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**Final report**

# Task 52: Solar Heat and Energy Economics in Urban Environment

## IEA-SHC Task 52: Participation of the CREM to Subtask B

Task 52
Solar Heat and Energy Economics in Urban Environments

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# Résumé

En janvier 2014, le programme Solar Heating and Cooling de l'Agence Internationale de l'Energie (IEA) a initié une Tâche portant sur le thème "Solar Heat and Energy Economics in Urban Environments" (Task 52). Cette Tâche a pour but d'analyser le futur rôle du solaire thermique dans les systèmes d'approvisionnement énergétiques en environnement construit. Les travaux de recherche ont été divisés en 3 Sous-tâches parmi lesquelles le CREM a majoritairement contribué à la Sous-tâche B. L'objectif de cette dernière portait sur le développement d'une méthodologie de calcul technique et économique visant à promouvoir l'intégration du solaire thermique en milieu urbain. Pour commencer, deux sondages ont été menés : le premier a permis de collecter les besoins des acteurs urbains relatifs à une intégration du solaire thermique ; le deuxième avait pour but de fournir un descriptif des outils de calcul disponibles/ utilisés par les participants à la Tâche. L'analyse de ces sondages a permis d'identifier le manque d'un outil d'aide à la décision promouvant l'intégration du solaire thermique très amont dans le processus de dimensionnement des concepts énergétiques. Sur ce constat, l'approche suivante en quatre étapes a été développée : après avoir identifié les conditions-cadres d'une situation donnée, un arbre décisionnel a été développé pour guider l'utilisateur dans la présélection d'un concept énergétique (faisant recours au solaire thermique dans la mesure du possible). Pour les cas où un concept intègre du solaire thermique, un outil excel a été développé pour calculer facilement des indicateurs clés tels que : la fraction solaire, les couts estimés et les émissions de CO2 correspondants. La dernière étape permet enfin d'affiner le concept énergétique identifié au travers d'un processus itératif (via le calculateur excel), ou en utilisant des outils plus avancés pour le dimensionnement du concept énergétique retenu. Par ailleurs, la Sous-tâche B a été en fort lien avec la Sous-tâche C où les divers systèmes solaires référencés ont servi de base de données pour le calculateur d'indicateurs solaires. Enfin, plusieurs participants à la Tâche ont fourni un descriptif de 7 bonnes pratiques en matière de systèmes énergétiques intégrant du solaire thermique. Initialement collectés dans le cadre de la Sous-tâche C, ces démonstrateurs ont été utilisés pour tester la méthodologie développée dans la Sous-tâche B. Bien que ce test ne porte que sur 7 cas, les résultats sont suffisamment prometteurs pour promouvoir le fruit de nos travaux en tant qu'approche d'aide à la décision amont pour le choix de systèmes énergétique intégrant le solaire thermique.

# Summary

In January 2014, the Solar Heating and Cooling Programme of the International Energy Agency (IEA) started a Task on "Solar Heat and Energy Economics in Urban Environments" (Task 52). This Task focuses on the analysis of the future role of solar thermal in energy supply systems in urban environments. The research works were divided in three Subtasks, where the CREM's role was mainly to contribute to Subtask B which aims at providing methodologies to support technical and economical calculations for successful integration of solar thermal in urban environments. In this respect, one survey representing the needs of urban actors and one describing the available/known tools amongst the Tasks participants were carried out. This revealed the lack of an early stage decision support tool oriented towards the integration of solar thermal in energy concepts. A four-step methodology was then developed as follows: after having identified the boundary conditions of a given situation, a decision path was developed to guide the user towards the pre-selection of an energy concept (using solar thermal when suitable). In the cases where the latter suggests the use of solar heat, an excel tool was developed to easily calculate key solar indicators like: the solar fraction, the evaluated costs and the related CO2 emissions. The last step consists in refining the initial energy concept through an iterative process, or by using more sophisticated tools to design the final energy concept. Subtasks B had furthermore a strong link to Subtask C, where the realized benchmark on solar systems was used as

database for the solar indicators calculation tools. Lastly, many Task participants described best practice examples of solar assisted systems. The 7 collected cases, primarily aiming at completing Subtask C, were also used to test the developed methodology and tools of Subtask B. Although the test was carried out on the 7 referenced cases only, the results are good enough to promote our work as early stage decision support approach for solar assisted energy systems.

# Appendix

Appendix 1: Subtask B report “Urban Energy Concept : Solar district heating – Methodology and tools”

Appendx 2: Sutask B3 & C2 report “Technology and Demonstrators: Technical Report Subtask B – Part B3”

Appendix 3: Scientific Paper “A methodology to integrate solar thermal energy in district heating networks confirmed by a Swedish real case study”

Appendix 4: The leaflet “Solar thermal applications in urban environment” providing flash light information and impressions about the seven best practice examples

# Contents

# List of abbreviations

| | |
|---|---|
| IEA | International Energy Agency |
| SHC | Solar Heating and Cooling program |

# 1 Introduction

## 1.1 Overall project goal

In January 2014, the Solar Heating and Cooling Programme of the International Energy Agency (IEA) started a Task on "Solar Heat and Energy Economics in Urban Environments" (Task 52). This Task focuses on the analysis of the future role of solar thermal in energy supply systems in urban environments. Based on an energy economic analysis - reflecting future changes in the whole energy system - strategies and technical solutions as well as associated tools were developed. Good examples of integration of solar thermal systems in urban energy systems are also developed and documented.

## 1.2 Background and Key objective

The present research works about Solar Heat & Energy Economics in Urban Environments aims at helping energy consultants, utilities and urban planners to better understand the role of solar thermal systems in energy supply systems of urban environments. This includes the development of long term scenarios for energy supply systems integration fluctuating electric and heat sources and sinks.

## 1.3 Work organization

The Task 52 is composed of 3 subtasks, namely:

- Subtask A: Energy scenarios which goal is to analyze the role of solar thermal in the energy system of urban environments with a horizon of 2050 based on scenarios analyses of energy system.
- Subtask B: Methodologies, Tools and Case studies for Urban Energy concepts which goal is to provide methodologies to support technical and economical calculations for successful integration of solar thermal in urban environments.
- Subtask C: Technology and Demonstrators were best practice examples of mainly renewable-based energy systems (with focus on solar thermal) are investigated in more detail.

## 1.4 CREM’s contribution

Apart from taking part to the bi-annual expert meetings, the main contribution of CREM was related to Subtasks B, and more particularly in:

- Assessing the needs of urban actors (Subtask B1-A);
- Contributing to the development of the methodology (Subtask B1-B);
- Feeding the tools survey (Subtask B2-A);
- Participating to the methodology integration (Subtask B2-B);
- Collecting and describing two best practice examples of solar thermal applications in urban environments (Subtask B3, linked to Subtask C2).

# 2 Methodology and use cases

## 2.1 Methodology

### 2.1.1 Identifying the need for a methodology

Identifying the needs of urban actors and classifying the available calculation tools were the first steps towards the establishment of a methodology aiming at supporting technical and economical calculations for successful integration of solar thermal in urban environments.

The survey on the needs of urban actors identified some key questions amongst different target groups (see Appendix 1, Chapter 7.1). It appeared that there is a common need to provide concept design guidelines at each system scale. And these should furthermore be justified based on consideration like: technical implementation complexity, coherence with the urban plan, architectural constraints, economical benefit, energy savings and climate impact. It appeared also clear from this survey that any scientifically sound guidance won't' be effective without addressing major influencing factors. These factors have the capability to make a technology happen or not, in a given economy and social context.

On the other hand, the tools survey (see Appendix 1, Chapter 7.2) showed the availability of many (pre-)design software's, either from the R&D or from the market, which are already too engineering specific in comparison to the basic identified key questions of the stakeholders. In other words, supporting a successful integration of solar thermal in urban environments is more asking for an early stage screening methodology than detailed system simulations or optimizations.

### 2.1.2 The developed methodology

Based on the above observations, a methodological approach was developed in order to guide stakeholders in the early elaboration of their energy concept. The graphical representation of the demarche is represented on the Figure 1 with the main following steps:

1. Project owner is either obliged or interested to elaborate an energy concept with a solar or renewable fraction in the energy mixt. In order to pre-determine a solar concept, the initial constraints have to be determined. These constraints are varying a lot from a project to another as a function of, for example, the country legislation, the type of needs or the owner's financial capacity. A quite exhaustive list of indicators is shown in this report to support the constraints determination. These indicators are classified in three groups related to the framework, the boundary conditions and the energy system design.
2. Based on the initial constraints of the concept, a decision path (see Appendix 1, Chapter 3) was elaborated to guide the stakeholder in the pre-selection of an energy system. The decision path makes a link between the initial constraints, the available area for solar panel and main energy system classification developed in the subtask C.
3. Using the output of the decision path, an Excel-tool (see Appendix 1, Chapter 4) was elaborated to calculate solar indicators. Based on heated floor area and available area for solar panel, some relevant indicators can be calculated at very early stage of the project. The tool can provide valuable estimation of the solar fraction, cost evaluation of the solar system or gains in the CO2 emissions. Moreover, in order to help the stakeholder in his choices, adapted commercial tools are proposed to address some specifics questions.
4. During this process, new solutions more efficient or more adapted to the situation, can be highlighted. The initial energy concept can be refined and a new run for the determination of the solar indicator can be realized.

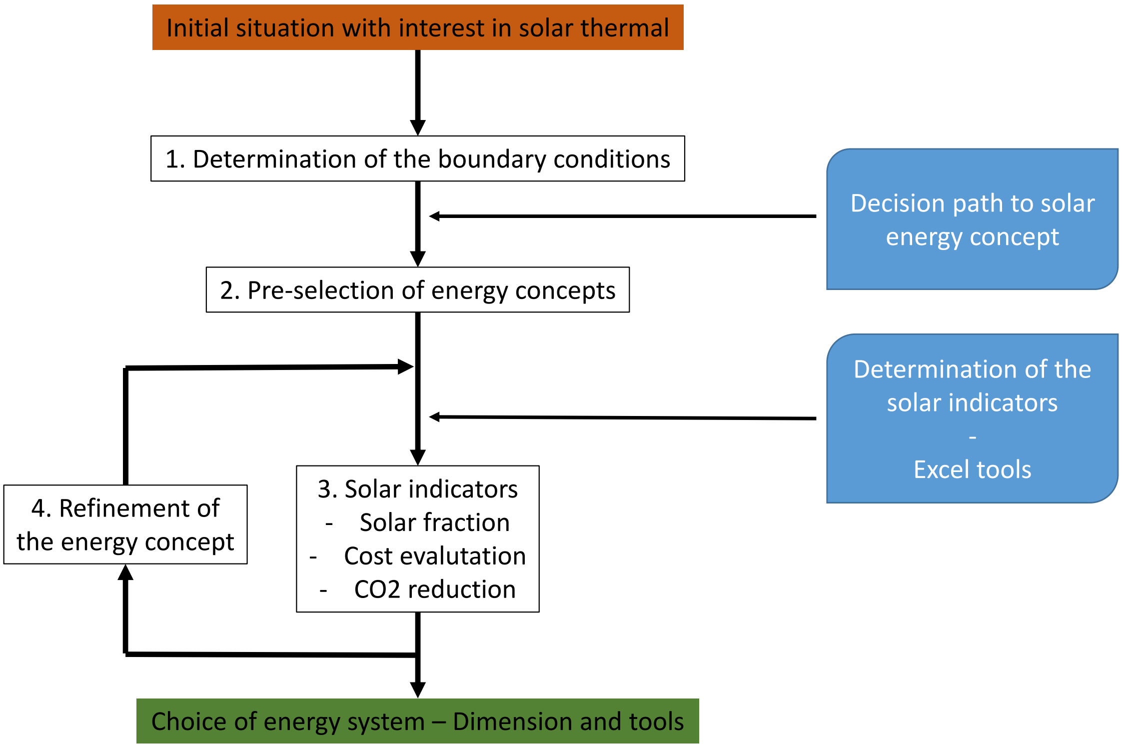


**Figure 1 : Methodological approach: from boundary conditions to indicator energy system comparison.**

The details of this methodology is available in the referenced report and annexes (see Appendix 1).

## 2.2 Use cases

The Excel-tool developed in the methodology is based on the classification and benchmarking works resulting from Subtask C1. In order to test the developed methodology and calculation tool, different cases were required. This exercise was then mutualized with Subtask C2 aiming at analyzing best practice examples of solar thermal applications in urban environments.

In this respect, seven realized best practice examples were compiled (see Appendix 2), out of which two reported from the CREM:

- Solar assisted apartment blocks “La Cigale” in Geneva
- Solar-assisted mountain holiday resort “Reka Feriendorf” in Naters, CH

The best practices were described following an original template which content should serve both Subtask B and C purposes.

# 3 Results and appraisal

The developed methodology with its decision path and excel calculation tool were challenged using the reported best practice example (use cases). During an Expert meeting, this decision path was tested with each participant responsible for a use case. The decision path could always lead to the same concept as the retained one. This means its role to easily guide the user towards the pre-selection of an energy system is achieved; a kind of go/no for concepts promoting solar thermal. In this respect, and although basic, this decision path is qualified as pertinent, especially because it considers both contextual aspects and technical best practice.

The application of the excel calculation tool gives also good results even in terms of economics evaluation (giving more credit to the quality of the benchmark realized in Subtasks C). The less convincing results are linked to a lack of detailed cost information of the best practice examples. Also, some of these reported cases benefitted from subsidies (for being pioneers in the retained solar assisted concept), thus twisting somehow the cost comparison. Related results analysis is available in the referenced report.

To be noted that both the solar assisted benchmark of Subtask C and the compiled best practice examples are related to (northern) European cases. This is directly linked to the panel of experts having participated to the Task 52. It also means that the methodology could not be applied to other southern or non-European situations.

# 4 Dissemination activities

Amongst the various dissemination activities of the Task52, the CREM could contribute to the three following dissemination opportunities:

- a peer-reviewed paper (see Appendix 3): A methodology to integrate solar thermal energy in district heating networks confronted with a Swedish real case study" Martin Joly, Gabriel Ruiz, Franz Mauthner, Paul Bourdoukan, Morgane Emery, Martin Anderson, Paper CISBAT 2017, Lausanne, Switzerland"

- a conference presentation: "A methodology to integrate solar thermal energy in district heating networks confronted with a Swedish real case study" Martin Joly, Gabriel Ruiz, Franz Mauthner, Paul Bourdoukan, Morgane Emery, Martin Anderson, Conference presentation CISBAT 2017, Lausanne, Switzerland"

- a leaflet providing flash light information and impressions about the seven best practice examples (see Appendix 4): "Solar thermal applications in urban environment"

- and a webinar (https://youtu.be/1ffeJ9C1EG8): "S. Herkel, M.Joly, G.Ruiz (moderator), *Energy Economy and Solar Heat – Perspectives and Best Practice*, December 2017, hosted by ISES.

# 5 Conclusions and outlook

The developed methodology, with its decision path and solar indicators calculation tool, provides a simple and efficient decision support for early stage energy system design. This methodology answers an identified lack of pre-selection solutions. Its role is not to promote solar thermal at any cost, but rather to guide the user towards an adequate system selection with the chance to consider solar thermal in its reflexions from the beginning. Key indicators are then easily accessible to help getting better estimate of what could be an achievable integration of solar thermal integration. In this respect, additional work could be done to improve the assumptions made in terms of techno-economic feasibility.

To continue developing the methodology in Switzerland, an extended collection of existing district heating networks should be done with a technical description and cost figures. Based on this, the assumptions of the calculation tool could be improved from one hand. On the other hand, the methodology could be applied to identify which of the existing district heating systems are more suitable to be assisted by solar thermal energy.