SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

TASK 53

New generation solar cooling & heating systems
(PV or solar thermally driven systems)

Task description and Work plan

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1 Task description

1.1 Background

The results of past IEA SHC Task 38 Solar Air-Conditioning and Refrigeration and ongoing IEA SHC Task 48 Quality Assurance and support Measures for Solar Cooling systems on the one hand showed the great potential of this technology for building air-conditioning, particularly in sunny regions. On the other hand, it has been shown that further work is necessary in order to achieve economically competitive systems, using either the solar thermal or the solar photovoltaic driving energy. One Task definition workshop has been held with the aim to define the required new activities and to develop a structure for a new Task entitled „ PV and solar thermal driven cooling & heating systems “. Stimulated by the rising cooling demand in the World and at the same time a very significant PV modules price decrease, an important interest for new generation solar cooling systems has arisen. At the same time, solar thermal cooling technology still suffers from an important lack of competitiveness due to a very small market size and difficulties to go to massive cost reduction at least in the small system (<50 $kW_{cooling}$) range. Besides, the solar photovoltaic source coupled with compression technology (heat pump) presents a very promising alternative but is still in its technical infancy.

Cooling market

<u>Worldwide trend:</u>

A tremendous increase in the market for air-conditioning can be observed worldwide especially in developing countries. Figure 1 below shows the sales rates of room air-conditioners (RAC units) in different regions of the world (blue mark representing Worldwide sales and green one European ones). The number of sold units increased from about 44 million units worldwide in 2002 to more than 94 million units in 2012 (JARN, 2012). In order to limit the negative impact on the energy consumption and on the electricity network management, new environmentally sound concepts are of particular importance.

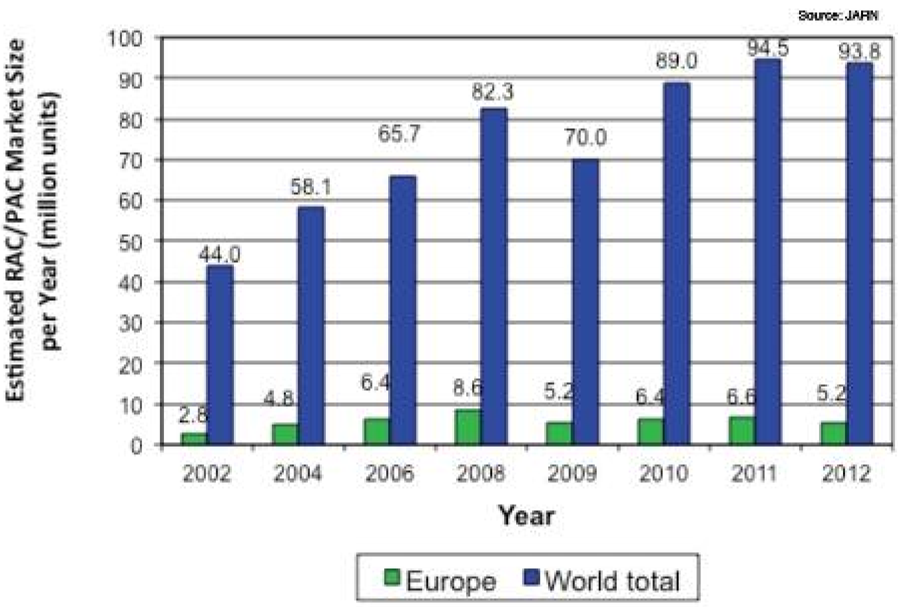


Figure 1: Evolution of air conditioning market worldwide (source: Jakob, 2013)

European trend:

In Europe, Energy consumption for cooling purposes is expected to face an increase of demand within the next 30 years. Climate and comfort requirements make the cooling market grow, and the architecture and technical equipment of larger, commercial buildings require more and more cooling. To reduce the cooling demand would require massive changes in public perception followed by modifications in (commercial) building design. As this seems unlikely for the foreseeable future, addressing the demand for cooling will become more relevant in the coming years. Space cooling is moving quickly from luxury into necessity and represents a fast growing market. This has remained relatively unnoticed by policy planners, partly because cooling needs are traditionally being met by electrical air conditioners, hiding the cooling element within the building's overall electricity consumption.

The rise in cooling demands is attributable to rising ambient temperatures, greater comfort expectations, the perception that cooling contributes to higher productivity, and the increase in internal loads of electronic equipment. A rise of the share of commercial buildings in Europe equipped with cooling to at least 60% is expected by 2020. The maximum potential cooling demand in Europe, if 100% of all useful space were air-conditioned, is estimated to an annual 1400 TWh cooling (RHC Common vision, 2011). Beside, Europe through its European Union has recently sent an important signal to decrease this forecast cooling load development: the new building directive (DIRECTIVE 2010/31/EU). By 2020 all new and refurbished buildings should be near zero energy. So the cooling demand will have to decrease. But this means as well that a massive use of Renewable energy sources will have to be done. Therefore solar cooling will have a chance to develop because of this context (RES HEAT directive, 2010).

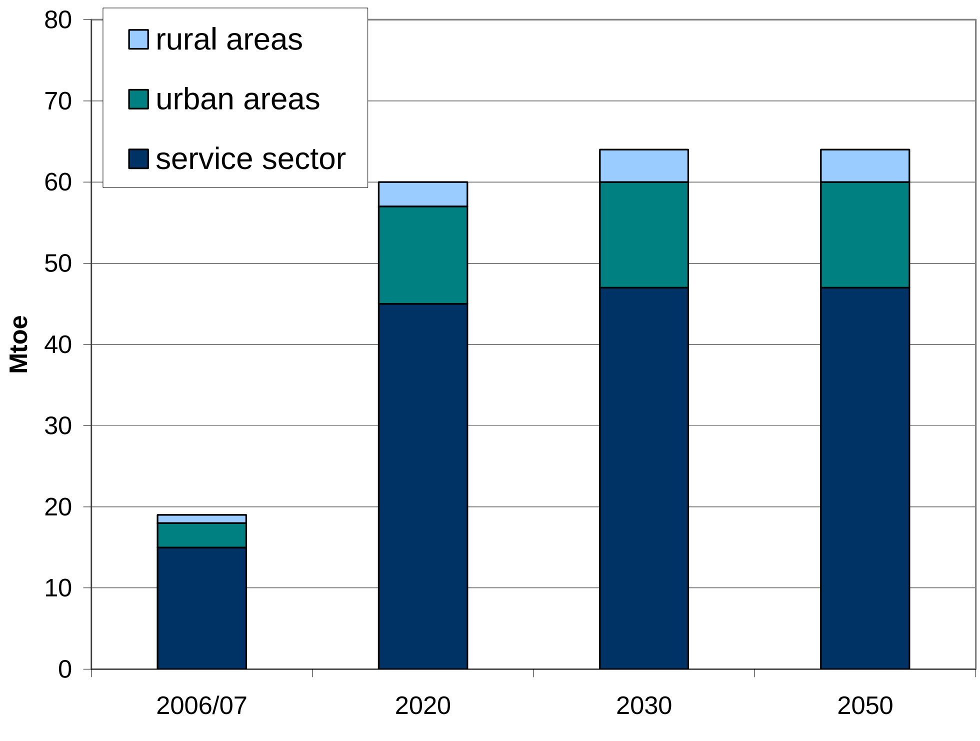


Figure 2: Expected evolution of cooling demand (source: RHC Common vision, 2011)

Because today most cooling is provided by electrically driven devices using electricity from the grid and derivated from nuclear or fossil primary energy, rising electrical power demand has been identified as one key indicator of the increase in cooling demands. Electrical peak loads, traditionally occurring during winters, are now shifting to the summer months and challenging capacity limits and therefore increasing the need of the solar cooling technology even in Europe.

Energy and environment

Although electrically driven chillers have reached a relatively high standard concerning energy consumption they still require a high amount of electricity and - equally importantly - cause significant peak loads in electricity grids. This is becoming a growing problem in regions with cooling dominated climates. In recent years an increasing number of cases occurred in which summer electricity shortages were created due to air-conditioning appliances (eg : 05/07/2010 in Toronto, Ontario). In some regions or municipalities building regulations were set up in order to limit the application of active air conditioning systems, unless they are not operated with renewable energies such as wood/biomass or photovoltaics.
This underlines the necessity of new solutions with low electricity consumption and in particular reduced consumption at electricity peak load conditions. The thermal or PV approach are both reducing dramatically this electricity from the grid.

Another topic related to environmental issues concerns the global warming potential of refrigerants. Refrigerant leakage in air-conditioning appliances– in particular in the automotive sector – led to several legislative initiatives towards limitation or even prohibition of classical fluorized refrigerants. Almost all thermally driven technologies use refrigerants which have no global warming potential. Efforts are made at the same time in the new generation compression chillers, trying to use refrigerant with lower global warming potential.

Solar assisted air-conditioning and refrigeration

It seems logical to apply solar energy for cooling purposes since in many applications, such as air-conditioning, cooling loads and solar gains are more or less in phase on a daily base. The same holds not necessarily for refrigeration application e.g. in the food processing sector. However, also in these sectors a coincidence between solar gains and load occurs at least on a seasonal level. In general, solar assisted cooling can mean to produce electricity from solar radiation by photovoltaics and to drive electrically driven cooling systems or to produce heat from solar radiation by solar thermal collector systems and to employ it in thermally driven cooling processes. Thermally driven technology is of particular interest in case of applications where both cooling and heating are needed. In such cases, a solar thermal collector can be used all year around, for heating in winter and cooling in summer. At the same time, using performing inverter based performing heat pumps, photovoltaic energy can be used all year long for thermal purposes : heating in winter and cooling in summer.

History

Solar thermally/Photovoltaic Driven Heating and Cooling systems are belonging to the IEA SHC Strategic Plan Key Technologies because they have the potential to cover much of the rising demand for air-conditioning by solar energy.

The concluded IEA-SHC Tasks related to Solar Air conditioning (Task 25 and Task 38) have permitted to make a considerable collaborative international work to develop this technology from pure R&D to first market introduction. A recent survey made on the basis of results of the IEA Task 38 and Task 48 work has shown the estimated number of installation worldwide was nearly of 600 systems in 2010 and nearly 1000 systems in 2012 (Figure 3)

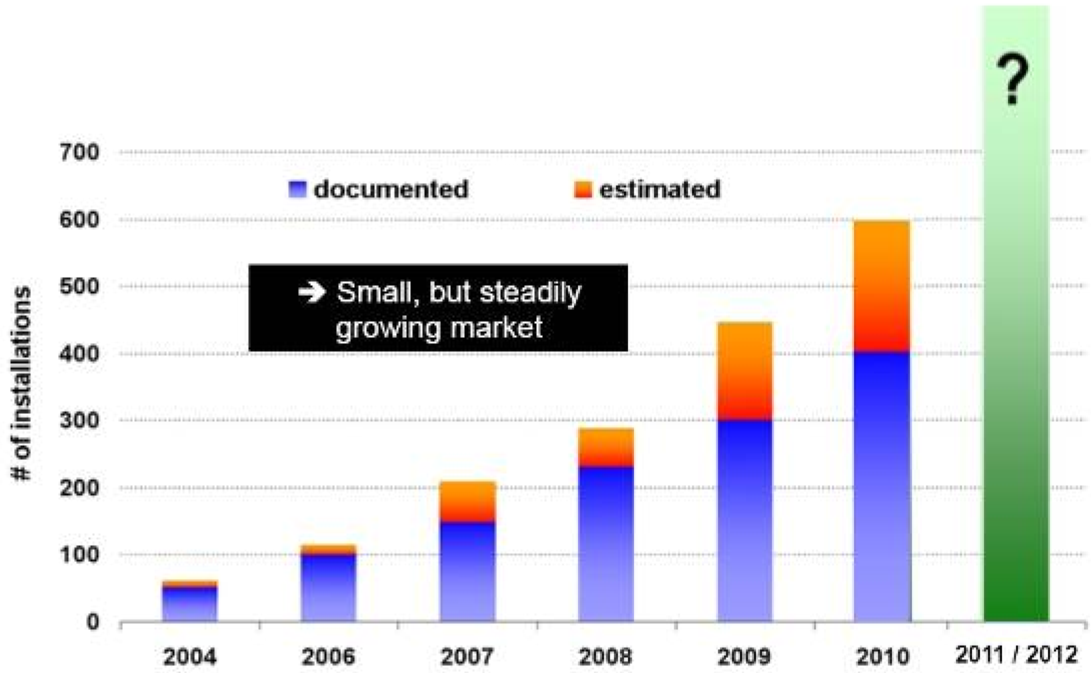


Figure 3: Estimation of number of solar cooling installations worldwide

Thanks to the IEA SHC Task 25 (from 1999 to 2004) was possible the creation of an outlook of the technology and initiate industrial and mature developments on solar thermal cooling.

With IEA SHC Task 38 (2006-2010), a creation of tools and methods has been managed to help the market introduction of the emerging technology and analyse the efficiency and reliability of the new generation of solar cooling systems available for demonstration and pilot installations as well as first commercial market deployment on solar thermal cooling.

With the ongoing IEA SHC Task 48 (2011-2015) on Quality Assurance and Support Measures for Solar Cooling, the objective is to find solutions to make the solar thermally driven heating and cooling systems at the same time efficient and reliable.

In 2013, Solar Air-Conditioning is more than ever representing a huge potential of development for solar energy (within 2030 the expected growth of energy demand in buildings especially in developed countries is far bigger on the cooling side than on the heating side) but this promising technology is facing one main issue: a general lack of economic competitiveness – as it is still the case for many renewable energies unless incentives are in place.

Solar thermal cooling has difficulty to emerge as a economically competitive solution for the main following reasons:

- Technical : Limit on adaptability of the solar thermal cooling technology to a large spectrum of applications due to the presence of important hydraulics (several loops), complexity on the management between solar resource, cooling and heating loads and overheating risk management between the 2 seasons (thermal balance of the targeted building). Last but not least, sorption technology generally uses and needs cooling towers consuming water, chemical treatments and facing legionella development risks.
- Economical: the investment cost for solar thermal cooling technology is still significantly high (3 to 5 times more than an equivalent reversible heat pump), especially for small systems.

Therefore, this technology still needs intensive R&D for quality improvement and best solution selection

However, for large systems beyond 100 $kW_{cooling}$, (which means nearly more than 300 m² solar thermal collectors) solar thermal cooling has very interesting perspectives because:

- A real capacity for economy of scale leading to solar cooling existing installations with investment cost of less than 2000 €/ $kW_{cooling}$
- Specialised engineering and control. Thanks to the size of the systems, a specific custom made and adapted-to-the-building control can be set up, optimising the system integration and performances
- Energy sales. For the large systems beyond $MW_{cooling}$, first experiences out of Europe (Singapore and USA) exist with solar thermal cooling and heating systems in ESCO configurations permitting to work on an energy sales business model. This innovating model has the very important interest for solar cooling to overcome the investment barrier for the building owner.

From all of these considerations, there is therefore a strong need to stimulate the solar cooling sector for small and medium power size by initiating a new task on new generation PV and solar thermal driven cooling and heating systems: PV and solar thermal approaches are included in the scope.

The proposed Task addresses these main goals:

(1) to analyze the interest of **new generation (PV or solar thermally driven) solar cooling & heating concepts systems for buildings** in all climates and **select best solutions which lead to highly reliable, durable, efficient and robust solar cooling and heating** (ambient + DHW) systems

(2) to contribute to **market entry of the new generation PV or solar thermally driven cooling technology** and identify **most promising market areas** in terms of **cost competitiveness and value of electricity.**

This new Task is deeply aimed as well to enlarge the actual European centred view and work to countries out of Europe (most of them are member of IEA SHC) such as China, India, Singapore, USA, Israel, South Africa and Australia. In these countries Solar Thermal and Solar PV technologies are really dynamic and represent a much bigger market potential for cooling (because of the climates, the energy structure, peak demand, etc.). Actions to stimulate participation to these countries will be implemented. It is to note as well that in the quoted above countries, solar thermal and solar PV technology companies will identify a far bigger market share to apply there products.

1.2 Why an IEA project?

The International Energy Agency offers an ideal platform for international collaborative R&D work. Several added values can be identified in a collaborative, international project compared to national activities. Participating countries take profit from the specific know-how of each of the other participants (such as study of the international state-of-the-art has to be done only once). Tools such as design or simulation programs may be similar for application in different regions. An international project may be capable to bring together technology suppliers from different countries with new markets.
Overall, the net profit for every participating country seems to be significantly higher compared to national activities with a similar level of effort.

1.3 Scope of the task

The scope of the Task are the technologies for production of cold/hot water or conditioned air by means of solar heat or solar electricity, i.e., the subject which is covered by the Task starts with the solar radiation reaching the collector or the PV modules and ends with the chilled/hot 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.

The main objective of this Task is to assist a strong and sustainable market development of solar PV or new innovative thermal cooling systems. It is focusing on solar driven systems for both cooling (ambient and food conservation) and heating (ambient and domestic hot water).

Technologies

In principle, solar assisted cooling systems may be operated by (1) solar thermal collectors connected to thermally driven cooling devices, (2) solar-to-electric converters (photovoltaics) combined with compression chillers or by (3) solar to mechanical energy converters (e.g. solar collector driven Rankine machines) combined with compression chillers.

The two first categories of systems seem to be closest to mass market application, although in particular in the case of small to medium units, PV driven compression chillers are the most promising and close to market solar solution today.

Even if, in areas with existing electricity grids, the question of PV driven cooling and heating seems to be reduced to the question of grid connected PV for reduction of peak loads, which result from air conditioning, the reality is not simple. Increase of self-consumption of solar PV in these countries leads to an important question of the coupling between PV and heat pumps as well as energy storage. PV driven solar cooling systems will be therefore specifically studied in this task.

The scope of the technologies in this Task is:
* Photovoltaïc + air conditioning system. By air conditioning, it means compression air conditioning and heat pumps (if heating as well) but as well in a larger extend, food conservation
* Solar thermally driven innovative and compact cooling+heating systems.

Applications

The main application covered by the project is cooling of buildings. Until recently, it seemed that solar assisted cooling had best chances for market deployment in cases of large buildings with central air conditioning systems, because of the unique development of solar thermal cooling solutions. But, with the huge market increase for cooling equipment in the small residential and small commercial sector and the tremendous PV panels cost decrease, the situation has changed.

Here reliable and cost effective solutions are necessary in which the solar collection provides heat and/or electricity over the whole year, i.e. for heating in winter, for cooling in summer and for production of domestic hot water through the entire year.

So called pre-engineered systems are seen as a solution for this application range. Therefore this Task also focuses on packaged solutions which will be pre-engineered systems with small capacities for the following building types: single family houses, small multi-family buildings, offices, shops, commercial centres, factories, hotels
All of these buildings can be **grid connected or off grid** in case of PV cooling and heating.
The studied cooling and heating power range will be from **1 $kW_{cooling/heating}$ to several tens of $kW_{cooling/heating}$.**
As for the association between photovoltaic and reversible heat pumps or air conditioners can be made indirectly with the presence of an electric grid, the main scope of the present Task will be **the direct coupling between solar and cold production machine.** However, special configurations and control strategies will be considered for certain countries, in Central Europe especially, to allow a maximised use of PV power direct for heating/cooling even without direct coupling.

1.4 Objectives

The proposed project is intended therefore to create a logical follow up of the IEA SHC work already carried out by trying to find solutions to make the solar driven heating and cooling systems at the same time cost competitive. This major target should be reached thanks to five levels of activities:

1) Investigation on new small to medium size PV & solar thermal driven cooling and heating systems and develop best suited cooling & heating systems technology focusing on reliability, adaptability and quality

2) Proof of cost effectiveness of the above mentioned solar cooling & heating systems

3) Investigation on life cycle performances on energy & environmental terms (LCA) of different options

4) Assistance for market deployment of new solar cooling & heating systems for buildings worldwide

5) Increase of energy supply safety and influence the virtuous demand side management behaviours

1.5 Task Structure

The work in this Task is organised in four Subtasks:

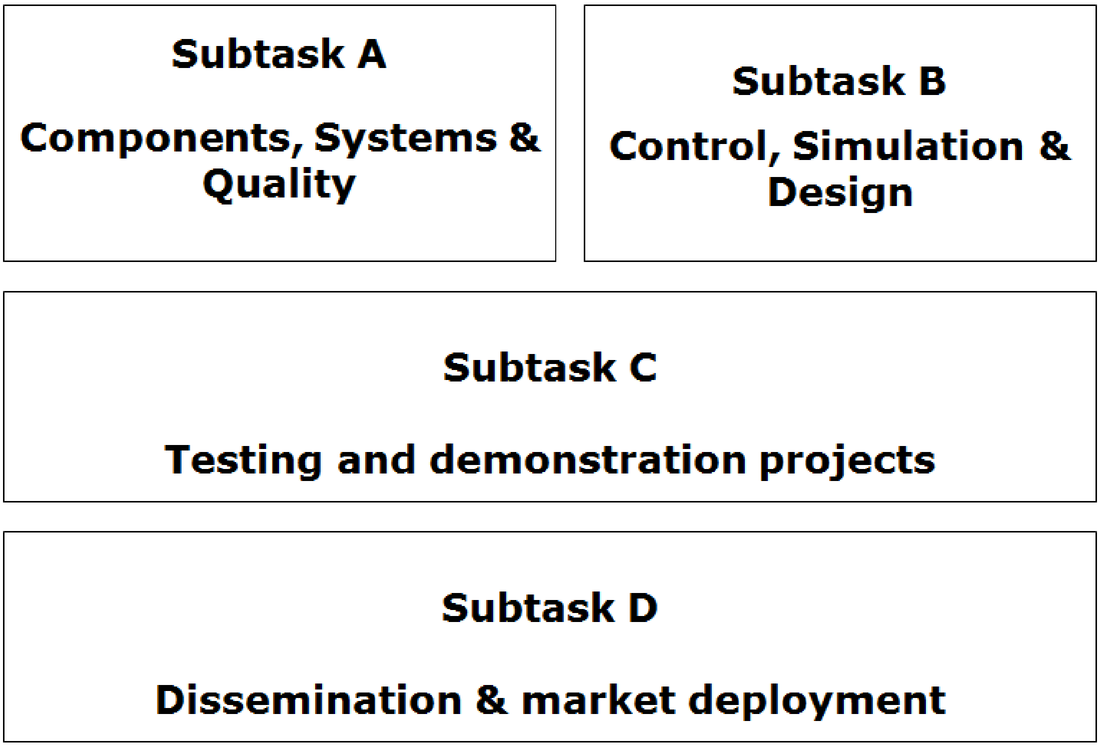
Subtask A: Components, Systems & Quality

Subtask B: Control, Simulation & Design

Subtask C: Testing and demonstration projects

Subtask D: Dissemination & market deployment

Each Subtask consists of several work packages with specific focus and results. The Subtasks are described in more detail in the subsequent sections.



1.6 Subtask A: Components, Systems & Quality

The general objectives of this subtask are:

* to better know and characterize the most important components of the new solar cooling & heating systems, considering existing solar thermal cooling systems as a reference
* to identify ongoing and future related standards and testing methods
* to identify where new solar cooling & heating systems are suitable
* to develop tools and deliverables permitting to show the level of quality of both the most critical components and systems.

The specific objectives of this subtask are:

* to know the commercially available equipment on the AC side compatible with PV electricity supply as well as solar thermal cooling equipment
* to know the R&D entities working at the moment on the topic and what are the ongoing outputs, especially the key points in the interface AC unit / PV modules and system /grid
* to define the different possibilities on the storage side for new solar cooling & heating
* to easily classify the ST/PV cooling products/application (schematic square view method) so as to prepare a certification process
* to define procedures for measuring the performance of the PV cooling & heating systems and prepare the conditions for a quality label
* to estimate the value of electricity and LCA of the main components and systems

The subtask is structured in the following sections:

A1: Reference system (for heating/cooling)

In this work, the characterization of the reference system will carried out so as to prepare the economical comparison with the developed solar cooling/heating systems. The reference system will be depending on the countries and even potentially on the geographical area to be studied. In addition, this system will depend on the range of energy use: cooling, ambient heating, domestic hot water.
Therefore a set of reference systems will be selected and described on their technical performance level and their global cost (investment, operation and maintenance cost).
This database will permit furthermore in the Subtask to make a comparison with new generation solar cooling and heating systems

A2: New system configurations for cooling (AC, food conservation) and heating (DHW, ambient)

This activity will be dedicated at building the state of the art of the new system configurations for cooling and heating. This activity will be achieved realised in the beginning part of the Task according to existing market available and close-to-market solutions. A second step of this activity will be to update this state of the art with progress occurring in the field thanks to R&D.

A3: Storage (electrical and thermal) concepts and management

This activity will focus on the analysis of storage solutions adequate for solar cooling and heating solutions on the market. Beyond the material itself, a particular focus will be made on the different possibilities to manage the storing/destoring sequences. Not only thermal sensible and latent storage tanks will be studied but as well electrical storage, building mass storage and potentially chilled water loop/ district network storage.

A4: Systems integration into buildings, microgrid and central Grid (existing control)
The activity will study in a conceptual approach called "square view" develop among IEA SHC task 44 consisting on simply presenting the different configurations of integration of solar cooling and heating systems among buildings, microgrids and the central grid. One criteria of limitation of the possibilities of configuration will be to consider systems available on the market to close to be commercialised.

A5: LCA and techno-eco comparison between reference and new systems
This activity will focus on the comparison between all the studied systems among this Subtask A and the reference systems when accurate (same location and same boundary conditions). The comparison will be both on a Life Cycle Analysis and on a techno-economical basis. So as to properly compare solutions, adequate key performance indicators will be investigated and selected from literature and practical experience from Task experts as well as industry players. Some recommendations will be developed to go for characterization test method (permitting to lead to a quality labeling scheme for new generation solar cooling systems) as well as standards

Effort

Estimated effort is 6 to 12 person-months per Participant (country) and 12 person-months for the Subtask Leader for the specific work for Subtask Leadership for the whole duration of the Task.

Deliverables

- D-A1: Definition of the existing cooling reference systems (**A1**)
- D-A2-1: State of the art of new generation commercially available and close to market products including costs, efficiency criteria ranking and performance characterization (**A2**)
- D-A2-2: Update of the state of the art including technical report on recent R&D work on the topic (**A2**)
- D-A3 : Technical report on best practices for energy storage including both efficiency and adaptability in solar cooling systems (including KPI's) **(A3)**
- D-A4-1: Report on a new and universal classification method "new generation solar cooling square view" for generic systems (**A4**)
- D-A5-1: Techno-economic analysis report on comparison between thermal and PV existing solar cooling systems including as well LCA approach and Eco label sensibility (**A5**)
- D-A5-2 : Draft document defining the Key Performance Indicators (KPI) of the market available systems and possible characterization test method (permitting to lead to a quality labeling scheme for new generation solar cooling systems) as well as standards (**A5**)

1.7 Subtask B: Control, Simulation & Design

General objective : to investigate the different control possibilities for the new generation solar cooling & heating systems for buildings so as to select the best strategies for given climates and countries and then develop modelling tools to predict performances and size/design systems. Besides, to manage a smart interaction with electric grid

Specific objectives :
* to analyze and select optimized control strategies to manage the interaction between solar and cooling machine (PV and heat pump unit especially)
* to provide modelling tools for complete generic systems
* to report sensitivity analysis on most of the selected systems
* to compare the performances at system level of all innovative systems
* to size the systems
* to investigate demand/response strategies to optimise the interaction with smart grids and work on forecasting tools dedicated to this purpose

The subtask is structured as follows:

B1: Reference conditions (economical, climatic, reference building with thermal and electrical load, etc..)

This activity will be developed in close cooperation with A1 and is aimed at understanding the reference boundary conditions for simulating a new generation solar cooling and heating system. These conditions are related to the climate, the building load especially, thermal and electrical. From the most promising identified markets, some set of duo climate/application will be selected and developed to produce data files. Among specific buildings to be selected, single house residential as well as multifamily and office and commercial building will be used. Air conditioning, heating, DHW and electrical appliances loads will be considered and potentially food conservation cooling loads for commercial buildings

B2: Grid access conditions and building load management analysis

This activity will focus on the conditions and impact of the new generation solar cooling and heating systems on the grid. This effect will be expressed through some values which will be inserted on the economical balance of the solar system (reduction of the grid stress factor for example, variable energy cost depending on the peak load situation). For example, could be modeled the impact on the grid for certain countries of a large amount of new generation solar cooling systems. This activity will benefit from the results and the work done in activity A4 to add a state of the art of the grid management possibilities.

B3: Models of components (identification/validation) and system simulation

The present activity is dedicated to identify, test and validate component models which are part of the systems covered by the Task. Beyond components, several modeling tool will be investigated to see which of them are able to go for full system modeling. The output will be the presentation of a set of tools showing their ability to model some configurations and then the presentation of the level of accuracy and user friendliness.

B4: Control strategy analysis and optimization for ST and PV

Thanks to the cumulated work achieved from B1 to B3, full systems will be modeled with adequate boundary conditions and accurate models, permitting to proceed to detailed parametric and sensitive analysis on the best control strategies to adopt to optimize given performance criteria.

B5: System inter-comparison (cost/performance/reliability) between systems and with conventional, solar thermal, gas, etc…

This activity will be in charge from the existing design tool developed for IEA SHC Task 48 to adapt it for new generation solar cooling and heating systems peculiarities. Then, of course, this tool will have its validity checked in comparison with models developed in B4. The tool will be extended from the existing one by adding a country more important energy and grid access cost sensitivity. Beside the development of the tool, an extra work consisting on giving rules of dimensioning will be built. This report could be written and presented showing results though the format and the interface of the design tool, thus for a better educative purpose.

Effort

Estimated effort is 9 to 24 person-months per Participant (country) and 15 person-months for the Subtask Leader for the specific work for Subtask Leadership for the whole duration of the Task.

Deliverables

* D-B1: Technical report presenting the reference conditions for modelling (reference load profile and comfort conditions in case of living / office room AC/cooling)
* D-B2: Overview on peak demand & demand side management possibilities including a state of the art on the management of the interface solar cooling (eg. AC unit / PV modules) and distribution system /grid
* D-B3: Technical report on components & system model validation
* D-B4: Technical report on optimised control strategies for solar cooling & heating systems
* D-B5-1: Technical report on system dimensioning
* D-B5-2: Guidebook/guideline on results of simulations including a country- and climate-sensitive economical analysis

1.8 Subtask C: Testing and demonstration projects

General objective : to stimulate, monitor and analyse performances of field test systems and demonstration projects for new generation solar cooling & heating systems

Specific objectives :
* to create a monitoring procedure for field tests or demo projects
* to select identified projects and organise a complete field test monitoring campaign for it
* to analyse potential technical issues on the monitored systems
* to report on the measured performances of the systems

The subtask is structured as follows:

C1: Monitoring procedure and monitoring system selection criteria
This task is dedicated to prepare the testing and the monitoring methodology to measure the performances of the selected demo projects. The idea is to consider the measurement points for selected demos projects. These points and the way to collect the measurement data will developed in partnership with activities A5 and A2. A valorization of past and ongoing results from IEA SHC Task 38, 44 and 48 will be done on how to properly monitor these new generation solar cooling and heating systems. An uncertainty analysis will be added to the method.

C2: System description for field test and demo projects
This activity is dealing with selection and description of field test and demo projects. The number of selected projects will be at least of 3, permitting to fully monitor the performances of the systems, according the procedure developed in activity C1.

C3: Monitoring data analysis on technical issues & on performances
This activity is aimed at recording and analyzing the monitoring data from the monitored projects selected in activity C2. The analysis methodology will be based on the work done in Task 38 but of course, adapted with features imposed by the new generation solar cooling and heating systems. The activity will include in addition to performance measurement and analysis an important side of analyzing technical issues and events occurring during the monitoring period.

C4: Best practices / feedback (planning+ commissioning + operation/measurements, user and grid utility…)
This activity is dealing with making a synthesis of the practical work of this subtask by producing a Best Practice document. This document will present the selected field test projects from the planning phase until the monitoring period, describing the different steps (planning, commissioning, etc..) as well as the consequence of the system management towards users and grid utilities. This technical descriptive document will be the basis of the part of the Handbook for New generation solar cooling and heating systems dedicated to best practices. An important contribution of planners will be valorized (flow chart for set in operation) as well as a best practice user will be built.

Effort

Estimated effort is 3 to 12 person-months per Participant (country) and 12 person-months for the Subtask Leader for the specific work for Subtask Leadership for the whole duration of the Task.

Deliverables
* D-C1: Monitoring procedure for field test & demo systems (depending on size and application)
* D-C2: Catalogue of selected systems (with full description)
* D-C3: Technical report on monitoring data analysis (technical issues + performances)
* D-C4: Technical content (best practices) for a part of the Handbook on efficient new generation cooling and heating systems

1.9 Subtask D: Dissemination and market deployment

General objectives :
* implementation of targeted promotion activities based on the collective work results;
* production of dissemination material for external communication; the implementation of knowledge transfer measures towards the technical stakeholders;
* development of instruments and their provision for policy makers and the creation and promotion of certification and standardisation schemes.

Specific objectives :
* to disseminate the Task results on national and international level
* to provide efficient communication tools such as brochures and guidelines
* to collect and structure evidence for policy actions

The subtask is structured as follows:

D1 Website dedicated to the Task
A website included into the IEA SHC portal will be established. This website will profit from a lot of mirror sites present among the participants of this Task, benefitting from their popularity to increase the number of vizualised pages.
This website will firstly present the Task results but it should welcome as soon as possible the presentation of first results of the Task.

D2 Handbook and simplified brochure
This activity is aimed at producing a Handbook on New generation solar cooling and heating systems. This book will present the results of the full Task through the 3 subtasks : state of the art of the technology, results of the modelling and optimisation work achieved in Subtask B and then as a third chapter the best practices results obtained in Subtask C. The book will be part of the SHC publications and will be written not only by putting together the activity reports. An important work of arrangement and didactic approach will be done so as to make this publication a reference book on the topic of New Generation solar cooling and heating systems.
Beside the handbook, a synthetic brochure will be produced so as to present the main results of the Task. This brochure will have maximum 4 to 6 pages. This brochure will be edited jointly by the Subtask Leader (Greenchiller) and IEA SHC program.

D3 Workshops and conferences
The task participants will organise one half a day workshop dedicated to the industrial players involved in the sector (solar thermal manufacturers and installers, thermally driven cooling industry, planners). This will happen preferably once a year and before fixed experts meeting to as to test and make a feedback on the last developments achieved inside the Task. Thanks to this yearly event, a full retrofit process will be achieved and this will permit to make participate industry interested bodies without implicating them directly and deeply inside the Task R&D work. Short report will have to be done for each event.

Effort

Estimated effort is 6 to 18 person-months per Participant (country) and 12 person-months for the Subtask Leader for the specific work for Subtask Leadership for the whole duration of the Task.

Deliverables

- D-D1: Website dedicated to the Task
- D-D2.1 : Handbook for new generation solar cooling and heating systems
- D-D2.2 : Simplified short brochure
- D-D4 : Outreach report
  - Customer and policy maker workshops
  - Organising industry workshops
  - Report on lobbying actions describing all the actions and their impacts

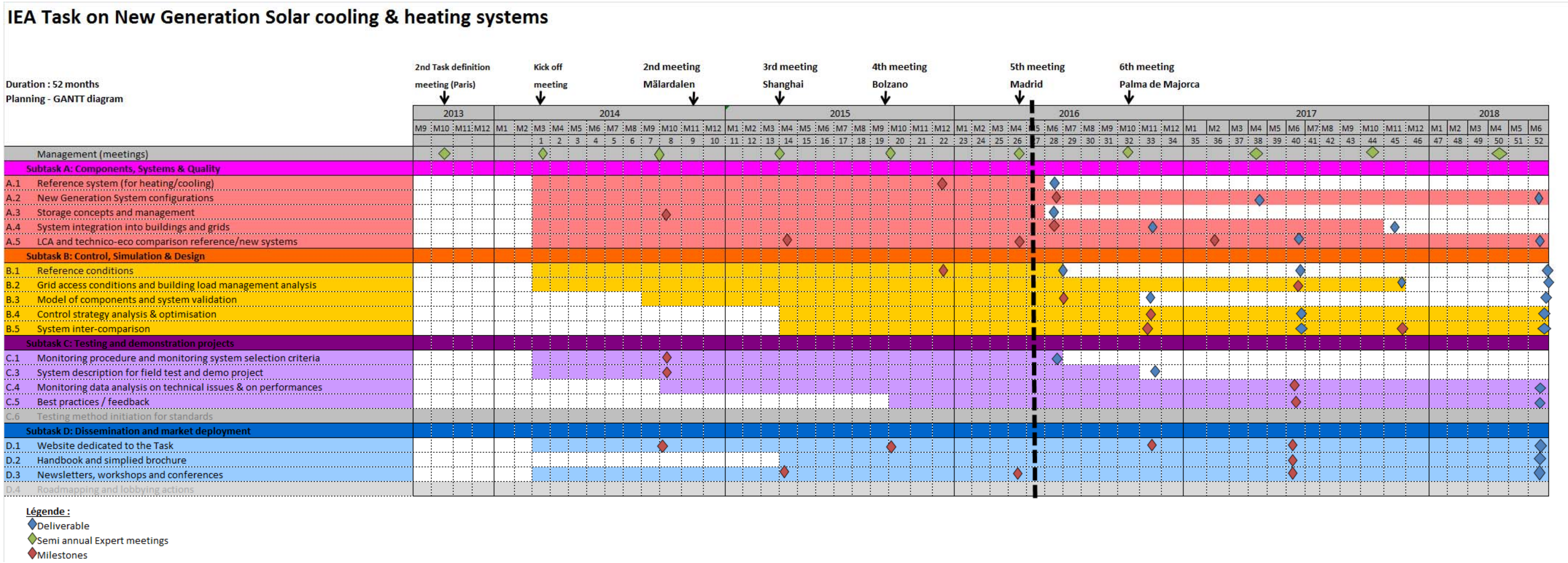
2 Information plan

The following documentation or information measures are planned during the course of the Task (corresponding Subtask in brackets):

- State of the art of new generation commercially available products (A)
- Techno-economic analysis report on comparison between thermal and PV existing solar cooling systems including as well LCA approach and Ecolabel sensibility (A),
- Technical report on optimised control strategies for solar cooling & heating systems (B)
- Guidebook/guideline on results of simulations including a country- and climate-sensitive economic analysis (B),
- Technical report on monitoring data analysis (technical issues + performances) (C)
- Website dedicated to the Task (D)
- Industry workshops addressing target groups (related to Experts meetings) (D),
- Handbook for new generation solar cooling and heating systems (D)
- Simplified short brochure (D) jointly edited by the Subtask Leader and IEA SHC program

3 Work plan and milestones

The work plan for the whole task is shown in the following Gantt chart.



Working Package Structure

Subtask A: Components, Systems & Quality
A1: Reference systems
A2: New system configurations for cooling and heating
A3: Storage concepts and management
A4: Systems integration into buildings, microgrid and central Grid
A5: LCA and techno-eco comparison between reference and new systems

Subtask B: Control, Simulation & Design
B1: Reference conditions
B2: Grid access conditions and building load management analysis
B3: Models of subcomponents and system simulation
B4: Control strategy analysis and optimization for ST and PV
B5: System inter-comparison

Subtask C: Testing and demonstration projects
C1: Monitoring procedure and monitoring system selection criteria
C2: System description for field test and demo project
C3: Monitoring data analysis on technical issues & on performances
C4: Best practices / feedback

Subtask D: Dissemination and market deployment
D1: Website dedicated to the Task
D2: Handbook and simplified brochure
D3: Newsletters, workshops and conferences

Milestone Table

The following tables contain the major milestones of each Subtask

Subtask A: Components, Systems & Quality		
No	**Description**	**Completed by month**
M-A1.1	Draft definition of the existing cooling reference systems	22
M-A1.2	Definition of the existing cooling reference systems	28
M-A2.1-1	Draft state of the art of new generation commercially available products including costs, efficiency criteria ranking and performance characterization	28
M-A2.1-2	State of the art of new generation commercially available products	38
M-A2.2-1	Draft update of the technical report on state of the art	38
M-A2.2-2	Update of the Technical report on state of the art	52
M-A3.1	Draft technical report on best practices for energy storage including both efficiency and adaptability in solar cooling systems (including KPI's)	8
M-A3.2	Technical report on best practices for energy storage including both efficiency and adaptability in solar cooling systems (including KPI's)	28
M-A4.1-1	Draft report on a new and universal classification method "new generation solar cooling square view" for generic systems	28
M-A4.1-2	Report on a new and universal classification method "new generation solar cooling square view" for generic systems	45
M-A5.1-1	Draft techno-economic analysis report on comparison between thermal and PV existing solar cooling systems including as well LCA approach and Eco label sensibility	14
M-A5.1-2	Techno-economic analysis report on comparison between thermal and PV existing solar cooling systems including as well LCA approach and Eco label sensibility	36
M-A5.2-1	Summary of the document defining the Key Performance Indicators (KPI) of the market available systems and possible characterization test method as well as standards	40
M-A5.2-2	Draft document defining the Key Performance Indicators (KPI) of the market available systems and possible characterization test method as well as standards	52

Subtask B: Control, Simulation & Design		
No	**Description**	**Completed by month**
M-B1.1	Template for Definition of reference conditions	22
M-B1.2	Definition of reference conditions	28
M-B2.1	Template for overview on peak demand & demand side management possibilities	40
M-B2.2	Overview on peak demand & demand side management possibilities	52
M-B3.1	Draft Technical report on components & system model validation	28
M-B3.2	Technical report on components & system model validation	34
M-B4.1	Template for technical report on optimised control strategies for solar cooling & heating systems	33
M-B4.2	Draft Technical report on optimised control strategies for solar cooling & heating systems	40
M-B4.3	Technical report on optimised control strategies for solar cooling & heating systems	52
M-B5.1-1	Draft Technical report on system dimensioning	40
M-B5.1-2	Technical report on system dimensioning	52
M-B5.2-1	Specifications for Guidebook/guideline on results of simulations including a country- and climate-sensitive economic analysis	40
M-B5.2-2	Guidebook/guideline on results of simulationsincluding a country- and climate-sensitive economic analysis	52

Subtask C: Testing and demonstration projects		
No	**Description**	**Completed by month**
M-C1.1	Draft Monitoring procedure for field test & demo systems (depending on size and application)	8
M-C1.2	Monitoring procedure for field test & demo systems (depending on size and application)	28
M-C2.1	Template for Catalogue of test/demo systems (with full description)	8
M-C2.2	Catalogue of test/demo systems (with full description)	33
M-C3.1	Draft1 Technical report on monitoring data analysis (technical issues + performances)	40
M-C3.2	Draft2 Technical report on monitoring data analysis (technical issues + performances)	46
M-C3.3	Technical report on monitoring data analysis (technical issues + performances)	52
M-C4.1	Draft Technical content (best practices) for a part of the Handbook on efficient new generation cooling and heating systems	46
M-C4.2	Technical content (best practices) for a part of the Handbook on efficient new generation cooling and heating systems	52

Subtask D: Dissemination and market deployment		
No	**Description**	**Completed by month**
M-D1.1	Draft website	8, 20, 32
M-D1.2	Final Website	52
M-D2.1-1	Table of content of Handbook for new generation solar cooling and heating systems	40
M-D2.1-2	Draft of Handbook for new generation solar cooling and heating systems	52
M-D2.1-3	Handbook for new generation solar cooling and heating systems	52
M-D2.2-1	Draft simplified short brochure	40
M-D2.2-2	Delivery Report – Simplified short brochure	52
M-D3.1	Organising national industry workshops, annual newsletters	14,26,40, 52
M-D3.2	Delivery Report – Outreach report on lobbying actions describ-ing all the actions and their impacts	52

4 Contributors/participants

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China	**SJTU (Jiao Tong University Beijing)**
	YAZAKI China
France	**TECSOL S.A**
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Germany	**ILK Dresden**
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In **bold letters**, regular participating entities present at the 5 first expert meetings.

In *italic* letters, entities not systematically present at the meetings but contributing to the Task