Most of the participants of the 7<sup>th</sup> expert meeting in Palermo

### 3 Progress since last status report

Matters concerning the whole task are:

- The 7<sup>th</sup> expert meeting was held on September 28-29 in Palermo, hosted by University of Palermo – Dept. DREAM. 67 experts attended the meeting. The meeting agenda is attached at the end of this document.
- In the afternoon of the first day and the morning of the second day of the expert meeting different topics were discussed in working groups. The results of these discussions were fixed in action item lists prepared by the subtask leaders and distributed to the task participants as timetable for the next period.
- After the expert meeting the 3<sup>rd</sup> International Conference Solar Air-Conditioning was held from October September 30 to October 2 in the University of Palermo. Many of the Task 38 meeting participants participated in the conference and a number of Task 38 related presentations were given at the conference.

#### 3.1 Subtask A: Pre-engineered systems for residential and small commercial applications

##### WP A1: Market Overview

The market overview comprises existing components and ongoing developments suitable for combined systems for heating and cooling with chilled water systems having cooling capacities less than 20 kW. The market overview report will be finished and submitted for the 66<sup>th</sup> ExCo meeting. It comprises the following topics: Chillers, heat rejection, cold stores and solar combisystems.

##### WP A2: Generic Systems

In this Work Package technical options, comprising the topics: driving heat, heat rejection, useful cooling and hydraulics are considered as the basis for the definition of generic systems.

At the last meeting the new modular way of drawing system schemes for the 3 main components of the solar-combi-plus-systems was presented:

- Hot side subsystem
- Cold side subsystem
- Heat rejection

The draft report on the generic systems has been sent out to the participants of the working group and a final report will be prepared and submitted for the 66<sup>th</sup> ExCo meeting.

##### WP A3: Monitoring

The monitoring activities are progressing. Many of the monitored systems started operation in summer 2008 or in spring 2009, respectively. Up to now, for four systems monitoring data for a period of one complete year are available. A final version of the general monitoring procedure which is used for subtasks A and B has been worked out and has been made available to all Task 38 participants. In total, there are 13 systems included in the Subtask A monitoring campaign. For 12 of them, monitoring is still in operation. For most of the 13 systems the available data has already been filled in the Task 38 monitoring Excel-tool and they will be included in the final system evaluation and comparison of results.

##### WP A4: Evaluation procedures

The work on evaluation procedures is involved within the monitoring procedure developed in Subtask A and B. This also comprises the work, originally foreseen within Subtask C4.

### WP A5: Installation and maintenance guidelines

Experiences with existing systems will be summarized in guidelines for installation and maintenance. This will also be a major contribution to the Handbook of Subtask D. As a first step, a questionnaire for end-users of small-scale solar heating and cooling systems has been elaborated which is used to get an overview of experiences regarding installation, operation and maintenance of such systems. The questionnaire will be filled in after a visit to the plant or a phone interview with the user or plant operator.

A list of small scale installations was set up in order to choose the installations for which the questionnaire will be filled in. 122 installations are already in the list, further will follow. Up to now, 4 interviews took place, further interviews are planned within the upcoming months.

In addition, an Excel tool was set up that will facilitate the analysis of the filled-in questionnaires.

## **3.2 Subtask B: Custom-made systems for large non-residential buildings and industrial applications**

### WP B1: Market overview

List of installed systems is updated and a short report is in preparation.

### WP B2: Selection of system design and control

Decision to focus on the control issues of SAC systems. In August 2009 a draft report comprising the detailed explanation of the control logic of 7 systems has been circulated. With this report a contribution to the handbook regarding control issues is foreseen.

### WP B3: Monitoring of demo projects and proposal for evaluation procedures

A revised edition of the monitoring procedure has been elaborated and sent out to all Task participants. The update of the monitoring procedure has been presented at the expert meeting and a working group has been held. Monitoring and operation results of 5 systems were presented at the 3<sup>rd</sup> International Conference Solar Air-Conditioning in Palermo.

### WP B4: Method for fast pre design of successful projects

A check list method based on a series of questions with pre-defined answers has been elaborated and sent around. In this method technical, economical and organization issues are considered. In parallel a pre-design tool has been elaborated; the tool consists of a load generator which produces an annual load file based on hourly values and a pre-design computer tool. A first complete version of the tool was circulated to the participants of the working group for beta-testing.

### WP B5: Guidelines for installation and call for tender

A detailed commissioning list has been elaborated and will be included in the attachments of the handbook as well as the report. Further activities concerning the elaboration of tender guidelines are not possible within the Task because of missing resources.

## **3.3 Subtask C: Modeling and fundamental analysis**

### WP C1: State of the art – Survey on new solar cooling developments

Survey reports on the following technologies have been elaborated and will be compiled to a draft report within October 2009.

- Ammonia/water absorption technology
- LiBr/H<sub>2</sub>O absorption technology
- Solid desiccant technology

- Liquid desiccant technology
- Adsorption technology
- Thermo-mechanical chiller technology

#### WP C2: Simulation tools

Task work on simulation will be finished in 2009. A draft report was prepared and will be combined within a final report. The following topics are considered:

- developments of simulation tools
- proposal of a benchmarking
- modelling of an absorption chiller using TRNSYS
- modelling of desiccant cooling using SPARK
- modelling of the ECOS system using Modelica
- absorption chiller simulation exercise comparing different modelling tools
- desiccant cooling simulation exercise comparing different modelling tools

#### WP C3: Thermodynamic / Exergy analysis

Several reports on the following topics have been worked out so far and are available:

- Exergy of solar cooling
- Exergy analysis of a desiccant air handling unit
- Entropic analysis of a desiccant air handling unit
- Exergy analysis of two types of ammonia/water heat pumps
- Exergy analysis of the ECOS desiccant cycle based on detailed simulation results
- Fundamental article on exergy of solar radiation
- Second law analysis of a solar collector
- Article on the appropriate reference temperature (more general state) in exergy analysis

It has been decided that further information about the impact of operating conditions on exergy destruction of desiccant systems is necessary. Also therefore one more year is needed to elaborate the final report until the end of the Task.

#### WP C4: Performance Evaluation/Performance criteria

The application of the FSC method for solar cooling is done in the unified monitoring procedure within Subtask A and B. WP C4 is therefore completely covered by Subtasks A and B.

#### WP C5: Heat rejection

Different reports were prepared so far and will be merged in a final report on heat rejection. Results so far are:

- Collection of differences of different chiller configurations for a specific thermally driven cooling
- Report on hygienic aspects of small wet cooling towers
- Report on adiabatic pre-cooling with dry cooling towers
- Test results of heat rejection with a horizontal ground heat exchanger

The report and FORTRAN programs on design calculations of wet and dry cooling towers will be elaborated.



### 3.4 Subtask D: Market transfer activities

#### WP D1: Performance assessment

Has been merged with the performance assessment definitions within the general monitoring procedure of Subtasks A and B

#### WP D2 Certification and standardization schemes

no new results

#### WP D3: Life Cycle Analysis of Solar Cooling systems

no new results

#### WP D4: 2<sup>nd</sup> edition of the Solar Cooling Handbook for Planners

In a working group between the responsible authors a final version of the table of content has been agreed and presented at the expert meeting. The contract with the publishers is prepared for signature. Two detailed offers from publishers were available: Earthscan (former James & James) and Springer. At the meeting was decided to select Earthscan as publisher.

The Handbook consists of two major parts: a more theoretical part one on components and systems and part two focusing on system design and operation including experiences. A draft of part one will be finished within 2009.

#### WP D5: Dissemination of results

##### *WP D5.1 Policy paper*

At the 7<sup>th</sup> expert meeting the proposal of a policy paper, worked out by Raffaele Piria in collaboration with the OA and the Leader of Subtask D, has been presented and discussed in a separate workshop. The draft policy paper has been sent out to all participants for comments and feedback. It will be finished for the 66<sup>th</sup> ExCo meeting.

##### *WP D5.3 National industry workshops*

Various national workshops are foreseen for the last project year. They may be connected to other national events in appropriate way. One industry workshop has been planned which will be carried out in Orlando/Florida in conjunction with the ASHRAE trade-show in January 2010.

##### *WP D5.4 e-newsletter for the industry*

The preparation of the second e-newsletter has been shifted to early 2010.

### 3.5 Summary of achievements since last expert meeting

Subtask	Title
<b>Task 38 general</b>	Active participation at the 3 <sup>rd</sup> International Conference Solar Air-Conditioning, September 30 <sup>th</sup> to October 2 <sup>nd</sup> 2009 in Palermo (Italy)
<b>A</b>	Report on existing components for small scale solar cooling systems finished Sub-report on cold stores finished
	Monitoring of 13 installations of small size solar cooling systems is continued
	Presentation of monitoring results of three installations at the meeting.
	Revised version of the monitoring procedure
	Final draft of report on generic system concepts Presentation of content of final report on generic system concepts at the Task meeting in autumn 2009
	Questionnaire for end-user interviews was finalized. List of 122 existing small-scale solar heating and cooling systems was put together but will be expanded further. First 4 questionnaires were filled. An Excel-analysis tool for the questionnaires was set up.
<b>B</b>	Draft report on system design and control, with special focus on control issues of SAC systems has been elaborated and circulated
	Publication of results of 5 monitored systems at the SAC conference in Palermo
	Revised monitoring procedure successfully applied to monitored systems
	A check list method for fast pre design has been produced
	First executable of a computer-based pre-design tool produced. Beta-testing ongoing
	A detailed commissioning list has been elaborated
<b>C</b>	Survey reports on 6 different technologies elaborated and compilation to a complete report in progress
	Surveys on simulation of different technologies finished
	Simulation exercises for solid and liquid DEC technology finished.
	Various reports about exergy analysis finished
	Reports on heat rejection comprising different topics already prepared
<b>D</b>	First draft of policy paper available

<b>Subtask</b>	<b>Title</b>
	Presentation of the final table of contents of the new handbook at the expert meeting
	The contract with the publishers for the new handbook has been prepared for signature. Decision made on publisher Earthscan

### 3.6 Action items for the next period

Subtask	Title	Main responsible
A	A1: - Adding of section on high-flow and low-flow operation of collector field	AEE INTEC and TU Graz
	A1: - Final description of heat rejection technologies	DTI
	A1: - Send out report to all Task participants for proof reading last week of October 2009	AEE INTEC
	A1: - Final report will be prepared by next ExCo meeting in autumn 2009	AEE INTEC
	A2: - Send out report to all Task participants for proof reading last week of October 2009	ZAE Bayern
	A2: - Final report will be prepared by next ExCo meeting in autumn 2009	ZAE Bayern
	A3: - Preparation of report on monitored plants <ul style="list-style-type: none"> <li>o Preparation of an external report with anonymous data</li> <li>o Concept for the presentation of the monitoring results by end of 2009</li> </ul>	AEE INTEC
	A3: - Common report with Subtask B describing the monitoring procedure	AEE INTEC and EURAC
	A3: - Draft concept for comparison of monitoring results ready for the next meeting	AEE INTEC
	A5: - Interviews with end-users of small scale solar heating and cooling systems	AIT
	A5: - Preparation of draft report by December 2009	AIT
	A5: - Preparation of first results of the interviews by next meeting	AIT
B	B1: - Short overall report on the market overview will be elaborated and delivered before next ExCo meeting in autumn 2009	EURAC
	B2: - Final report will be prepared before next ExCo meeting in autumn 2009	AIT
	B3: - Adaption of the monitoring procedure to the discussed problems: reference of DEC-systems and CHP as thermal backup	AEE INTEC

<b>Subtask</b>	<b>Title</b>	<b>Main responsible</b>
	B3: - Final report will be elaborated until the end of the Task	AEE INTEC and EURAC
	B4: - Feedback on the check list method of TECSOL requested	all interested participants
	B4: - Report on the check list method will be finalized within 2009 until the end of the Task	TECSOL
	B5: - Final report on commissioning guideline within 2009	ILK Dresden
<b>C</b>	C1: - Final report of survey on new developments in solar air-conditioning will be prepared until end of October 2009	Uni Malta
	C2: - Final report on comparison of the simulation tools for DEC - Final report on comparison of the simulations for absorption chiller	Universite Savoie and Fraunhofer ISE
	C2: - Compilation of final reports before ExCo meeting in autumn 2009	Universite Savoie
	C3: - Draft report until next expert meeting - Final report on exergy analysis until the end of the Task	Uni Catania
	C5: - Final report until 2010	DTI
<b>D</b>	D4: - Signature of the contract with the publisher of the handbook (Earthscan)	POLIMI
	D5: - Feedback on draft policy paper	all interested participants
	D5: - Preparation of the 2 <sup>nd</sup> e-newsletter until next meeting presenting mainly monitoring results of operation in 2009	ISE

## 4 Task Time Plan and Milestones

The following bar charts reflect the current status of the Task with an updated time schedule according to the current work plan.

(Note: triangle for milestones and rhombus for deliverables)



**4.1 Subtask A: Pre-engineered systems for residential and small commercial applications**

	2006	2007				2008				2009				2010			
	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	Dec
A1: Market overview																	
Template for market survey of existing components		▲									▲						
Draft report on existing components													▶				
Overview of existing components finished													◆				
A2: Generic system concepts																	
Template for system concepts available					▲												
Draft report on generic system concepts													▶				
Final report on generic system concepts																	◆
A3: System monitoring																	
Template for report on monitoring and results																	
Draft report on monitored systems																	▶
Final report on monitored systems																	◆
A5: Installation and maintenance guidelines																	
Template for installation and maintenance guidelines																	
Draft report on installation and maintenance guidelines																	▶
Final report on installation and maintenance guidelines																	◆



### 4.2 Subtask B: Custom-made systems for large non-residential buildings and industrial applications

Timetable Subtask B	2006		2007				2008				2009			2010			
	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	Dec
<b>B1: Market Overview</b>																	
First List of installed solar cooling systems available			▲														
First List of thermally driven cooling machines and solar components available			▲														
Report market overview - supply side - available					◆								◆				
<b>B2: Selection of system design and control (Tim Selke, Marcus Jones)</b>																	
Detailed list of selected solar cooling system available				▲													
Results - system design / control best practice and frequent mistakes					△												
Preversion report - system design and control						▲											
Final version report - system design and control									◆				◆				
<b>B3: Monitoring of demo projects and evaluation procedure (Wolfram Sparber)</b>																	
List of plants being monitored			▲														
Presentation of unified monitoring procedure and first results					▲												
Presentation of further results and first optimizations						▲											
Presentation of results after 2nd (1st) summer																	
Delivery report: realised demo projects, monitoring results and evaluation procedure													◆				◆
<b>B4: Method for fast pre design of successful projects (Daniel Mugnier)</b>																	
Presentation of used tools for fast pre design					▲												
Sending of a pre Version of the tool to the partners - application / evaluation						▲											
Presentation of the results of application									▲								
Delivery: Tool and report - soft tool packages													◆				◆
<b>B5: Commissioning and call for tender guideline (Reiner Buchholz - Uwe Franzke)</b>																	
Presentation of first topics and guideline structure						▲											
Delivery pre version of single chapters									△				▲				
Delivery report: Commissioning guideline													◆				◆

Delays resulting during the task ...

**4.3 Subtask C: Modeling and fundamental analysis**

	2006	2007				2008				2009			2010		
	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	Mar	Jun	Sep
<b>C1 : Survey on new developments</b>															
Developments in solar cooling							▲								
New technologies developments											▲				
Draft report												▲			
Final report												▲			
<b>C2 : Simulation</b>															
Analysis of simulation tools for solar air conditioning				▲											
Propose a benchmark exercise							▲								
Comparison between tools								▲							
Validation with experimental facilities										▲					
Draft report												▲			
Final report												▲			
<b>C3 : Thermodynamic analysis</b>															
Prepare a data structure adapted to the exercise analysis			▲												
Get the experimental results								▲							
Comparative analysis of novel concepts using exergy analysis										▲					
Draft report													▲		
Final report															▲
<b>C4 : Performance criteria</b>															
FSC method					▲										
DEC system evaluation								▲							
Draft report														?	
Final report															?
<b>C5 : Heat rejection</b>															
Thermal drycoolers optimizations					▲										
Hygienic aspects										▲					
Draft report													▲		
Final report															▲

4.4 Subtask D: Market transfer activities

	2006	2007				2008				2009				2010		
	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep
<b>D2: Certification and standards schemes</b>																
Survey on certification issues, including safety								▲								
Certification and standards scheme report													◆			
<b>D3: Life Cycle Assessment</b>																
Selection of sample systems			▲													
Supplier and literature data gathering					▲											
Life Cycle Assessment report									◆							◆
<b>D4: Solar Air Conditioning Handbook, 2nd ed.</b>																
Draft version of 2nd ed.											▲					
Final version of 2nd ed.																◆
<b>D5: Dissemination activities</b>																
Policy paper																◆
Training materials									▲		▲					◆
Industry workshops																◆
E-newsletter								▲			◆		◆		◆	◆

## 5 Meeting schedule

### Expert meetings

Previous meetings		
<i>meeting #</i>	<i>place</i>	<i>date</i>
1 <sup>st</sup> expert meeting	Bolzano/Italy	October 19-20, 2006
2 <sup>nd</sup> expert meeting	Aix-les-Bains/France	April 23-24, 2007
3 <sup>rd</sup> expert meeting	Barcelona/Spain	October 15-17, 2007
4 <sup>th</sup> expert meeting	Vienna/Austria	April 1-2, 2008
5 <sup>th</sup> expert meeting	Lisbon/Portugal	October 6-7, 2008
6 <sup>th</sup> expert meeting	Freiburg/Germany	April 27–28, 2009
7 <sup>th</sup> expert meeting	Palermo/Italy	September 28–29, 2009

Future meetings		
<i>meeting #</i>	<i>place</i>	<i>date</i>
8 <sup>th</sup> expert meeting	Aarhus/Denmark	April 26–27, 2010
9 <sup>th</sup> expert meeting (final meeting)	Graz, Austria	September 27–28, 2010

### Task Workshops/Conferences

Previous workshops/conferences		
<i>meeting #</i>	<i>place</i>	<i>date</i>
Conference “Solar Air-Conditioning and Refrigeration”	Bolzano/Italy	October 18, 2006
Workshop “Solar Air-Conditioning and Refrigeration”	Aix-les-Bains /France	April 25, 2007
Workshop “Solar Air-Conditioning and Refrigeration”	Barcelona/Spain	October 15, 2007
Conference “Sustainable cooling systems – Part 1: Solar cooling”	Vienna/Austria	March 31, 2008
EUROSUN 2008	Lisbon/Portugal	October 7-10, 2008
Joint Workshop of Task 38 with IEA HPP Annex 34 “Thermally Driven Heat Pumps for Heating and Cooling”	Freiburg / Germany	April 29, 2009
3 <sup>rd</sup> International Conference Solar Air-Conditioning	Palermo/Italy	September 30 – October 2, 2009

Future activities		
<i>meeting #</i>	<i>place</i>	<i>date</i>
Task 38 workshop at the ASHRAE Trade Show	Orlando, Florida	January 2010
Active participation of Task experts at the EuroSun 2010	Graz, Austria	September 29 – October 1, 2010

## **6 Issues for the ExCo**

- Review of first Task deliverables

**Appendix A: Agenda of the 7<sup>th</sup> experts meeting in Palermo/Italy  
(September 28-29, 2009)**



## Task 38 Solar Air-Conditioning and Refrigeration

Agenda for the 7<sup>th</sup> expert meeting of

### **Task 38 „Solar Air-Conditioning and Refrigeration“**

September 28 - 29, 2009 in Palermo, ITALY

organised by University of Palermo, Dip. DREAM

Meeting Venue: **Polididattico:** edificio 19 Viale delle Scienze 9,  
90128 Palermo (see map)

#### **Monday, September 28, 1<sup>st</sup> day of Task 38 meeting**

- 08:30 – 09:00** Registration
- 09:00 – 13:00** Internal Workshop for Task 38 (Part 1)
- 13:00 – 14:30 Lunch time
- 14:30 – 15:30** Internal Workshop for Task 38 (Part 2)
- 16:00 – 17:30** Working groups (Part1)
- 17:30 – 18:30 Technical visit

#### **Tuesday, September 29, 2<sup>nd</sup> day of Task 38 meeting**

- 09:00 – 13:00** Working groups (Part 2 and 3)
- 13:00 – 14:30 Lunch time
- 14:30 – 16:30** Internal Workshop for Task 38 (Part 3)
- 17:00 – 18:00** Meeting summary

**Monday, September 28: 1<sup>st</sup> day of expert meeting**  
**Internal Workshop (chaired by Hans-Martin Henning)**

Time	Title	by	from
09:00	Welcome, Organisational issues	Marco Beccali	University of Palermo
09:15	Welcome, Introduction, IEA, Overview, Structure of the meeting	Hans-Martin Henning	Fraunhofer ISE
<b>Block 1 – Subtask A: Achievements, Reports etc.</b>			
09:30	Subtask A: Status report	Dagmar Jähnig	AEE Intec
09:45	Contents of final report on generic system concepts (A2)	Christian Schweigler	ZAE Bayern
10:00	Solar Cooling plant of SOLID - Detailed description and Level 3 Measurement results	Thomas Weissensteiner	Graz University of Technology
10:15	New monitoring results of solar heating and cooling system at ZAE, Garching	Martin Helm	ZAE Bayern
10:30	First monitoring results of Sortech system at MA 34 Vienna	Anita Preisler	AIT
<b>10:45 – 11:15 Coffee break</b>			
<b>Block 2 – Subtask B: Achievements, Reports etc.</b>			
11:15	Subtask B: Status report	Wolfram Sparber	EURAC research
11:30	Presentation of the updates of the Task 38 Monitoring Procedure	Alexander Thür	AEE Intec
11:45	Presentation of the final report on control strategies (for small and large scale systems)	Marcus Jones	AIT
<b>Block 3 – Subtask C: Achievements, Reports etc.</b>			
12:00	Subtask C: Status report	Etienne Wurtz	INES
12:15	Hygienic aspects of small wet cooling towers	Erich Podesser	AEE Intec
12:30	State of the art - A survey on new solar cooling developments	Robert Ghirlando	University of Malta
12:45	Development of a commercial software tool for Solar Air Conditioning systems based on TRNSYS simulation engine	Ignasi Gurruchaga	Aiguasol
<b>13:00 – 14:30 Lunch break</b>			
<b>Block 4 – Subtask D: Achievements, Reports etc.</b>			
14:30	Subtask D: Status report	Mario Motta	POLIMI
<b>Block 5 – Additional presentations</b>			
15:00	Benchtest procedure for adsorption chillers and life cycle analysis of Sortech chiller	Cathérine Hildbrand	HEIG-VD
15:15	The Australian Solar Cooling Initiative. An update on solar cooling in Australia	Paul Kohlenbach	Solem Consulting
<b>15:30 – 16:00 Coffee break</b>			
<b>Working groups – part 1</b>			
<b>Time: 16:00 – 17:30</b>			
<b>Aula 11</b>	<b>Aula 12</b>	<b>Aula Seminari B</b>	<b>Aula Seminari C</b>
Generic solar combi-plus-systems + design of hot side subsystem	Commissioning guidelines	Performance criteria and exergetic analysis	Pre-Design
Christian Schweigler, ZAE Bayern and Dagmar Jähnig, AEE INTEC	Uwe Franzke, ILK Dresden	Luigi Marletta, Uni Catania	Hans-Martin Henning and Tomas Núñez, Fraunhofer ISE, Daniel Mugnier, Tecsol
<b>17:30 – 18:30 Technical visit of the DEC-System at DREAM</b>			
<b>20:30</b>	<b>Task 38 –Dinner</b>		



## Tuesday, September 29: 2<sup>nd</sup> day of expert meeting

### Working groups part 2

Time: 9:00 – 10:45

Aula 11	Aula 12	Aula Seminari B	Aula Seminari C
Subtask A and B- Monitoring – results and evaluation	Heat rejection	Control of systems	Absorption: Simulation and modelling
Alexander Thür, AEE Intec and Wolfram Sparber, EURAC	Lars Reinholdt, Teknologisk Institute	Marcus Jones, AIT	Constanze Bongs, Fraunhofer ISE

10:45 – 11:15

*Coffee break*

### Working groups part 3

Time: 11:15 – 13:00

Aula 11	Aula 12		
2 <sup>nd</sup> Version of Handbook for Planners	Installation and maintenance guidelines for pre-engineered systems		
Mario Motta, POLIMI and Hans-Martin Henning, Fraunhofer ISE	Anita Preisler, AIT		

13:00 – 14:30

*Lunch break*

### Internal workshop

14:30 – 16:30

*Workshop: the Task 38 Policy Paper*

Mario Motta, POLIMI;  
Hans-Martin Henning, Fraunhofer ISE  
Raffaele Piria, Eclareon

16:30 – 17:00

*Coffee break*

### Block 6 – Summary

17:00	Subtask D	Mario Motta	Polimi
17:15	Subtask C	Etienne Wurtz	INES
17:30	Subtask B	Wolfram Sparber	EURAC
17:45	Subtask A	Dagmar Jähnig	AEE Intec
18:00	Summary of meeting	Hans-Martin Henning	Fraunhofer ISE
18:10	<b>Official end of meeting</b>		



## Task 38 Solar Air-Conditioning and Refrigeration

7

### Semi-Annual Status Report

to be presented at the 67<sup>th</sup> ExCo meeting  
June 21-24, 2010, San Francisco, USA

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- 6 Issues for the Executive Committee

# 1 Short description of Task 38

## 1.1 Task Objectives

The main objective of the Task is the implementation of measures for an accelerated market introduction of solar air conditioning and refrigeration with focus on improved components and system concepts. The market introduction will be supported through

- activities in development and testing of cooling equipment for the residential and small commercial sector;
- development of pre-engineered system concepts for small and medium size systems and development of optimized and standardized schemes for custom made systems;
- reports on the experiences with new pilot and demonstration plants and on the evaluation and performance assessment procedure;
- provision of accompanying documents supporting the planning, installation and commissioning of solar cooling plants;
- analysis of novel concepts and technologies with special emphasis on thermodynamic principles and a bibliographic review;
- performance comparison of available simulation tools and applicability for planning and system analysis;
- market transfer and market stimulation activities, which include information letters, workshops and training material as well as the 2nd edition of the Handbook for Solar Cooling for Planners.

## 1.2 Scope

The scope of the Task are the technologies for production of cold water or conditioned air by means of solar heat, i.e., the subject which is covered by the Task starts with the solar radiation reaching the collector and ends with the chilled water and/or conditioned air transferred to the application. However, although the distribution system, the building and the interaction of both with the technical equipment are not the main topic of the Task this interaction will be considered where necessary. In particular, for small scale systems which may use the solar collector as the only heat source the overall system including the building and its thermal mass is focused in order to optimize the overall performance. The Task also covers solar refrigeration for other than comfort air-conditioning applications such as industrial processes and other applications (e.g. food conservation).

## 1.3 Means

The work in this Task is organized in four Subtasks:

- Subtask A: Pre-engineered systems for residential and small commercial applications
- Subtask B: Custom-made systems for large non-residential buildings and industrial applications
- Subtask C: Modeling and fundamental analysis
- Subtask D: Market transfer activities

Each Subtask consists of several work packages with specific focus and results.

## 1.4 Duration

Start date: September 1, 2006

Completion date: December 31, 2010

## 2 Status of participation

Participating countries are: Australia, Austria,, Canada, Denmark, France, Germany, Italy, Mexico, Portugal, Spain, Sweden and Switzerland.

Still missing is the National Participation letter from Mexico.

The responsible persons for Subtask leadership in Task 38 are:

- Subtask A: Dagmar Jähnig (AEE INTEC, Austria)
- Subtask B: Wolfram Sparber (EURAC research, Italy)
- Subtask C: Etienne Wurtz (INES; France)
- Subtask D: Mario Motta (Politechnico di Milano, Italy)

During the 8<sup>th</sup> expert meeting held in Aarhus/Denmark 39 experts from the following countries participated: Austria, Denmark, France, Germany, Italy, Portugal, Spain, Switzerland and USA. Almost 25 % of experts participating in the meeting came from companies. Some experts had troubles to attend the meeting due to transport problems (vulcano eruptions in Island).

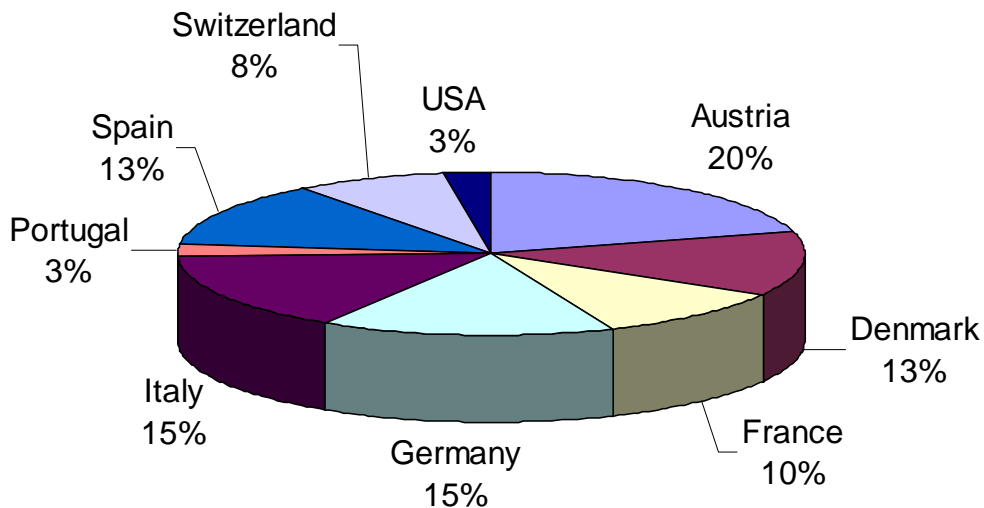


Fig. 1: Distribution of participants at the 8<sup>th</sup> expert meeting per countries

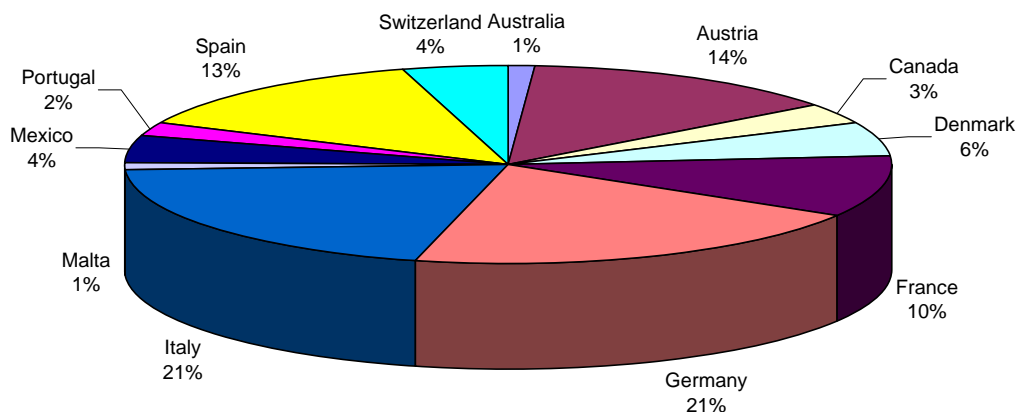


Fig. 2: Distribution of participants in the Task per countries (status May 2008)



Fig 3: Most of the participants of the 8<sup>th</sup> expert meeting in Aarhus

### 3 Progress since last status report

Matters concerning the whole task are:

- A Task 38 workshop has been held at the ASHRAE Trade Show in Orlando/Florida on January 27.
- The 8<sup>th</sup> expert meeting was held on April 26 to 27 in Aarhus/Denmark, hosted by the Danish Technological Institute DTI. 39 experts attended the meeting (see Figure above) at which the intermediate results were presented and further work steps planned. (Agenda attached at the end of this document)
- In the afternoon of the first day and the morning of the second day of the expert meeting different topics were discussed in working groups. The results of these discussions were fixed in action item lists prepared by the subtask leaders and distributed to the task participants as timetable for the next steps.
- After the expert meeting on April 28 the public workshop "Solar driven cooling and air-conditioning in a Danish and worldwide perspective" has been held at the School of Architecture, Aarhus, and was organized by DTI, Danvak Solenergi and IDA Danvak. Presentations at the workshop were given by local experts and Task 38 experts.

#### 3.1 Subtask A: Pre-engineered systems for residential and small commercial applications

##### WP A1: Market Overview

The market overview comprises existing components and ongoing developments suitable for combined systems for heating and cooling with chilled water systems having cooling capacities less than 20 kW.

The final report on market overview has been finished and submitted to the ExCo. The report comprises the following topics: Chillers, heat rejection, cold stores and Solar Combisystems.

##### WP A2: Generic Systems

In this Work Package technical options, comprising the topics: driving heat, heat rejection, useful cooling and hydraulics, are considered as the basis for the definition of generic systems. In the report the new modular way of drawing system schemes for the 3 main components (hot side subsystem, cold side subsystem and heat rejection) of the solar-combi-plus-systems is applied.

The final report on the generic systems has been finished and submitted to the ExCo.

##### WP A3: Monitoring

The monitoring activities are progressing and the list of systems in the monitoring program has been updated again. Overall 12 systems are in operation and monitoring data have been filled in the Task 38 – Monitoring Excel Tool.

A template for the common report describing the monitoring procedure (Subtask A and B: A3a+B3a) has been elaborated and sent out to the responsible partners for some updates. The report includes a template for a short description of monitored plants (similar to descriptions of system that were already made for the EU project SOLAIR plus some facts about monitoring).

##### WP A4: Evaluation procedures

The work on evaluation procedures is involved within the monitoring procedure developed in Subtask A and B. This also comprises the work, originally foreseen within Subtask C4 and it is therefore moved to Subtask C.

#### WP A5: Installation and maintenance guidelines

Experiences with existing systems will be summarized in guidelines for installation and maintenance for pre-engineered systems. Results will also contribute to the Handbook of Subtask D.

A list of small-scale installations was set up including more than 150 systems worldwide. It was integrated into the Subtask B market overview. Based on the questionnaire for end-users elaborated at the last meeting up to now 16 interviews took place. So far the interviews were carried out with end-users or plant operators in 6 different countries and represent 7 application types.

### **3.2 Subtask B: Custom-made systems for large non-residential buildings and industrial applications**

#### WP B1: Market overview

The final report has been finished and submitted to the ExCo.

Based on the overview of world wide installed solar heating and cooling systems a more detailed discussion of hydraulic schemes has been done on the base of 20 systems. This results in a publication for the Eurosun 2010.

The main information has been further elaborated for the Handbook chapter 11.

#### WP B2: Selection of system design and control

Decision to focus on the control issues of SAC systems. The final report has been finished and submitted to the ExCo.

The control issues were analyzed and discussed on the base of installed systems and information delivered by the Task 38 participants. Using this input the subchapter for the handbook is under elaboration. Also a publication for the Eurosun 2010 has been prepared.

#### WP B3: Monitoring of demo projects and proposal for evaluation procedures

The version 5.8 of the monitoring procedure has just been sent out to all Task participants, main changes were made in the calculation of DEC systems. A text document where the procedure will be explained and the monitored systems are presented is under elaboration. Very probably detailed data of 10 systems will be available in autumn 2010. The main results will be presented in a subchapter of the chapter 11 of the handbook and also the report is planned to be ready in autumn 2010.

#### WP B4: Method for fast pre-design of successful projects

A check list method based on a series of questions with pre-defined answers has been elaborated. The checklist is in form of an excel file and considers technical, economical and organizational issues. A near to final version is available.

In parallel a pre-design tool has been elaborated. A first version of the tool has been circulated to the participants of the working group.

A short report and a final version of the checklist is expected to be delivered within June 2010 and shall be part of the Annex of the handbook.

#### WP B5: Guidelines for installation and call for tender

A detailed commissioning list has been elaborated in form of an excel document following the different areas of a SHC system. A complete draft of a written report is available explaining commissioning as a whole process and delivering various further information and links. The delivery of the final version of the report and the excel file is expected for June 2010. It is planned to include both outcomes in the annex of the handbook.

### **3.3 Subtask C: Modeling and fundamental analysis**

#### WP C1: State of the art – Survey on new solar cooling developments

The final report comprising the following technologies has been finished and submitted to the ExCo.

- Ammonia/water absorption technology
- LiBr/H<sub>2</sub>O absorption technology
- Solid desiccant technology
- Liquid desiccant technology
- Adsorption technology
- Thermo-mechanical chiller technology

#### WP C2: Simulation tools

Two reports on the following topics have been finished and submitted to the ExCo:

- Description of simulation tools used in solar cooling - New developments in simulation tools and models and their validation (Solid desiccant cooling, Absorption chiller)
- Benchmarks for comparison of system simulation tools – Absorption chiller simulation comparison

#### WP C3: Thermodynamic / Exergy analysis

Several partial reports on the following topics were compiled to a final report. A draft of the final review is recently reviewed and will be ready for approval in summer 2010.

- Exergy of solar cooling
- Exergy analysis of a desiccant air handling unit
- Entropic analysis of a desiccant air handling unit
- Exergy analysis of two types of ammonia/water heat pumps
- Exergy analysis of the ECOS desiccant cycle using the simulation results
- Fundamental article on exergy of solar radiation
- Second law analysis of a solar collector
- Article on how to take the external temperature in exergy analysis

#### WP C4: Performance Evaluation/Performance criteria

The application of the FSC method for solar cooling is done in the unified monitoring procedure within Subtask A and B.

#### WP C5: Heat rejection

Different reports and results have been prepared so far and will be merged in a final report on heat rejection technologies.

Results so far:

- Collection of differences of different chiller configurations for a specific thermally driven cooling
- Report on hygienic aspects of small wet cooling towers



- Report on adiabatic pre-cooling with dry cooling towers
- Test results of heat rejection with a horizontal ground heat exchanger

### 3.4 Subtask D: Market transfer activities

#### WP D3: LCA (Life Cycle Analysis)

The activities on the definition of a common methodology, the data collection on the main components of the reference systems, the development of a common LCA methodology have been completed. The final draft of the database of conventional and solar driven systems is available as well as preliminary results of the LCA.

#### WP D4: 2<sup>nd</sup> edition of the Solar Cooling Handbook for Planners

A final version template for the table of contents of the handbook has been agreed and the negotiation with the publishers has been worked out. The writing up of the handbook will be realized in two phases. The first part (basics, component description, theory) is almost completed. The second part is in production and will be finished only after finalizing the monitoring of summer 2010 results of the monitoring activities of summer 2010 will be included.

#### WP D5: Dissemination of results

##### *WP D5.1 Policy paper*

With the help of the senior consultant Raffaele Piria (Eclareon, Vice president of ESTIF) a concept of the policy paper "Towards a policy strategy for Solar Assisted Cooling" has been developed. The draft was sent around, few feedbacks were received but end of 2009 a final draft was released and uploaded. Because of the need for a position paper on the topic a draft version has been worked out, also using the experiences from the policy paper. The position paper will be completed in summer 2010.

##### *WP D5.2 Training Material*

The final version of the training material, available in four languages, has been released and uploaded to the internal Task 38 website. The final outcomes of the Task activities will be implemented in the material by the end of the task.

##### *WP D5.3 National industry workshops*

As decided during the expert meeting in Palermo the national industry workshops will be held in the last year of work of the Task aiming at presenting the results of the several activities to various stakeholders. The workshops do not have to be organized specifically for Task 38, but can be joined with other similar initiatives. In these cases, the events will be organised in order to guarantee a "window" where to address the above mentioned stakeholders, presenting them the Task results.

##### *WP D5.4 Semi-annual e-newsletter for the industry*

The preparation of the second e-newsletter has been postponed to mid/autumn 2010 because it is planned to present monitoring data and results from operation 2010.

### 3.5 Summary of achievements since last expert meeting

Subtask	Title
<b>Task 38 general</b>	“Solar Cooling and Air-Conditioning” workshop at ASHRAE Trade Fair organized by the Canadian Task experts. More than 120 professionals attended the workshop. Several speakers from Task 38 and US industries and R&D.
	On April 28 the public workshop “Solar driven cooling and air-conditioning in a Danish and worldwide perspective” has been held at the School of Architecture Aarhus (Denmark). Presentations at the workshop were given beside local experts mainly by Task 38 experts.
<b>A</b>	The final report on market overview has been finished and submitted to the ExCo. The report comprises the following topics: Chillers, heat rejection, cold stores and Solar Combisystems.
	The final report on the generic systems has been finished and submitted to the ExCo.
	The monitoring activities are progressing and the list of systems in the monitoring program has been updated again. Overall 12 systems are in operation and monitoring data has been filled in the Task 38 – Monitoring Excel Tool. A template for the common report describing the monitoring procedure (Subtask A and B: A3a+B3a) has been elaborated and sent out to the responsible partners
	A list of small-scale installations was set up including more than 150 systems worldwide. It was integrated into the subtask B market overview. Based on the questionnaire for end-users elaborated at the last meeting up to now 16 interviews took place.
<b>B</b>	The final report on the market overview has been finished and submitted to the ExCo. Based on the overview of world wide installed solar heating and cooling systems a more detailed discussion of hydraulic schemes has been done and a publication for the Eurosun 2010 has been prepared.
	The final report on the selection of system design and control with special focus on the control issues has been finished and submitted to the ExCo.
	The latest monitoring procedure has already been successfully applied to monitored systems. The main results of the monitoring are prepared to be presented in a subchapter of the chapter 11 of the handbook and also the report is planned to be ready in autumn 2010.
	A check list method for fast pre design has been produced and presented. A short report and a final version of the checklist are expected to be delivered within June 2010 and should be part of the Annex of the handbook.
	A user-guideline for the pre-design has been written and circulated to Task experts for review.

<b>Subtask</b>	<b>Title</b>
	A detailed commissioning list has been elaborated and a final draft of a written report is available.
<b>C</b>	The final report on 6 different technologies has been finished and submitted to the ExCo.
	Two reports on the following topics have been finished and submitted to the ExCo:  Description of simulation tools used in solar cooling - New developments in simulation tools and models and their validation  Benchmarks for comparison of system simulation tools – Absorption chiller simulation comparison
	Several partial reports on thermodynamic and exergetic analysis where compiled to a final report.
	Different reports and results have been prepared to be merged in a final report on heat rejection technologies.
<b>D</b>	The final draft of the database of conventional and solar driven systems is available as well as preliminary results of the LCA.
	A final version template for the table of contents of the handbook has been agreed and the negotiation with the publishers has been worked out.
	A final draft of the policy paper “Towards a policy strategy for Solar Assisted Cooling” was released and uploaded. Furthermore a draft version of a position paper has been prepared.
	The final version of the training material, available in four languages, has been released and uploaded to the internal Task 38 website.

### 3.6 Action items for the next period

<b>Subtask</b>	<b>Title</b>	<b>Main responsible</b>
<b>A</b>	A3: - Verify SPF for conventional systems again. Also cross check with the ISE pre-design tool! Decision at the next meeting (September 2010) at the latest.	AEE INTEC
	A3: - Systems where only the solar part of space heating consumption is being measured: Check for possibilities get data for the backup for space heating and the total space heating consumption.	AEE INTEC
	A3: - Send filled Excel-sheets for field test monitoring to the responsible of each system - Check and correct data, improve systems for summer operation 2010.	AEE INTEC Responsible partner

<b>Subtask</b>	<b>Title</b>	<b>Main responsible</b>
	A3: - Update common report with Subtask B (A3a+B3a) describing the monitoring procedure	EURAC
	A3: - Send short descriptions of each system to AEE INTEC by May 17, 2010 (including the monitoring scheme (PPT file) for each system). - AEE INTEC sends out template for long monitoring reports to everybody by the End of May - Everybody sends long monitoring reports to AEE INTEC when monitoring has finished (end of cooling season 2010) - Final comparison concept will be discussed at the Graz meeting when most of the cooling season data of 2010 is available.	all partners  AEE INTEC  all partners  AEE INTEC
	A5: - Conduct a few more interviews with end-users of small scale solar heating and cooling systems until end of July - Conduct interviews with package solution providers until end of July	
	A5: - Preparation of draft report by next meeting	AIT
	A5: - Work on handbook chapter 10 in August and September 2010	AIT INTEC
<b>B</b>	B2: - Preparation of the investigation of "Hydraulic schemes and control strategies" as part of the chapter 11 of the handbook	AIT
	B3: - Preparation of final report on detailed described monitoring procedure by October 2010, circulation of a draft version before end of summer	EURAC
	B4: - Upload of the check list method tool on the website of TECSOL in summer 2010	TECSOL
	B4: - Thermally driven chiller tool: preparation of guidelines by end of Task	TECSOL
	B4: - Draft report on cost curves (ROCOCO) by end of June	TECSOL
	B5: - Preparation of final report on commissioning guidelines by June 2010	ILK Dresden
<b>C</b>	C1: - Include feedback from ExCo as well as contributions from Spanish partners in final report	Uni Malta
	C1: - Collection of TRNSYS types, preparation of index	Universite Savoie

<b>Subtask</b>	<b>Title</b>	<b>Main responsible</b>
	C2: - Preparation of final report on comparison of the simulation tools for DEC	Universite Savoie
	C5: - Preparation of final report	DTI
<b>D</b>	D3: - Complete simulation campaign on LCA of Solar Cooling systems by Summer 2010 - Final report on LCA by September 2010	DREAM
	D4: - Final TOC with all the suggestions/changes will be sent out - Finalize negotiation with publishers for Solar Air-Conditioning and refrigeration Handbook - Follow the work of Part II within mid summer 2010	POLIMI, ISE
	D5: - Results of position paper workgroup with comments will be implemented in a new document by June 2010 - Preparation of position paper by June 2010 for presentation to ExCo-Meeting	POLIMI, ISE
	D5: - Preparation of the 2 <sup>nd</sup> e-newsletter (Eurosun issue) by summer/autumn 2010 including system monitoring results of operation 2009	ISE
	D5: - Organisation of National industry workshops	all interested participants

## 4 Task Time Plan and Milestones

The following bar charts reflect the current status of the Task with an updated time schedule according to the current work plan.

(Note: triangle for milestones and rhombus for deliverables)



**4.1 Subtask A: Pre-engineered systems for residential and small commercial applications**

	2006	2007				2008				2009				2010			
	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	Dec
A1: Market overview																	
Template for market survey of existing components		▲															
Draft report on existing components										→	▲						
Overview of existing components finished													◆				
A2: Generic system concepts																	
Template for system concepts available					▲												
Draft report on generic system concepts										→	▲						
Final report on generic system concepts													◆				
A3: System monitoring																	
Template for report on monitoring and results										→	▲						
Draft report on monitored systems																	→
Final report on monitored systems																	◆
A5: Installation and maintenance guidelines																	
Template for installation and maintenance guidelines									→	▲							
Draft report on installation and maintenance guidelines													→	▲			
Final report on installation and maintenance guidelines																	◆



**Subtask B: Custom-made systems for large non-residential buildings and industrial applications**

Timetable Subtask B	2006		2007				2008				2009			2010				
	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	Dec	
<b>B1: Market Overview</b>																		
First List of installed solar cooling systems available			▲															
First List of thermally driven cooling machines and solar components available			▲															
Report market overview - supply side - available					◆							◆						
<b>B2: Selection of system design and control (Tim Selke, Marcus Jones)</b>																		
Detailed list of selected solar cooling system available				▲														
Results - system design / control best practice and frequent mistakes					△		▲											
Preversion report - system design and control							▲											
Final version report - system design and control									◆			◆						
<b>B3: Monitoring of demo projects and evaluation procedure (Wolfram Sparber)</b>																		
List of plants being monitored			▲															
Presentation of unified monitoring procedure and first results					▲													
Presentation of further results and first optimizations							▲											
Presentation of results after 2nd (1st) summer									▲									
Delivery report: realised demo projects, monitoring results and evaluation procedure												◆					◆	
<b>B4: Method for fast pre design of successful projects (Daniel Mugnier)</b>																		
Presentation of used tools for fast pre design					▲													
Sending of a pre Version of the tool to the partners - application / evaluation							▲											
Presentation of the results of application									▲									
Delivery: Tool and report - soft tool packages												◆					◆	
<b>B5: Commissioning and call for tender guideline (Reiner Buchholz - Uwe Franzke)</b>																		
Presentation of first topics and guideline structure							▲											
Delivery pre version of single chapters									△			▲						
Delivery report: Commissioning guideline												◆					◆	

Delays resulting during the task ...

**4.2 Subtask C: Modeling and fundamental analysis**

	2006	2007				2008				2009			2010		
	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	Mar	Jun	Sep
<b>C1 : Survey on new developments</b>															
Developments in solar cooling						▲									
New technologies developments											▲				
Draft report											▲				
Final report												▲			
<b>C2 : Simulation</b>															
Analysis of simulation tools for solar air conditioning			▲												
Propose a benchmark exercise							▲								
Comparison between tools								▲							
Validation with experimental facilities										▲					
Draft report											▲				
Final report												▲			
<b>C3 : Thermodynamic analysis</b>															
Prepare a data structure adapted to the exercise analysis		▲													
Get the experimental results								▲							
Comparative analysis of novel concepts using exergy analysis											▲				
Draft report													▲		
Final report															▲
<b>C4 : Heat rejection</b>															
Thermal dry coolers optimizations					▲										
Hygienic aspects											▲				
Draft report													▲		
Final report														▲	

4.3 Subtask D: Market transfer activities

	2006	2007				2008				2009				2010			
	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	Dec	Mar	Jun	Sep	
<b>D3: Life Cycle Assessment</b>																	
Selection of sample systems			▲														
Supplier and literature data gathering					▲												
Final draft of Database of conventional and SAC													▲				
Life Cycle Assessment report																◆	
<b>D4: Solar Air Conditioning Handbook, 2nd ed.</b>																	
TOC Draft version of 2nd ed.																	
First draft 2nd ed. HB Part 1													▲				
Final version of 2nd ed. Part 1														▲			
Final version of 2nd ed.																◆	
<b>D5: Dissemination activities</b>																	
Policy paper														▲			◆
Training materials																	◆
Industry workshops					◆												◆
E-newsletter											◆		◆			◆	◆

## 5 Meeting schedule

### Expert meetings

<b>Previous meetings</b>		
<b><i>meeting</i></b>	<b><i>place</i></b>	<b><i>date</i></b>
1 <sup>st</sup> expert meeting	Bolzano/Italy	October 19-20, 2006
2 <sup>nd</sup> expert meeting	Aix-les-Bains/France	April 23-24, 2007
3 <sup>rd</sup> expert meeting	Barcelona/Spain	October 15-17, 2007
4 <sup>th</sup> expert meeting	Vienna/Austria	April 1 <sup>st</sup> -2 <sup>nd</sup> , 2008
5 <sup>th</sup> expert meeting	Lisbon/Portugal	October 6-7, 2008
6 <sup>th</sup> expert meeting	Freiburg/Germany	April 27 – 28, 2009
7 <sup>th</sup> expert meeting	Palermo/Italy	September 28 – 29, 2009
8 <sup>th</sup> expert meeting	Aarhus/Denmark	April 26 – 27, 2010

<b>Future meetings</b>		
<b><i>meeting</i></b>	<b><i>place</i></b>	<b><i>date</i></b>
9 <sup>th</sup> expert meeting (last meeting)	Graz, Austria	September 27 – 28, 2010

**Task Workshops/Conferences****Previous workshops/conferences**

<i>meeting</i>	<i>place</i>	<i>date</i>
Conference "Solar Air-Conditioning and Refrigeration"	Bolzano/Italy	October 18, 2006
Workshop "Solar Air-Conditioning and Refrigeration"	Aix-les-Bains /France	April 25, 2007
Workshop "Solar Air-Conditioning and Refrigeration"	Barcelona/Spain	October 15, 2007
Conference "Sustainable cooling systems – Part 1: Solar cooling"	Vienna/Austria	March 31, 2008
EUROSUN 2008	Lisbon/Portugal	October 7-10, 2008
Joint Workshop of Task 38 with IEA HPP Annex 34 "Thermally Driven Heat Pumps for Heating and Cooling"	Freiburg / Germany	April 29, 2009
3 <sup>rd</sup> International Conference Solar Air-Conditioning	Palermo/Italy	September 30 – October 2, 2009
Task 38 workshop at the ASHRAE Trade Show	Orlando, Florida	January 2010
Public workshop "Solar driven cooling and air-conditioning in a Danish and worldwide perspective"	Aarhus/Denmark	April 28, 2010

**Future activities**

<i>meeting #</i>	<i>place</i>	<i>date</i>
Active participation of Task experts at the EuroSun 2010	Graz, Austria	September 29 – October 1, 2010

## **6 Issues for the ExCo**

No specific issues for the ExCo.

**Appendix A: Agenda of the 4<sup>th</sup> experts meeting**



## Task 38 Solar Air-Conditioning and Refrigeration

Agenda for the 8<sup>th</sup> expert meeting of

### **Task 38 „Solar Air-Conditioning and Refrigeration“**

April 26 - 27, 2010 in Aarhus, DENMARK

organised by Danish Technological Institute DTI

Meeting Venue: Danish Technological Institute - Main Building  
Kongsvang Allé 29  
8000 Aarhus C  
Denmark

#### **Sunday, April 25, 19:00 h, Informal get-together + buffet**

**Meeting point: Radisson BLU Hotel, Margrethepladsen 1, 8000 Aarhus C**

**Restaurant: “Musikhuset”, Thomas Jensens Allé 2, 8000 Aarhus C**

#### **Monday, April 26, 1<sup>st</sup> day of Task 38 meeting**

**08:30 – 09:00 Registration**

**09:00 – 12:15 Internal Workshop for Task 38 (Part 1)**

12:15 – 13:30 Lunch time

**13:30 – 15:00 Internal Workshop for Task 38 (Part 2)**

**15:30 – 17:00 Working groups (Part1)**

17:15 – 18:15 Technical visit

#### **Tuesday, April 27, 2<sup>nd</sup> day of Task 38 meeting**

**09:00 – 12:15 Working groups (Part 2 and 3)**

12:15 – 13:30 Lunch time

**13:30 – 15:15 Internal Workshop for Task 38 (Part 3)**

**15:45 – 17:00 Meeting summary**



**Monday, April 26: 1<sup>st</sup> day of expert meeting  
Internal Workshop (chaired by Hans-Martin Henning)**

<b>Time</b>	<b>Title</b>	<b>by</b>	<b>from</b>
09:00	Welcome, Organisational issues	Hanne Christoffersen	DTI
09:15	Welcome, Introduction, IEA, Overview, Structure of the meeting	Hans-Martin Henning	Fraunhofer ISE
<b>Block 1 – Subtask A: Achievements, Reports etc. (part 1)</b>			
09:30	Subtask A: Status report	Dagmar Jähnig	AEE Intec
09:45	SolarCombi+ Final results	Assunta Napolitano	EURAC
10:00	Comparing different sinks of heat rejection of an existing solar powered absorption cooling system	Fernando Palacin	CENER
<b>10:15 – 10:45 Coffee break</b>			
<b>Block 1 – Subtask A: Achievements, Reports etc. (part 2)</b>			
10:45	Experiences with two small scale installations in Solarthermie 2000plus - Technical College for Engineering in Butzbach and Radiological Practice in Berlin	Alexander Morgenstern	Fraunhofer ISE
11:00	Monitoring results of two solar air-conditioning systems in France	Romain Siré	TECSOL
<b>Block 2 – Subtask B: Achievements, Reports etc. (part 1)</b>			
11:15	Subtask B: Status report	Assunta Napolitano	EURAC
11:30	Skive Town Hall – measurements and control strategy	Ebbe Münster	PlanEnergi
11:45	Townhall and Service Center Gleisdorf - Monitoring results	Alexander Thür	AEE Intec
12:00	Monitoring results of Energybase	Anita Preisler	AIT
<b>12:15 – 13:30 Lunch break</b>			
<b>Block 3 – Subtask C: Achievements, Reports etc.</b>			
13:30	Subtask C: Status report	Paul Boudoukan	INES
13:45	Innovative evaporative cooling tower	Bjarke Paaske	DTI
14:00	Last advances in air-cooled LiBr/water absorption machines	Daniel Marcos	Universidad Carlos III de Madrid
<b>Block 4 – Subtask D: Achievements, Reports etc.</b>			
14:15	Subtask D: Status report	Mario Motta	POLIMI
14:30	Life Cycle Analysis of Solar Cooling systems: final results	Marco Beccali	DREAM
14:45	Solar cooling economics and subsidy schemes	Amandine Le Denn	TECSOL
<b>15:00 – 15:30 Coffee break</b>			
<b>Working groups – part 1</b>			
<b>Time: 15:30 – 17:00</b>			
<b>Conference room (No. 512)</b>	<b>Room No. 502</b>	<b>Room No. 504</b>	<b>Room No. 509</b>
Subtask A Monitoring – results and evaluation	Solar Cooling Position Paper		
Alexander Thür and Dagmar Jähnig, AEE Intec	Hans-Martin Henning, Fraunhofer ISE		
<b>17:15 – 18:15 Technical visit</b>			
		Klaus Rosenkilde	DTI
<b>19:30</b>	<b>Task 38 –Dinner at “Sjette Frederiks Kro” (Salonvejen 1, 8240 Risskov), <a href="http://www.sjettefrederikskro.dk">www.sjettefrederikskro.dk</a></b>		

## Tuesday, April 27: 2<sup>nd</sup> day of expert meeting

### Working groups part 2 Time: 9:00 – 10:30

Conference room (No. 512)	Room No. 502	Room No. 504	Room No. 509
Hydraulic schemes and control of systems – Inputs for handbook	LCA	Pre-Design – Status report	
Assunta Napolitano, EURAC and Marcus Jones, AIT	Marco Beccali, DREAM	Hans-Martin Henning / Daniel Mugnier	

### 10:30 – 10:45 *Coffee break*

### Working groups part 3 Time: 10:45 – 12:15

Conference room (No. 512)	Room No. 502	Room No. 504	Room No. 509
Subtask B - Monitoring results – Inputs for handbook	Installation and maintenance guidelines for pre-engineered systems		
Assunta Napolitano, EURAC	Anita Preisler, AIT		

### 12:15 – 13:30 *Lunch break*

### Additional presentations

13:30	Thermal cooling, PV compression cooling and pure compression cooling - an economic comparison.	Wolfgang Streicher	TU Graz
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### Handbook

13:45	2 <sup>nd</sup> Version of Handbook for Planners	Mario Motta, POLIMI and Hans-Martin Henning, Fraunhofer ISE	
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### 15:15 – 15:45 *Coffee break*

### Block 6 – Summary

15:45	Subtask C	Paul Bourdoukan	INES
16:00	Subtask B	Assunta Napolitano	EURAC
16:15	Subtask A	Dagmar Jähnig	AEE Intec
16:30	Subtask D	Mario Motta	Polimi
16:45	Summary of meeting	Hans-Martin Henning	Fraunhofer ISE

### *End of meeting*

Telephone Interview   
 Personal Interview   
 Filled in by plant owner

To  
 Organisation: AIT - Austrian Institute of Technology  
 Person: Anita Preisler  
 e-mail: anita.preisler@ait.ac.at

Date:

**Dear owner of a small scale solar cooling system,**

We are a group of scientists and engineers who are working in the frame of the International Energy Agency in the field of solar air conditioning. For scientific and statistic purposes we set up this questionnaire which helps to collect basic data of small scale solar cooling systems. The data are evaluated scientifically and treated confidentially. It is not necessary to answer all the questions; leave the check box open if you don't know the answer. The questionnaire is divided in four main parts: general questions – technical questions about the system - questions about the economical (cost) situation and at the end questions about design plans and measuring data. The estimated time necessary to fill in the questionnaire is 20 minutes - thank you very much for your help!

If you want to know more about this project, please visit  
<http://www.iea-shc.org/task38/index.html>

**General data: (location, building type, building orientation, user profile ....)**

Name:

Object:  single family house  multi family house  office building  other

Cooled useful area: ca.        m<sup>2</sup>

Cooled room type(s):

Year of construction (building):

County:                      Town:                      Postal Code:

Street name and number:

Telephone no.:                      Mobile phone no.:

E-mail:

**General questions:**

**1. What/who induced you to the installation of a solar cooling plant? (Multiple denominations possible)**

- recommendation of other plant owners     fair visit     advice of consultant  
 installer     energy conservation     other

2. **Did the plant fulfil your expectations?**       yes       no

If no: why?

3. **When was the plant installed?**      date (year)

4. **How do you judge the plant quality?**

very good     good       moderate     bad

Comments:

**System configuration:**

5. **Technology used?**

**Cold side:**

Absorption       Adsorption       DEC (Desiccant evaporative cooling)

cooling capacity:      kW

**Hot side:**

Flat plate collectors     evacuated tube collectors     concentrated collectors

size:      m<sup>2</sup>

6. **What is the plant used for?**

air conditioning       domestic hot water preparation       space heating support

other

7. **What kind of cold distribution system is used?**

ventilation       fan coils     radiant floor       ceiling

TABS (thermally activated building structure), which kind

other

8. **Do you have a hot storage?**

yes     no    Litres?

9. **Do you have a cold storage?**

yes     no    Litres?

10. **Where is the chiller located?**

- technical room       under the roof       on the roof       cellar  
 other

**11. Where is the hot storage located?**

- technical room       under the roof       on the roof       cellar  
 other

**12. Where are the solar panels installed?**

- on the roof       garden       other

orientation of collectors:

inclination of collectors:

**13. How far is the hot storage from the solar panels?**      meters

**14. Do you have a backup system?**       yes       no

**If yes: What kind of backup do you have?**

- compression chiller       ground water usage       earth collector  
 hot side back up       other

**15. Why did you choose this system configuration?**

- offered by installer       recommendation of other plant owners  
 other

**Planning and Installation:**

**16. Who did the planning for the system?**      Name of company:

- local installer       company specialised on renewable technologies  
 other

**17. How long did it take to install the plant?**      days

**18. Who was in charge of the installation?**      Name of company:

- local installer       company specialised on renewable technologies  
 other

19. How many people were involved in the installation? \_\_\_\_\_ people

20. Were there any delays during installation?  yes  no  
 If yes: what were these delays caused by?

21. What kinds of problems were encountered during installation?

22. How were these problems solved?

23. How long did it take to solve the problem?

24. Did this lead to extra costs?  yes  no

If yes: how much? €

**System operation:**

25. Are you comfortable in the solar cooled area?  yes  no

Comments:

26. How convenient is the operation of the system? What do you have to do as the user?  
 Please describe any problems you may have.

27. Do you know when the solar thermal system is working and when the backup system is working?

yes  no

Comments:

**If yes: How do you know which system is working?**

shown at the local controller  via internet access to my system supplier

other:

28. Is there any kind of monitoring of the performance of your system?

yes, please describe

no

**Maintenance:**

**What maintenance actions are necessary on a regular basis and how often?**

Maintenance item	Every day	Once a week	Once a month	Once a year	Less than once a year	Other
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Comments:

**29. Who does this maintenance?**

- owner himself     
  installer     
  specialised company on maintenance  
 other

Comments:

**30. Have there been any problems with the solar cooling system since the installation was completed?**

- yes     
  no

**If yes: what kind of problems have occurred?**

**31. Have these problems been solved?**

- yes     
  no

Comments:

**32. Was it easy to solve these problems?**

- yes     
  no

Comments:

**33. How could these problems have been avoided?**

**Costs:**

34. How much did the solar cooling plant cost? €

35. Have you saved money since you installed your solar cooling system?

yes                       no

Comments:

36. How much have you saved? €

Comments:

37. Is it what you expected? Are you satisfied?

yes                       no

Comments:

38. Would you recommend a solar cooling plant to a friend?

yes                       not at the moment

Comments:

**Do you have following information?**

- Cooling load dimensioning of each room                       yes    installer    no
- Installation plan of pipes     yes    installer    no
- Operation instructions and/or technical manual                       yes    installer    no
- Photos of the plant installation     yes    installer    no
- Would you hand out/send us this information?                       yes    no

**Are you interested in further investigations of your solar cooling plant?**

- I am very interested in a plant investigation
- I do not have special interest – however my plant is available for further investigation
- Unfortunately my plant is not available for further investigation



**Task 38 - Solar Air-Conditioning and Refrigeration Workshop**

# Program

This workshop is presented in conjunction with the [AHR Expo](#). Please note this schedule has not been finalized and may change.

**Registration - 8:30 am****9:00 am - US Solar Thermal Market and Policies**

Presented by [Les Nelson](#)

**9:20 am - Green Buildings: Solar Cooling Opportunity**

Presented by Ian Sinclair

**9:40 am - Solar Air Conditioning Task 38**

Presented by Dr. Hans-Martin Hening

**10:00 am - Solar Collector Technology**

Presented by Professor [Steven Harrison](#)

**10:30 am - Refreshment**

Refreshments will be provided

**10:45 am - Absorption Closed Cycles and Machines**

Presented by [Dr. Yunho Hwang](#)

**11:05 am - Adsorption Closed Cycles and Machines**

Presented by Dr. Hans-Martin Hening

**11:25 am - Solid Desiccant Cycles and Machines**

Presented by Professor [Marco Beccali](#)

**12:05 pm - Liquid Desiccant Cycles and Machines**

Presented by [Dr. Andrew Lowenstein](#)

**12:25 pm - Lunch**

Lunch will be provided

**1:05 pm - Heat Rejection**

Presented by Lars Reinholdt

**1:25 pm - Solar Cooling System Design and Engineering**

Presented by [Dr. Christian Schweigler](#)

**2:00 pm - Review of Installed Systems in Europe**

Presented by [Dr. Wolfram Sparber](#)

**2:30 pm - Solar Systems in North America**

Presented by [Dr. Lucio Mesquita](#)

**2:50 pm - Solar Cooling Economics**

Presented by [Dr. Daniel Mugnier](#)

**3:20 pm - Closing / Discussion**

## Solar driven cooling and air-conditioning in a Danish and worldwide perspective

### Dato og tid

28. april kl. 9.00 til 28. april kl. 16.30

### Mødested

Arkitektskolen Aarhus, Studsgadeaud., Nørreport 20, Aarhus

### Beskrivelse

Solar driven cooling and air-conditioning in a Danish and worldwide perspective.

The service for comfort air-conditioning requires a major part of the consumed energy in buildings in many countries. Furthermore as a result many other countries face severe growing problems with electricity peak loads in electricity grids. In Denmark the use of air-conditioning and cooling is growing as well. In some regions or municipalities (as in Denmark) building regulations are set up in order to limit the application of active air conditioning systems, unless they are operated with renewable energies.

The use of solar thermal energy in combination with thermally driven cooling systems (chillers, open sorptive cycles) can be a possible solution among others. The main objective of the international collaborative project Task 38 "Solar Air-Conditioning and Refrigeration" in the framework of the IEA SHC Programme is the implementation of measures for an accelerated market introduction of solar air-conditioning and refrigeration with a major focus on improved components and system concepts.

In the workshop the international experts of the IEA SHC task will present the newest international knowledge on solar driven air-conditioning and cooling and it will be put into a Danish perspective including presentation of Danish initiatives and activities in the field.

### Program

#### **Program for public work shop day 28. April 2010**

#### **9:00 Registration**

#### **9:15 Welcome**

Presented by Klaus Ellehauge, Ellehauge & Kildemoes, Denmark

#### **9:20 The Samsø project: How to achieve +100% energy suooly from renewables**

Presented by Jesper Kjems, Samsø Energy academy

#### **10:00 A CO<sub>2</sub> neutral heat supply in Aarhus by 2030**

Presented by Adam Brun, Varmeplan Århus

#### **10:30 Refreshment**

Refreshments will be provided

#### **10:45 Solar Air Conditioning Task 38**

Presented by Dr. Hans-Martin Henning, ISE Fraunhofer, Germany

#### **11:05 Adsorption Closed Cycles and Machines**

Presented by Dr. Hans-Martin Henning, ISE Fraunhofer, Germany

#### **11:35 Absorption Closed Cycles and Machines**

Presented by M.Sc. Manuel Riepl, ZAE Bayern

#### **12:05 Solid Desiccant open Cycles and Machines**

Presented by Pietro Finocchiaro, DREAM, Palermo, Italy

#### **12:25 Lunch**

Lunch will be provided

#### **13:05 AC-Sun, a thermo-mechanical chiller**

Presented by Søren Minds, AC-Sun, Denmark

#### **13:25 Heat Rejection, Liquid Desiccant open Cycles and Machines and new technologies**

Presented by Lars Reinholdt, DTI, Denmark

#### **14:00 Solar Cooling System Design and Engineering**

Presented by Dr. Martin Helm, ZAE Bayern, Germany

#### **14:30 Review of Installed Systems in Europe**

Presented by Dr. Assunta Napolitano, EURAC, Italy

#### **15:20 Solar Cooling Economics**

Presented by Dr. Daniel Mugnier, TECSOL, France

#### **15.50 Closing / Discussion**

### Foredragsholdere

### Arrangør

Danvak Solenergi/IDA Danvak/IEA SHC task 38 Solar Air-Conditioning and Refrigeration

### Priser

Kr. 1100 ekskl. moms. for medlemmer

Kr. 1500 ekskl. moms. for andre

Kr. 500 ekskl. moms. for seniormedlemmer

Kr. 200 ekskl. moms. for juniormedlemmer